RESERVE BANK OF NEW ZEALAND
TE PŪTEA MATUA

Stats NZ
Tatauranga Aotearoa

TE TAI ŌHANGA
THE TREASURY

Regional Activity Indices (RAIs): Technical Note

26 February 2021

Summary

The Regional Activity Indices (RAIs) are a set of experimental indicators that seek to track how regional economies are performing in near real-time. Each regional index summarises 6 monthly indicators of economic activity, covering consumer spending, jobseeker numbers, online job vacancies, traffic volumes (light and heavy vehicles), and electricity demand. They are reported at the level of 14 regional councils – with Nelson, Tasman, and Marlborough combined into one region – and can be updated around 2-3 weeks after the end of each month.

Each individual RAI is a weighted average of its constituent indicators. Specifically, it is the weighted average that best captures the common movement of these indicators. This approach filters out the noise associated with individual indicators, and provides a more comprehensive measure than each individual indicator by itself.

The RAIs have been constructed by staff at the Treasury, Stats NZ and the Reserve Bank of New Zealand (RBNZ). As such, the RAIs should be viewed as an experimental product that is being made publicly available to provide a more granular, and timelier signal of movements in New Zealand's regional economies. As a result of their experimental nature, there are a number of limitations on how the RAIs can be interpreted (see the interpretation guidance that accompanies this note for more details). The indices themselves can be viewed and accessed on the Stats NZ COVID-19 data portal.

Data Sources

The indices make use of 6 monthly indicators of economic activity that are released around 2 weeks after the end of each month (Table 1). This data allows for the construction of 14 separate indices at the regional council level beginning Sept 2011.

Table 1: Data sources and timeliness

Series (monthly)	Source	Sample start
Consumer card spending	Marketview/Paymark	Jan 2010
Jobseeker numbers (work ready)	MSD	April 2004
Online job ads index	MBIE	Sept 2010
Electricity grid demand	Electricity Authority	Aug 2006
Light traffic index	NZTA/Treasury/RBNZ	Jan 2000
Heavy traffic index	NZTA/Treasury/RBNZ	Jan 2000

Methodology

The methodology used to construct the RAIs is based on *Principal Component Analysis* (PCA), and is commonly used in empirical macroeconomics. It is essentially the same methodology used by the Federal Reserve Bank of Chicago to construct the Chicago Fed National Activity Index (CFNAI). The methodology is also very similar to that used for the construction of the New Zealand Activity index (NZAC) – with some notable exceptions (see limitations section below).

There are two key steps involved in the construction of the RAIs from the raw input indicators, (1) input preparation, and (2) application of the PCA algorithm:

1. Input preparation

- *Indicator-specific treatments*. Each of the six indicators are gathered from different sources, and at different levels of disaggregation. As a result, several of the inputs require basic treatments (e.g., aggregation) to yield a comparable set of time-series at the regional council level. These treatments are covered in Annex 1.
- *Conversion to annual percentage changes (apcs)*. Once prepped, each of the six indicators is converted into annual percentage changes. This serves to (1) convert each indicator from a 'levels' interpretation to a 'growth' interpretation, and (2) provide a simple method of removing seasonality from the levels data.
- *Mean/variance standardisation*. The raw indicators represent completely distinct measures of economic activity, each with their own specific units (e.g. dollars spent, number of vehicles, Gigawatt hours etc). These indicators all grow at intrinsically different rates, and have intrinsically different volatilities. The mean/variance standardisation is needed to adjust for these differences, and ensures that all the input indicators can be meaningfully compared and weighted on the *same scale*.

The apc and mean/variance transformations are particularly noteworthy, as these transformations dictate aspects of how the indices are interpreted. As a result, the effects of these transformations are covered in more detail in Box 1 below (also see the Interpretation Guidance that accompanies this document for more details).

2. Principal Component Analysis

Once all the input indicators have been prepared, they can be passed to the PCA algorithm, which is a standard routine in the machine-learning / empirical macroeconomics literature. At an intuitive level, PCA seeks to condense the information from a (potentially large) number of input indicators into a smaller set of representative 'components', whilst minimising the amount of 'information' that is lost in the process. It does this by seeking weighted averages of the input data that capture as much of the *co-movement* between the input indicators as possible.

For the construction of the RAIs, we focus on the *first principal component* – that is, the 'highest-ranking' weighted average that captures the largest amount of the co-movement between the input indicators. This process amounts to condensing the information from 6 underlying input indicators into one summary index. As such, the Regional Activity Index represents the 'common movement' of its constituent indicators. Annex 2 shows the RAIs obtained after performing the PCA.

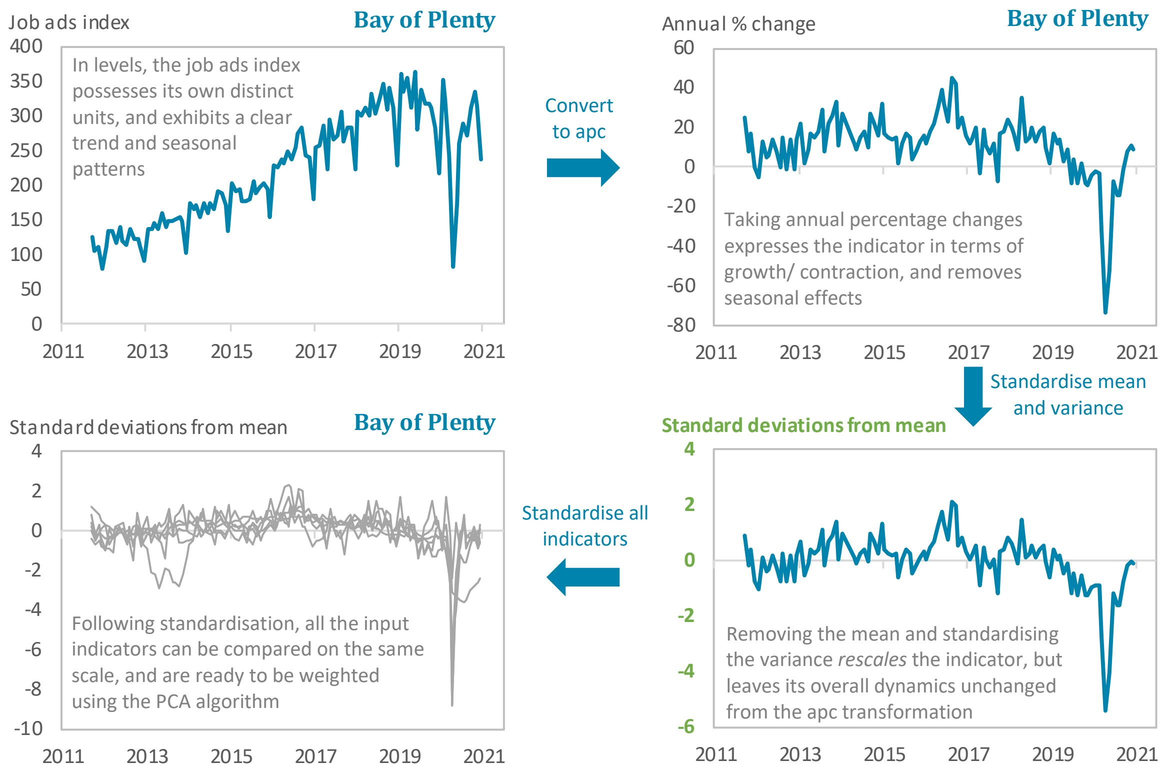
Given the diverse set of indicators that make-up the index, the RAIs can be interpreted as a summary measure of the economic fundamentals that drive its constituent indicators. Under this interpretation, the RAIs enable us to track the historical evolution of economic conditions in different regions of New Zealand.

Box 1: Indicator transformations: annual percentage changes and mean/variance standardisation

As mentioned in the main text, the following two transformations are important, as they influence the interpretation of the RAIs.

Annual percentage changes

This transformation serves two purposes. Firstly, it converts each indicator from a 'levels' interpretation to a 'growth' interpretation. For example, after the apc conversion the online job ads series represents 'the year-on-year percentage growth (or contraction) in online job advertisements. Secondly, the apc conversion serves as a particularly simple method for removing any seasonal patterns in the data (as growth is measured with respect to the same month in the preceding year).



Mean/variance standardisation

Even after conversion to annual percentage changes, the different indicators will have different average rates of growth(/contraction), and even more importantly – they will have different volatilities. For example, electricity usage tends to be much more volatile (even in apc terms) than say jobseeker numbers. Left untreated, this will have a significant impact on the PCA weightings – causing the most volatile variable(s) to dominate over those that are less volatile. The second transformation is therefore to *standardise* the mean and variance (i.e., volatility) of each series. This is performed by taking each series (in apc terms), subtracting its mean, and dividing by its standard deviation, so that each series now has a mean = 0, and standard deviation = 1). The result of this transformation is threefold:

1. *Deviations from mean interpretation*: the result of subtracting the mean is that – after transformation – each indicator is now expressed in terms of the deviation from its mean.
2. *Normalised variance/volatility*: this adjusts for the intrinsic differences in volatility that are present in different indicators. Dividing each indicator (in apc terms) by its standard deviation normalises each series for its intrinsic volatility.
3. *Removal of units*: a secondary effect of dividing by the standard deviation is that this operation cancels out the percentage change interpretation of the indicators. Each series is now interpreted in terms of 'the number of *standard deviations* from its mean'.

The combination of these three effects is what enables an otherwise distinct set of indicators to be plotted on the same scale, and for them to be meaningfully compared and weighted.

Limitations

Regional input data is limited

The RAIs should be treated as an experimental product. This is largely due to data limitations surrounding the underlying regional input indicators. In particular, the scope of the regional input data is relatively limited (only six indicators), and only available over a relatively short time horizon (Sept 2011 to present). Similar indices in other countries typically have access to many more indicators, and over a much longer timespan. Furthermore, some of the underlying input indicators are relatively volatile – most notably traffic flows and electricity usage.

These limitations mean that the RAIs can be sensitive to particularly large movements in one or two of the base indicators. Such movements will not always be reflective of broader economic fundamentals, and so can trigger misleading or false signals of changes in activity.

Such misleading and/or false signals can usually be exposed by analysing the movements of the underlying input indicators for the region in question. This process of 'unravelling the indices' is especially advisable when there is a large swing/spike in one or more of the indices.

We can't scale the RAIs in the same way as NZAC

Another technical limitation with the RAIs – and a key difference from NZAC – is the scaling and interpretation of the regional indices. Specifically, with NZAC we are able to scale the raw index obtained through PCA by the mean and standard deviation of year-on-year real GDP growth. This enables us to analyse movements in NZAC in the more familiar units of real GDP growth. As well as enabling a more intuitive reading of the index, calibrating movements in NZAC to movements in real GDP growth in this fashion allows us *some* – albeit limited – insight into when the economy might be expanding/contracting based on movements in NZAC.

Unfortunately, this type of scaling is not currently possible for the RAIs. The key reason for this is a lack of appropriate regional data with which to perform a reliable scaling. Specifically:

- the regional GDP data reported by Stats NZ is only compiled at an annual level of aggregation (whereas national GDP is reported quarterly); and
- the regional indices span a shorter time horizon than NZAC (Sept 2011 to present for the RAIs, as opposed to October 2003 to present for NZAC).

These two factors mean that there are far fewer observations with which to perform a regional scaling (only 9 annual observations for the regional indices, vs around 70 quarterly observations for NZAC).

Furthermore, regional GDP is only reported in nominal terms. Nominal GDP growth is not well-suited to scaling the RAIs, as it conflates real economic growth with price growth. As inflation is not measured on a regional basis, there is no reliable way to adjust regional GDP for local price movements to obtain a *real* measure of regional economic growth.

These constraints dictate why the RAIs must be presented in the form a unit-free, 'pure index'. If some other suitable measure of regional economic activity existed, that (a) reliably indicates whether the economy is expanding or contracting, and (b) is reasonably well correlated with the RAIs, then the RAIs could be calibrated to that measure.

Results

Each RAI is estimated independently. As such, the weights of the component indicators differ from region to region (see Table 2). To highlight the starkest example, electricity grid demand receives a negligible weight in the West Coast – where electricity usage is highly influenced by some large-scale industrial activities – and is not therefore highly correlated with other economic variables in that region. By contrast, grid demand receives a much higher weight in Northland, where electricity usage apparently moves much more in sync with other indicators. In general, the co-movements between economic variables will differ (perhaps substantially) from one region to the next, and so the relative weighting of the underlying indicators in the regional indices will also differ.

Table 2: PCA weights

Region	Consumer card spending	Electricity grid demand	Online job advertisements	Jobseeker numbers (work ready)	Light traffic	Heavy traffic
Northland	0.44	0.39		0.31	0.50	0.41
Auckland	0.48	0.32		0.34	0.46	0.39
Waikato	0.45	0.19		0.34	0.48	0.48
Bay of Plenty	0.46	0.18		0.36	0.48	0.43
Gisborne	0.54	0.12		0.26	0.53	0.49
Hawke's Bay	0.50	0.36		0.26	0.50	0.36
Taranaki	0.52	0.16		0.26	0.50	0.47
Manawatū-Whanganui	0.44	0.34		0.20	0.49	0.50
Wellington	0.47	0.20		0.25	0.50	0.48
Tasman/Nelson/Marlborough	0.48	0.23		0.26	0.51	0.47
Canterbury	0.48	0.11		0.40	0.50	0.45
West Coast	0.50	-0.01		0.31	0.54	0.50
Otago	0.49	0.16		0.40	0.48	0.40
Southland	0.53	0.22		0.41	0.51	0.18

Note: The precise weights for online job advertisements have been suppressed until this data can be released publicly.

Consumer card spending and light traffic receive consistently high weights across all 14 regions (~0.5), indicating that these two variables share a strong co-movement. These are followed by online job advertisements and heavy traffic, which also tend to receive a relatively strong weight (~0.4). Jobseeker numbers receive a moderate weight (~0.2-0.4). Electricity grid demand is the most variable indicator, ranging from effectively a zero weight in the West Coast, to >0.3 (reasonably strong) in Northland, Auckland, Hawke's Bay, and Manawatū-Whanganui[1].

Table 3 presents the proportion of the 'total variance' that is explained by the RAI (i.e., the first principal component) in each region. Loosely speaking, this measure gives an indication of how much 'information' (in terms of the variance of the original indicators) is lost/thrown-out by collapsing the data down to just the first principal component. As should be expected, there is a much stronger co-movement between the constituent indicators in some regions compared to others. As a result, the proportion of variance explained ranges from just below 45% (West Coast), to above 65% (Auckland). In general, we consider these results to be

[1] Note that PCA does not constrain the weights to sum to one.

reasonable – with the caveat that users would do well to bear in mind that the RAIs are likely to give a better signal of economic dynamics in some regions more than others.

For comparison, the national NZAC explains about 55-60% of the total variance of its constituent indicators (though note that NZAC is based on 8 indicators as opposed to 6).

Table 3: PCA proportion of variance explained

Region	Proportion of total variance explained (%)
Northland	56
Auckland	67
Waikato	65
Bay of Plenty	62
Gisborne	44
Hawke's Bay	54
Taranaki	48
Manawatū-Whanganui	57
Wellington	57
Tasman/Nelson/Marlborough	55
Canterbury	53
West Coast	44
Otago	58
Southland	44

Annex 1: Indicator treatments

<table>
<tr><th>Indicator</th><th>Treatments/preparation</th></tr>
<tr><td>Consumer card spending</td><td>Consumer card spending in the Nelson, Marlborough and Tasman regions are aggregated into a single region.</td></tr>
<tr><td>Electricity grid demand</td><td>Reconciled grid demand data at the level of individual nodes (ie, grid junction points) is publicly available online from the EMI portal. These nodes are mapped to the 14 regional council level using a concordance developed by Stats NZ.</td></tr>
<tr><td>Online job advertisements</td><td>The online job advertisement indices are computed by MBIE at the 14 regional council level, based on data provided by Trademe and SEEK. No further treatment is required.</td></tr>
<tr><td>Jobseeker numbers (Work Ready)</td><td>The latest counts of Jobseeker Work Ready claimants are publicly available online from the MSD website. These are joined to a historical series of jobseeker claimant numbers provided to us by MSD.

As the benefit system has changed over the time period covered by the RAIs (most notably in 2013), this historical series provided by MSD contains modelled estimates of the number of claimants that would have been eligible under the current system pre-2013.

Also note that as the COVID-19 Income Relief Payment (CIRP) likely offset a much larger increase in the number of Jobseeker Work Ready claims, we add the number of CIRP claims to the JS Work Ready counts for the duration that the CIRP was active.

For estimation and graphing, we reverse the sign of the Jobseeker deviations so that these deviations move in the same direction as the other economic variables (i.e. dips in a contraction). This does not affect the magnitude of the PCA weights, only the sign.</td></tr>
<tr><td>Light traffic</td><td rowspan="2">Detailed daily data on traffic counts is available from the NZTA open data portal. This data is reported at the level of individual monitoring sites, and includes both national telemetry, and regional continuous sites.

Daily traffic counts at these sites are aggregated to the monthly level, and mapped to regional councils. The monthly counts for all sites within each region are then summed, to obtain a measure of total monthly vehicle flow within each region. From here the data is processed in the same manner as the other indicators (i.e. the data is converted into annual percentage changes, and then standardised).

Note that due to the uneven arrival of traffic data each month, the number and identity of sites included will vary from month to month.</td></tr>
<tr><td>Heavy traffic</td></tr>
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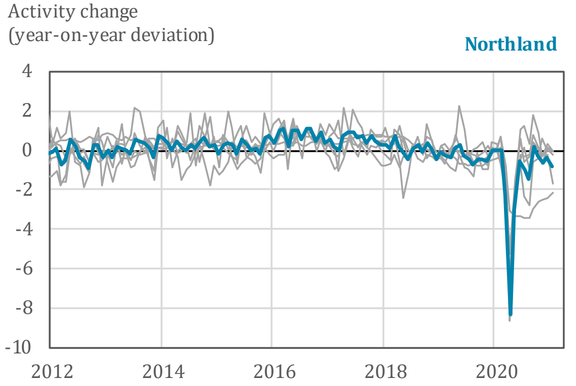
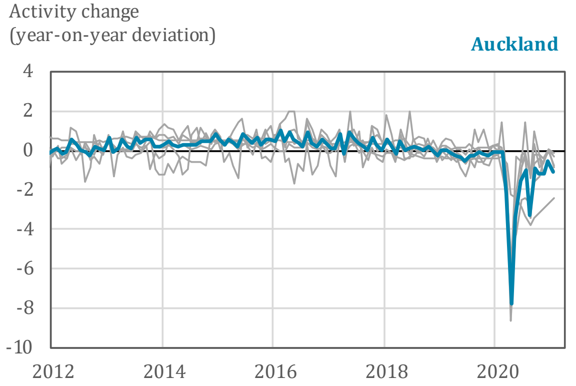
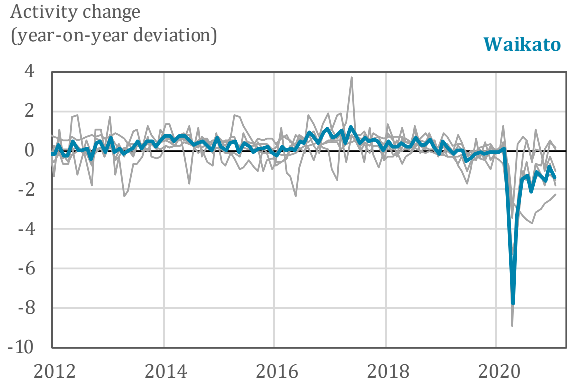
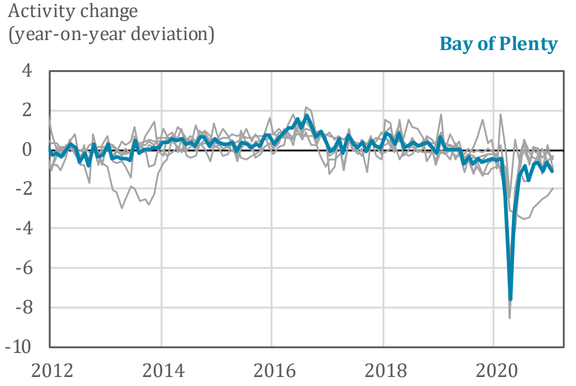
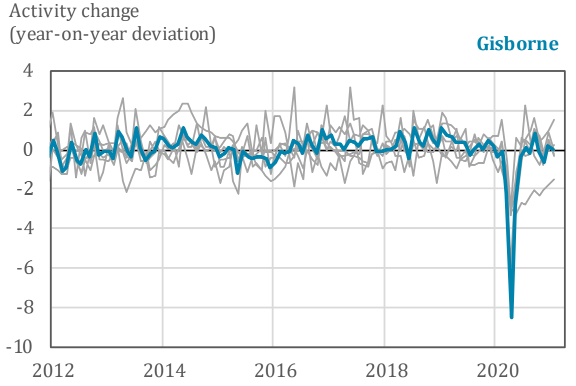
Annex 2: Regional Activity Indices (Jan 2021)

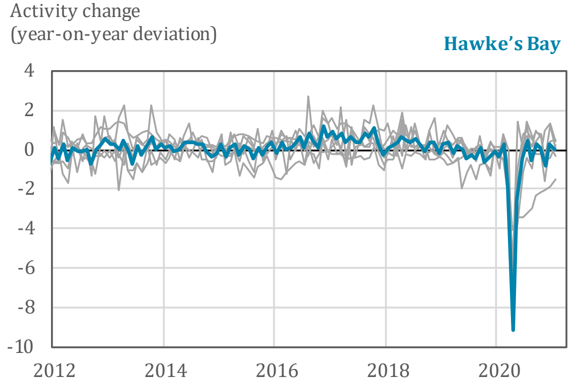


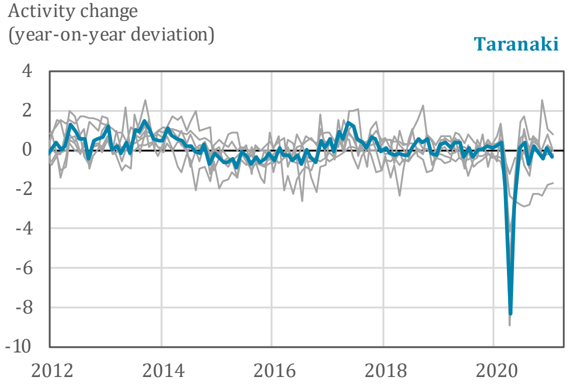


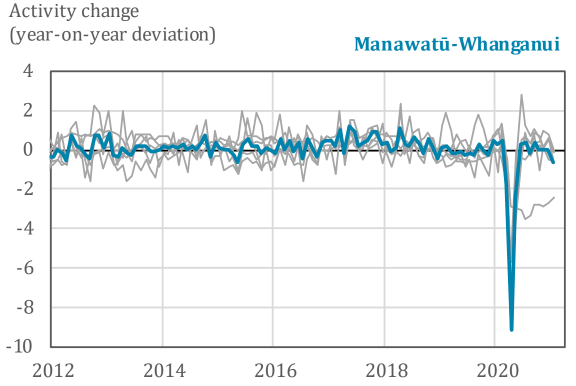


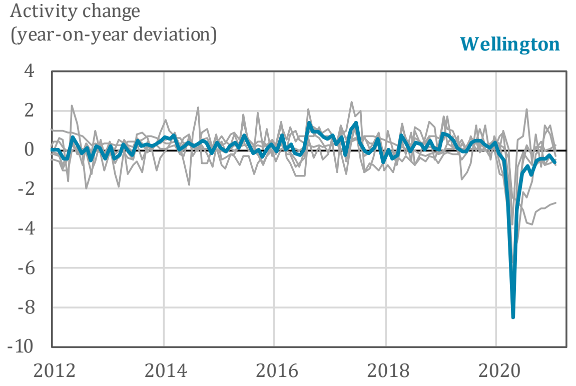


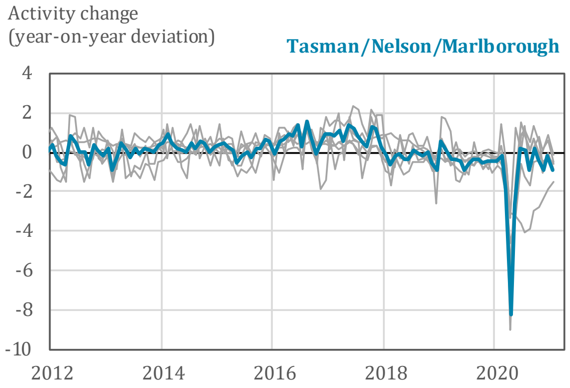











Activity change
(year-on-year deviation)
Tasman/Nelson/Marlborough
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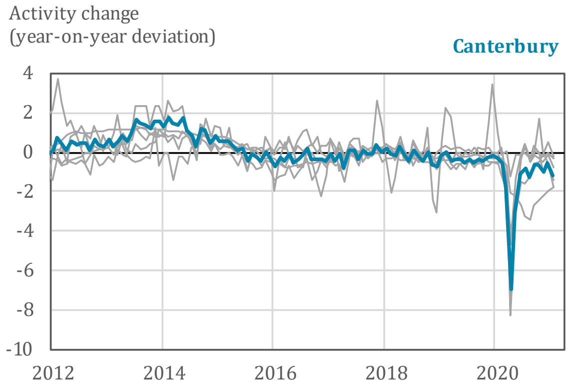
-4
-6
-8
-10
2012
2014
2016
2018
2020


Activity change
(year-on-year deviation)
Canterbury
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-2
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-8
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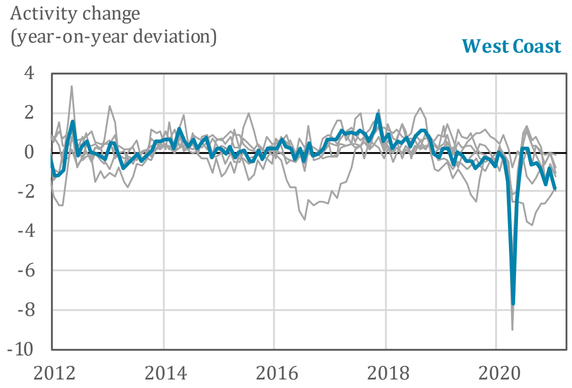
Activity change
(year-on-year deviation)
West Coast
4
2
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-2
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2012
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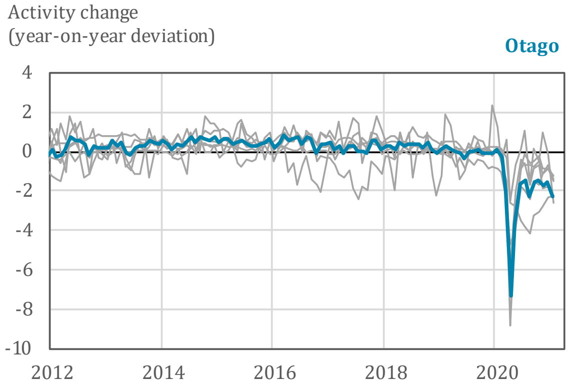
Activity change
(year-on-year deviation)
Otago
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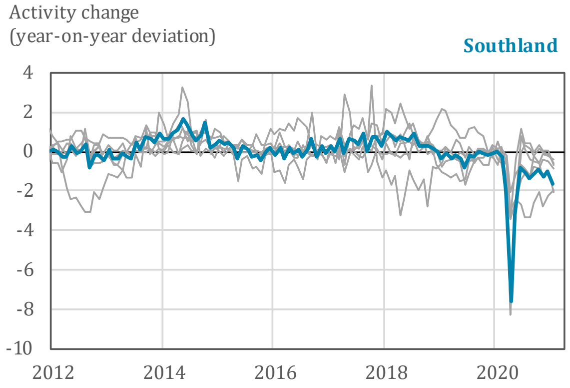
Activity change
(year-on-year deviation)
Southland
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2012
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2020