Changes in New Zealand's Business Insolvency Rates after the Global Financial Crisis

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Abstract

We examine the question of whether the rate of business insolvencies in New Zealand is related to overall macroeconomic conditions. In particular, our interest is in whether the rate of business insolvencies changed in the wake of the Global Financial Crisis (GFC). We find that there was a large increase in insolvencies in New Zealand following the onset of the GFC in 2008. We also find that the timing of the change did not occur uniformly over the country but occurred at different times in four key regional centres. Sharply rising relative costs were the most important macroeconomic factor influencing corporate insolvencies in New Zealand, Auckland, Waikato and Wellington, but have been immaterial in determining New Zealand's total personal insolvencies. It is employment growth and house price inflation that have been significant in explaining total personal insolvencies.

JEL codes

G33; E32; R11

Keywords

Bankruptcy; business cycles; structural breaks; New Zealand; Global Financial Crisis

Summary haiku

Businesses do fail.
Things get worse in recessions
as costs rise sharply.

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Tables and Figures

1 Introduction

Business failures occur all the time and there are many firm-specific reasons why businesses fail. However, it seems reasonable to think that the rate of failures is also related to overall macroeconomic conditions. The sharp impact of the Global Financial Crisis (GFC) on the New Zealand economy provides a suitable context in which to assess this idea. In particular, we are interested in whether the rate of business insolvencies in New Zealand, as measured by corporate and total personal insolvencies, changed in the wake of the GFC[1]. Further motiving this idea is the finding that properties of the expansion phases of the New Zealand business cycle have been found different from those for contraction phases (Hall and McDermott, 2009, 2016). To our knowledge this combination of issues has not been tested elsewhere.

A salient feature of New Zealand's insolvencies' data is the coincidence in timing of spikes in insolvencies and adverse developments in the business cycle. It is possible that an increase in insolvencies leads to reduced labour demand and increased nervousness among credit providers, which in turn leads to a decline in aggregate output and some downward pressure on residential house price inflation. Conversely, the opposite direction of causality may also be possible, a decline in aggregate output may make risky business propositions less viable and lead to more bankruptcies. In this paper, we do not take a firm stand on the direction of causality; rather we place primary emphasis on establishing the extent to which New Zealand's macroeconomic environment has been associated with business insolvencies

We are also interested in whether any change in the bankruptcies occurred uniformly over the country or not, as Hall and McDermott (2007) have established that there are distinct regional business cycles within New Zealand, and Fabling and Grimes (2005) have found that, for a sample period prior to the GFC, regional economic activity and asset values have been important transmitters of area-specific shocks to regional insolvencies.

Further, it is of consequence that New Zealand has a dearth of monthly macroeconomic data which can be used to monitor and understand the business cycle. An important exception is the monthly data on personal and corporate insolvencies published since 2003 on the New Zealand Insolvency and Trustee Service's website[2]. We are therefore additionally interested in the extent to which this and companion data are useful in helping us understand particular business cycles.

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[1] Much previous business cycle work for New Zealand's post-Second World War period has been focussed on identifying and explaining movements in classical business cycles, e.g., Hall and McDermott (2007, 2009, 2016), Reddell and Sleeman (2008), and Williams (2017a, 2017b). The latter two papers focus particularly on the GFC period and its aftermath. Fabling and Grimes' (2005) study, examining the determinants of forced insolvency in New Zealand at national and regional levels, is for a sample period prior to the onset of the GFC.

[2] https://www.insolvency.govt.nz/support/about/statistics.

Our approach can be seen in the context of pre-GFC work on the impact of macroeconomic variables on corporate insolvencies in the U.K. and the U.S., and the pre-GFC study for New Zealand by Fabling and Grimes (2005).

The U.K. and U.S. studies can be traced back to Altman (1971), and subsequent papers by Wadhwani (1986), Platt and Platt (1994), Vlieghe (2001), Lui and Wilson (2002), and Dunis and Triantfyllidis (2003)[3]. Their key statistically significant macroeconomic variables include measures of economic activity or employment, various determinants of profits, a direct or proxy measure for inflation, a debt/GDP or provision of credit/GDP ratio, and a property price/GDP ratio. Findings from these studies of particular relevance to this study include Wadhwani's (1985) conclusion that, in the absence of index-linked loans, inflation (via nominal interest rates) had been significant in raising bankruptcy rates and default premia, especially if a firm did not have access to external capital. Vlieghe (2001) also included the nominal interest rate to reflect any effects of inflation. Platt and Platt (1994) chose an employment rather than an aggregate economic activity variable to reflect changes in economic activity. Also of potential interest is a key finding of Vlieghe (2001). In the context of a dataset that includes the U.K.'s early-1990s five-quarter recession and subsequent recovery, and the unprecedented spike in the corporate liquidation rate in the U.K. in 1992, he finds that the main determinant of liquidation rates in the late 1980s was the rapidly increasing level of indebtedness, whereas post-1992 the liquidation rate decrease was primarily due to lower interest rates, lower real wages and the cyclical recovery of GDP.

Fabling and Grimes (2005) pre-GFC work for New Zealand used an adapted version of Vlieghe's (2001) theoretical model, was estimated in long run and dynamic form using panel data methods, and utilised data at the aggregate and at regional levels. The key macroeconomic variables that they find explain insolvencies are aggregate/regional economic activity, financial variables, CPI inflation and, for the regional panel but not at the aggregate level, collateral-related regional property price variables.

Our work can be distinguished from that of Fabling and Grimes (2005) and the aforementioned other previous studies in two ways, Firstly, this is because we focus on insolvencies before and after New Zealand's GFC-related five-quarter recession from 2008q1 to 2009q1[4]. Secondly, we utilise methodology which acknowledges well-known asymmetric business cycle behaviour. In particular, our methods first search for any GFC-related structural break, and then our count data regression models are used to explore relationships between business insolvencies and key macroeconomic activity variables.

We conduct our investigation in two parts. First, in section 2, we examine the time series properties of business insolvencies in New Zealand and for four key regional centres. In

[3] A theoretical model justifying the assessment of macroeconomic variables can be found in Vlieghe (2001), who acknowledges his model as a stylised version of Wadhwani (1985) and in the style of Scott (1981).
[4] Hall and McDermott (2016, Table 1).

particular, we search for any structural break in the rate of insolvencies using a Poisson model. Second, in section 3, we use Poisson and negative binomial regression models of business insolvencies where national and regional insolvencies are a function of macroeconomic variables such as employment growth, business credit growth, consumer goods and services inflation, house price inflation, terms of trade changes, and a relative cost shock variable. Section 4 concludes the paper.

2 Testing for Changes in the Rate of Insolvencies

2.1 Data

Our monthly data for business insolvencies span the period July 2003 to November 2018[5]. We focus primarily on the Insolvency and Trustee Service (ITS) Corporate Insolvency statistics, published for New Zealand as a whole and for our four regional centres [6]. But because an exceptionally high proportion of New Zealand's businesses are small and medium enterprises (SMEs), and because a very substantial number of these SMEs have business loans secured as collateral over personal assets such as residential housing[7], we have also utilised the Total Personal Insolvency Statistics for New Zealand, to benchmark these results against those from the ITS corporate insolvency statistics[8].

Figure 1 provides time series plots for New Zealand, for both the number of corporate insolvencies and the number of personal insolvencies, from July 2003 until November 2018. The latter figures are made up from personal bankruptcies, "no asset procedure" applications accepted and "summary instalment order" applications accepted. The solid line with the scale on the left shows monthly corporate insolvencies while the dotted line with the scale on the right shows the number of personal insolvencies. The Figure reveals that there was a sharp increase in the numbers of both corporate and personal insolvencies during 2008, consistent with our *a priori* expectations that the GFC and New Zealand's associated recession, would have resulted in

[5] It is not possible to start our sample period prior to July 2003, due to an observable discontinuity in company liquidations/insolvency data series around 2003. The lack of consistency between the former involuntary company liquidations series as utilised by Fabling and Grimes (2015) for the sample period 1988q1 to 2003q2, and the currently published corporate insolvency statistics would seem associated with: (1) New Zealand government Minister Lianne Dalziel's announcement of 18 February 2003 of projected Insolvency Law changes; and (2) the New Zealand Companies Amendment Act 2006, s 6, being subsequently inserted on 1 November 2007 into the Companies Act 1993 in Part 15A (Voluntary Administration).

[6] https://www.insolvency.govt.nz/support/about/statistics/corporate-insolvency-statistics/monthly-its-administered-liquidations/. Insolvency data on this website are listed by the regional centre they are lodged in but we label them by region so as to align their terminology with other data we use in the paper.

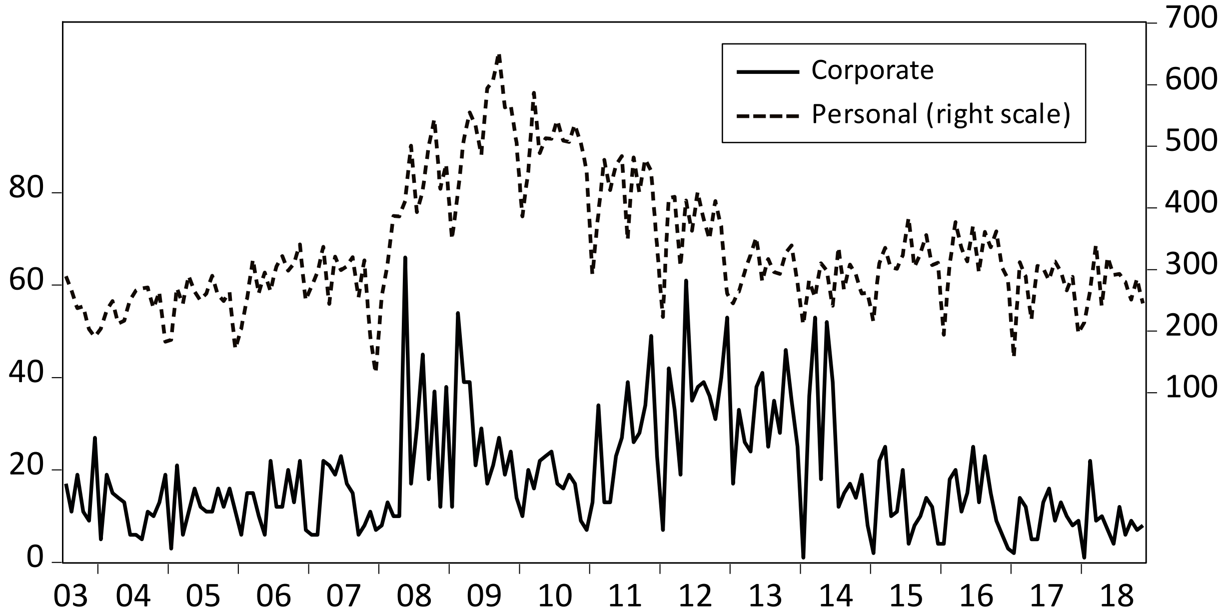
[7] For detail on these two aspects, see Fabling and Grimes (2005).

[8] https://www.insolvency.govt.nz/support/about/statistics/insolvency-procedure-statistics/monthly-bankruptcy-figures/. Unfortunately, associated with the passing of the Insolvency Act 2006 implemented on 3 December 2007, and the administering and reporting on the sizeable numbers of accepted "no asset procedure" insolvencies being passed to the Official Assignee, total personal insolvency numbers for our four regions are not published consistently for the full sample period.

an increase in insolvencies[9]. After a brief lull in the number of corporate insolvencies, a further increase took place in 2012 before returning to a more 'normal' level a couple of years later. In contrast, personal bankruptcies stayed high after the initial surge before slowly returning to more normal levels over a 5-year period.

Figure 1 shows the number of monthly insolvencies to be volatile. Table 1 summarises some key features of the associated data. The median number of corporate insolvencies is 15 per month across New Zealand, of which around half are in Auckland. There does not appear to be any trend in the data, and there is some variation in the persistence. Corporate bankruptcies recorded in all four regional centres have first-order autocorrelation coefficients less than 0.5 and half-lives less than one month. The national data for both corporate and personal insolvencies shows some degree of persistence, with the half-life of a shock being more than three months.

Figure 1: Monthly Insolvencies in New Zealand 2003 (July) to 2018 (November)



The coefficient of variation shows that Waikato has the greatest volatility, and although Wellington's volatility is also high this appears to be the result of a single episode. Substantial month to month variability is evident for the Canterbury and Auckland regions, while variability is somewhat less so for corporate New Zealand, and very much less so for personal insolvencies, the latter perhaps due to its considerably greater occurrence.

A key feature of the data is that insolvencies are a discrete variable and so a natural way to think about the data is as if the count of insolvencies follows a Poisson process. For that to be a

[9] The GFC is believed by many to have begun from July 2007 with the U.S. credit crunch, and by others to have related more directly to Lehman Brothers filing for Chapter 11 bankruptcy protection on 15 September 2008.

reasonable assumption we would expect the mean to be close to the variance (and so the coefficient of variation to be less than 1 when the mean is greater than 1). However, this assumption does not hold in the data as the variance seems to increase in the wake of the GFC. Therefore, we later examine whether the insolvency data follows a Poisson process but with a structural break. The histograms of the data presented in the Appendix as Figure A1 do show a Poisson-like distribution.

Finally, the last two columns report skewness and kurtosis, measures that should be close to zero and three for a normal distribution. There is positive skewness in all regions, because there are relatively fewer downward spikes to match the pronounced upward spikes. Wellington business bankruptcies display substantial kurtosis, with tails much thicker than those of the normal distribution.

Overall, Table 1 shows that the data we are working with are somewhat autocorrelated, and display noticeable variability, skewness, and kurtosis. Text-book business cycles are often illustrated in terms of degree of over or under utilisation of capacity that moves symmetrically around a trend. However, just as New Zealand's post-war classical business cycles have been shown as markedly asymmetric, with all contraction phases from the 1960s being considerably shorter than their corresponding expansion phases[10], so the data for insolvencies also seem to be asymmetric. More specifically, there appears to be a normal rate of insolvencies during the expansion prior to the GFC-related business cycle, with that normal rate then being interrupted by a spike in insolvencies associated with the onset of that recession.

The non-normality of the data is one of its most striking features, and so the modelling strategy we have chosen has to be sufficiently flexible to account for this feature.

Table 1: Key Time Series Features of Total Personal and Corporate Insolvencies Data, 2003 (July) to 2018 (November)

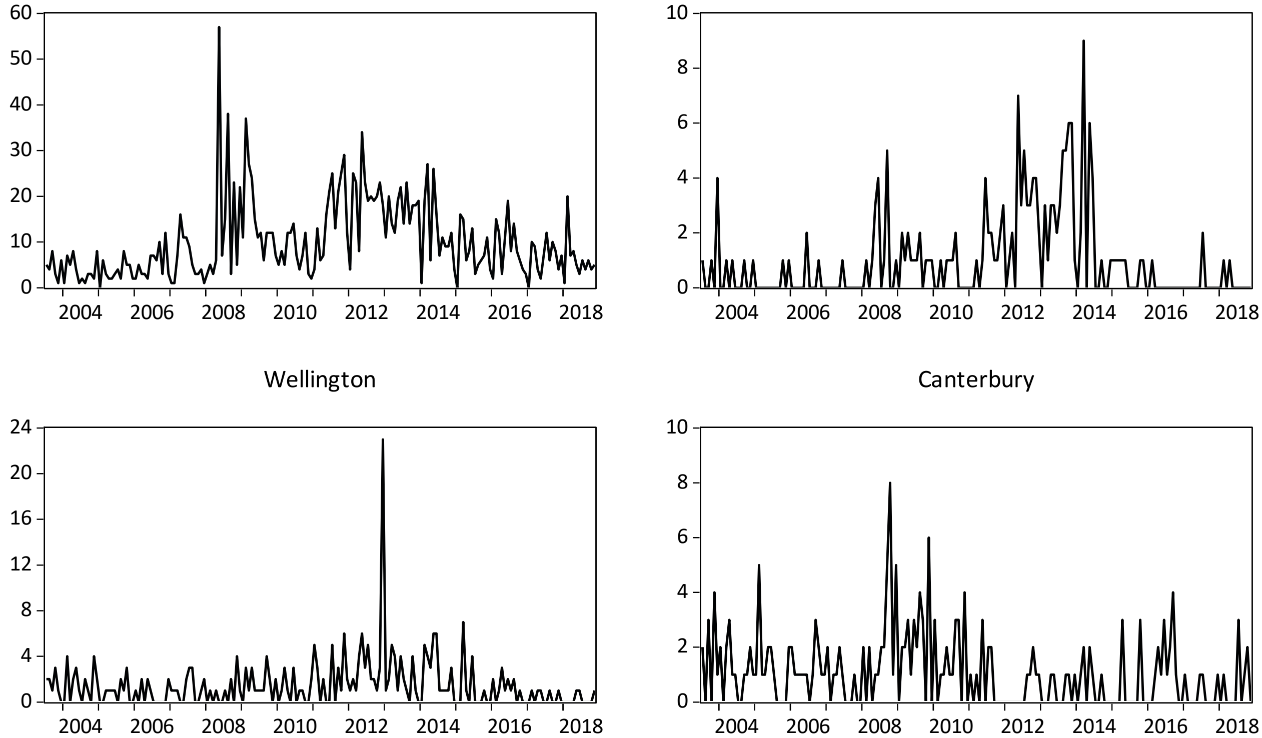
	Mean/ Median	**autocorr.**	**Persistence**	**Coeff. of variation**	**Skewness**	**Kurtosis**
New Zealand #	332/305	0.81	3.43	0.31	0.88	3.20
New Zealand	18.6/15	0.82	3.39	0.67	1.25	4.39
Auckland	9.9/7	0.36	0.67	0.84	1.78	8.06
Waikato	0.9/0	0.41	0.77	1.64	2.28	8.74
Wellington	1.5/1	0.11	0.31	1.52	5.35	49.21
Canterbury	1.1/1	0.12	0.33	1.26	1.83	7.66

Notes: "New Zealand #" refers to total personal insolvencies while other labels refer to corporate insolvencies. "autocorr." is the first order autocorrelation coefficient. Persistence is the half-life of a shock to an AR(1) model, interpreted as a measure of the degree to which shocks persist; it is measured using $\ln(0.5)/\ln(\alpha)$, where α is the coefficient of the AR(1) model. "Coeff. of variation" is the ratio of standard deviation to the mean.

[10] Hall and McDermott (2016, Table 1)

Figure 2 shows a panel of four time series plots of corporate insolvencies for the regional centres of Auckland, Waikato, Wellington, and Canterbury. The Figure reveals that substantial changes in the insolvencies in each region seem to occur at different times. There is a distinct increase in insolvencies in Auckland following the GFC but increases seem to occur later in Waikato and Wellington. Canterbury shows a short sharp increase around the time of the GFC but there then appears to be a lower rate of insolvencies in subsequent years. Their autocorrelation, volatility, skewness, and kurtosis characteristics reported in Table 1 can be seen reflected in Figure 2.

Figure 2: Monthly Corporate Insolvencies in Four Regions of New Zealand 2003 (July) to 2018 (November)



2.2 Model and Estimation Method

Our insolvencies data is discrete and comes in the form of the number of insolvencies in a fixed interval (here monthly). A Poisson random variable is one whose distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time. It is therefore natural to use a Poisson distribution to model our insolvencies data.[11]

[11] One drawback of the Poisson model is that it imposes the assumption of mean-variance equality which is clearly violated in the sample we have. It is possible to relax this assumption by using a negative binomial distribution at the cost of introducing another parameter to be estimated. The negative binomial would also be appropriate if insolvencies are contagious since contagious insolvencies have positive correlated occurrences causing larger variances than if the occurrences were independent. That said, the salient feature of the data is the sharp change in

We assume that the number of insolvencies in a given region per month follows a Poisson distribution with mean rate θ until the *k*-th year. After the *k*-th year, the number of insolvencies follows a Poisson distribution with mean rate λ. Let Y_t be the number of insolvencies in a given region in month *t*, then

$$P[Y_t = y] = \begin{cases} \dfrac{e^{-\theta}\theta^y}{y!} & t = 1, \dots, k \\ \dfrac{e^{-\lambda}\lambda^y}{y!} & t = k+1, \dots, n \end{cases}, y = 0,1,2, \dots,$$

Further assume that θ and λ can be modelled as Gamma distributions with probability density function

$$f(x; a_i, b_i) = \frac{a_i e^{-a_i x}(a_i x)^{b_i - 1}}{\Gamma(b_i)}, x \geq 0, i = 1,2$$

where *i*=1 refers to the parameters for the model for θ and *i*=2 refers to the parameters for the model for λ. We also assume that, in turn, the parameters can be modelled as Gamma distributions with probability density function

$$f(x; c_i, d_i) = \frac{c_i e^{-c_i x}(c_i x)^{d_i - 1}}{\Gamma(d_i)}, x \geq 0, i = 1,2$$

where *i* refers to the parameters for the models for b_i. In addition, we assume a discrete uniform distribution for the parameter *k*.

Such a model yields the conditional distributions $f(\theta|Y, \lambda, , b_1, b_2, k)$, $f(\lambda|Y, \theta, b_1, b_2, k)$, $f(b_1|Y, \theta, \lambda, , b_2, k)$ and $f(b_2|Y, \theta, \lambda, , b_1, k)$. Each of these conditional distributions are gamma distributions with the shape and scale parameters reported in Table 2.

Table 2: Conditional distribution and parameters used in the Gibbs sampler

Conditional distribution	**Shape parameter**	**Scale parameter**
$f(\theta\|Y, \lambda, , b_1, b_2, k)$	$a_1 + \sum_{t=1}^{k} Y_t$	$k + b_1$
$f(\lambda\|Y, \theta, b_1, b_2, k)$	$a_2 + \sum_{t=k+1}^{n} Y_t$	$n - k + b_2$
$f(b_1\|Y, \theta, \lambda, , b_2, k)$	$a_1 + c_1$	$\theta + d_1$
$f(b_2\|Y, \theta, \lambda, , b_1, k)$	$a_2 + c_2$	$\lambda + d_2$

For the estimate of the break point we need

$$f(\lambda|Y, \theta, b_1, b_2, k) = \frac{L(Y; k, \theta, \lambda)}{\sum_{j=1}^{n} L(Y; j, \theta, \lambda)}$$

the mean rate of insolvency rather than inflated variances. Therefore, the best practical solution is to use the Poisson model in a quasi-likelihood setting and calculate the standard errors using robust methods.

where the likelihood is given by

$$L(Y; k, \theta, \lambda) = exp\big(k(\lambda - \theta)\big)\left(\frac{\theta}{\lambda}\right)^{\sum_{j=1}^{k} Y_i}.$$

We use the Gibbs sampling method (Kim and Nelson, 1999) to simulate the posterior densities of θ, λ and *k,* then use the mode of these densities as our estimates of θ, λ and *k*. We use a simulated chain of length 1000 with an additional burn-in period of 500 iterations. Plots of the chain for θ, λ and *k* suggest the burn in period is reasonable.

Our visual examination of the data (Figures 1 and 2) is suggestive of more than one break in the mean rate of insolvencies. To test for the possibility of more than one break we adopt the following sequential procedure:

- STEP 1: Test whether there is a break vs no break in the full sample. If there are no breaks, then stop the procedure and conclude there are no breaks.
- STEP 2: If there is a break, then test whether there is an additional break in each of the 2 sub-samples on either side of the break. If there are no further breaks, then stop and conclude there is one break.
- STEP 3: If there is a break in either sub-sample, we can conclude there are two or three breaks depending on the results in each sub-sample. Given the sample size available then the maximum number of breaks we can practically test for is three.

2.3 Results

Our estimation results for the full sample period are reported in Table 3. The estimated break point (*k*) of corporate insolvencies in New Zealand is January 2008, based on the mode of the simulated *k* variates (i.e. *k*=55). This breakpoint, together with the estimated breakpoint for Auckland of February 2008, is 9-10 months before the fall of Lehman Brothers on 15 September 2008, and some months after the U.S. credit crunch said to have begun in July 2007. The somewhat earlier breakpoint of September 2007 for total personal insolvencies is not inconsistent with the July 2007 date.

For insolvencies across New Zealand and for Auckland's corporate insolvencies, the mean rate of insolvencies after the breakpoint (λ) is substantially higher than the mean rate of insolvencies prior to the break point (θ)[12]. This provides further evidence that there was an increase in the mean rate of insolvencies per month as the GFC was gathering momentum. The mode of the distribution for New Zealand increased from 13 corporate insolvencies prior to 2008 to 21 after 2008.

The 90% confidence intervals of the break period for New Zealand and Auckland around the beginning of 2008 provide a high degree of confidence that an increase in the rate of corporate insolvencies occurred at that time. In contrast the 90% confidence intervals for the

[12] This is not the case for corporate insolvencies in the Waikato, Wellington and Canterbury regions.

break periods in Waikato, Wellington and Canterbury are very wide providing little evidence that a single break took place. The model suggests that the period late in the sample was generally favourable for businesses in Wellington and Canterbury with fewer insolvencies taking place.

Table 3: Posterior estimate of key model parameters using the full sample

	θ	**λ**	**Break period**
New Zealand #	261	356	2007(9)*
	[251,341]	[350,390]	[2007(3),2013(1)]
New Zealand	12.9	20.8	2008(1)*
	[12.4,16.2]	[20.4,23.5]	[2007(12),2008(6)]
Auckland	4.5	12.0	2008(2)*
	[4.2,6,6]	[11.7,14.0]	[2007(12),2008(4)]
Waikato	0.9	0.9	2011(8)
	[0.7,1.8]	[0.6,1.8]	[2008(11),2018(4)]
Wellington	1.6	1.1	2015(2)
	[1.4,3.0]	[0.7,1.4]	[2013(1),2018(7)]
Canterbury	1.3	0.8	2011(5)
	[1.2,2.9]	[0.7,2.0]	[2010(7),2018(8)]

Notes: "New Zealand #" refers to total personal insolvencies while other labels refer to corporate insolvencies. θ is the estimated mean of insolvencies prior to the break in the k-th year, while λ is the mean after the k-th year. The numbers in the square brackets are the estimated 90% confidence intervals for the estimated mean. The break periods and 90% confidence intervals are shown in the column labelled 'Break period'. * denotes the difference of mean rate of insolvencies across the estimated break date is significantly different at the 5% level.

We do no further testing for breaks in Waikato, Wellington and Canterbury but do re-estimate the model for personal and corporate insolvencies in New Zealand and corporate insolvencies in Auckland using the post GFC sample period.[13] Our estimation results for the post-GFC sample period are reported in Table 4. The estimated break point (k) for all three variables (personal insolvencies in New Zealand, corporate insolvencies in New Zealand and corporate insolvencies in Auckland) shows evidence of a significant break between 2012 and 2014.[14] The rate of insolvencies declines significantly, suggesting a return to a normal rate of insolvencies after five or so years of elevated insolvencies following the GFC.[15]

[13] No breaks were detected in any region using the pre-GFC period.

[14] This break period is consistent with Williams (2017a) having categorised the post-GFC period mid-2010 to late-2012 as "domestic caution and global uncertainty". The following key events can then be noted as potentially contributing to the accompanying slowdown in economic activity and the subsequent somewhat increased insolvencies: the OCR increase of 50 basis points during June and July 2010; the deterioration in global sentiment over 2011 and 2012, and drought conditions during the summer of 2012/13.

[15] As a robustness check we performed a Bai-Perron (2003) test for multiple breaks. The results are reported in Table A1 and provide supporting evidence of a break in the rate of insolvencies around 2008 (where the rate of insolvencies increased) and a further break between 2010 and 2014 (where the rate of insolvencies decreased). In contrast to our Bayesian Poisson model, the Bai-Perron tests find evidence of multiple breaks in Waikato, Wellington and Canterbury insolvency rates. These additional breaks are at the start of the GFC for Waikato and Canterbury and in 2011 for Wellington. The timing of these breaks is consistent with the break in other regions and so seems plausible. However, given the Bai-Perron test was not specifically set up for the type of application we are using and to avoid the temptation to over fit the model to every outlier we prefer to rely on the results from the Poisson model.

Table 4: Posterior estimate of key model parameters using the post-GFC sample

	θ	λ	Break period
New Zealand #	439	297	2012(9)*
	[429,498]	[290,335]	[2012(5),2013(12)]
New Zealand	26.9	11.2	2014(10)*
	[26.2,30.4]	[10.6,14.2]	[2014(9),2015(8)]
Auckland	15.0	7.5	2014(11)*
	[14.5,17.8]	[7.0,10.2]	[2014(9),2016(10)]

Notes: "New Zealand #" refers to total personal insolvencies while other labels refer to corporate insolvencies. θ is the estimated mean insolvencies prior to the break in the *k*-th year, while λ is the mean after the *k*-th year. The numbers in the square brackets are the estimated 90% confidence intervals for the estimated mean. The break periods and 90% confidence intervals are shown in the column labelled 'Break period'. * denotes the difference of mean rate of insolvencies across the estimated break date are significantly different at the 5% level.

3 Examining the relationships between Business Insolvencies and Economic Activity

The above break-period dates of January/February 2008 for change in the number of corporate insolvencies in New Zealand and Auckland are consistent with the timing of phase changes in New Zealand's GFC-related recession, which began with the March quarter of 2008. However, our Poisson-based tests tell us little about the nature of the relationship between the number of corporate insolvencies and key macroeconomic variables.

So, given the asymmetric nature of New Zealand's national business cycle phases, the notable variations across New Zealand's regional business cycles, and the marked shift in the number of New Zealand corporate insolvencies during the March 2008 quarter, we now explore relationships between insolvencies and key macroeconomic variables as well as relationships at a regional level.

Our most general specification for the number of insolvencies (*insolv)* is consistent with the theoretical and empirical work of Vlieghe (2001) and of Fabling and Grimes (2005), and can be specified in general terms as:

$$insolv = f(econact, credit\ growth, CPIinfl, HPinfl, tot, cost)$$

where *econact* represents national/regional economic activity, *credit growth* reflects vulnerability to a credit shock (proxying a leverage-based variable), *CPIinfl* is CPI inflation (reflecting reduction of nominal debt obligations), *HPinfl* is property price inflation (as a household net wealth/collateral effect), *tot* is a terms of trade variable (allowing for the possibility of small open economy/imported intermediate goods effects), and *cost* is a "relative cost shock" or "margin squeeze" variable[16].

[16] It can be noted that in Fabling and Grimes work, neither a terms of trade variable nor an exchange rate variable had a significant influence.

3.1 Data

We use quarterly data from 2003q3 to 2018q3, with primary focus on the number of corporate insolvencies in New Zealand and the four regions of Auckland, Waikato, Wellington and Canterbury[17]. The quarterly data on insolvencies is the three month sum of the monthly data used in the previous section.

The main independent variable of interest is economic activity but a measure of that variable is no longer available at a regional level[18]. Instead we use labour market employment data which is available at a regional level and which, at the aggregate level is closely related to overall economic activity (Hall and McDermott, 2016, Table 4). In particular, we use the growth rate of employment in New Zealand and the four regions of Auckland, Waikato, Wellington, and Canterbury. The growth rate of employment is represented by the log fourth difference of the Household Labour Force Survey's (HLFS) seasonally adjusted total employment variable (source: Statistics New Zealand).

For the variables used to control for other influences on the rate of insolvencies: *credit growth* is annual change in the nominal national business lending of bank and nonbank lending institutions (source: Reserve Bank of New Zealand)[19] scaled by nominal seasonally adjusted production-based GDP (source: Statistics New Zealand); *CPIinfl* is the log fourth difference of the Consumer Price Index (CPI) (source: Statistics New Zealand); *HPinfl* is the log fourth difference of the Sale Price to Appraisal Ratio (SPAR) house price index (source: Real Estate Institute of New Zealand); *tot* is the terms of trade based on merchandise export and import prices (source: Statistics New Zealand); and *cost* is the ratio of producers price index (PPI) inputs to outputs (source: Statistics New Zealand).

3.2 Model and Estimation Methods

The dependent variable of our model, insolvencies, takes on non-negative integers and so a natural framework to use is a count data model, such as the Poisson regression model or the

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[17] The previous U.K. and U.S. studies referred to above, and Fabling and Grimes (2005) were able to use the *rate* of total insolvencies as their dependent variable. In Fabling and Grimes (2005), this was because a series for the total number of companies registered by the Companies Office was available for the denominator. We have not found a similar readily available series for our sample period, so our results are restricted to those using the *number* of corporate insolvencies. Results reported by Fabling and Grimes are similar, whether the dependent variable is the number or the rate of insolvencies. It is further the case that disaggregating their number of total forced insolvencies variable so as to provide separate equations for the number of personal bankruptcies and the number of involuntary company liquidations provided very similar results.

[18] Fabling and Grimes (2005) and Hall and McDermott (2007) were able to report results using the National Bank of New Zealand's quarterly measures of National and Regional Economic Activity.

[19] Hess, Grimes and Holmes (2009) have found a lagged bank credit expansion variable significant in explaining credit losses in Australasian banking; and Grimes and Hyland (2015) have used the ratio of non-performing loans to total assets of New Zealand registered banks as an exogenous indicator of supply-side credit restrictions to assist in explaining credit losses in Australasian banking.

negative binomial regression model.[20] For the Poisson model, the conditional mean of insolvencies, y, is

$$E[y|\mathbf{x}] = \exp(\mathbf{x}\beta),$$

where **x** is the vector of regressors discussed earlier plus a constant. The maximum likelihood estimator of β is obtained by maximizing the log likelihood function

$$l(\beta) = \sum_{t}^{T} y_t \log(\mu_t) - \mu_t - \log(y_t!),$$

where $\mu_t = \exp(x_t'\beta)$ specifies a model for the conditional mean of insolvencies. However, the Poisson regression model is quite restrictive in that it requires mean-variance equality, which is typically violated in empirical applications.

A common alternative to the Poisson regression model is the negative binomial regression. This model can accommodate over- or under-dispersion, though at the cost of an additional parameter labelled excess variance, ν. The maximum likelihood estimators of β and ν are obtained by maximizing the log likelihood function

$$l(\beta, \nu) = \sum_{t=1}^{T} y_t \log(\nu\mu_t) - (y_t + \nu^{-1}) \log(1 + \nu\mu_t) + \log\Gamma(y_t + \nu^{-1}) - \log(y_t!) - \log\Gamma(\nu^{-1}).$$

Of course, consistency and efficiency of the negative binomial regression requires that the conditional distribution of insolvencies is exactly negative binominal. Although the negative binomial relaxes this very strict assumption it seems unlikely that insolvencies will be distributed exactly as a negative binomial.

To overcome this very strict assumption, we use a three-step quasi-maximum likelihood procedure that is robust such that estimates of β and ν will be consistent even if the distribution is incorrectly specified.

- STEP 1: Estimate the standard Poisson regression.
- STEP 2: Use the Cameron and Trivedi (1990) test of over-dispersion. The null hypothesis of this test is that we have mean-variance equality or equivalently ν=0. To compute this test we regress the squared residuals of the Poisson model less insolvencies on squared insolvencies. We then test significance of the regression coefficients using the standard *t*-test.
- STEP 3: If we fail to reject the null hypothesis ν=0, we then use the estimates from the Poisson regression. Otherwise re-estimate the model using the negative binomial regression with the excess variance parameter, ν, fixed using the estimate derived from the Cameron and Trivedi (1990) auxiliary regression computed in step 2.

[20] The number of personal insolvencies is sufficiently large that they could be well approximated as a continuous variable in a standard linear model and thus estimated by OLS. However, such an approximation is not appropriate for the corporate insolvency data where the number of insolvencies per quarter can be small, especially in the regions. Since we need to use maximum likelihood for the corporate insolvencies we chose to use it for both data sets and avoid any approximations altogether.

3.3 Results

Our estimates of ν for the count data models, using all the macroeconomic variables (labelled unrestricted models) are reported in Table 5, and the corresponding estimates for models restricted to variables that are statistically significant are reported in Table 6 (labelled restricted models). The hypothesis of mean-variance equality is mostly rejected. The exceptions are Wellington in both the restricted and unrestricted cases, and Waikato in the unrestricted case. Estimates of ν indicate that our measure of over-dispersion is 6 to 9 percent in the upper North Island (and New Zealand). There is no evidence of over-dispersion in Wellington. The measure of over-dispersion for Canterbury is implausibly large and more likely a sign of misspecification. This general finding of over-dispersion could well be a sign of insolvency contagion where one failing firm has a knock-on effect to other firms.

Table 5: Unrestricted quasi-maximum likelihood estimates for the insolvency models

	NZ #	**New Zealand**	**Auckland**	**Waikato**	**Wellington**	**Canterbury**
Constant	6.501*	3.536*	3.431*	1.039*	1.774*	0.354
	(0.119)	(0.186)	(0.292)	(0.334)	(0.255)	(0.290)
Lagged	0.0005*	0.009*	0.011*	0.116*	0.023	0.106*
insolvency	(0.0001)	(0.002)	(0.004)	(0.027)	(0.015)	(0.043)
Employment	-2.071	-0.248	2.181	-1.763	-2.500	2.323
growth	(1.215)	(2.513)	(2.004)	(4.121)	(3.430)	(3.972)
House price	-0.762*	-0.143	-1.648	-1.831	-2.086	-0.372
Inflation	(0.319)	(0.871)	(0.996)	(2.468)	(1.253)	(1.603)
CPI Inflation	0.076	1.646	-8.587	-11.418	-11.355	20.576
	(1.635)	(3.567)	(6.498)	(12.237)	(8.490)	(10.561)
Credit growth	-0.213	-0.273	-0.625	-0.937	-0.393	-0.804
	(0.158)	(0.362)	(0.539)	(1.224)	(0.686)	(0.781)
Terms of trade	-1.054*	-1.439	-1.921	2.907	-0.596	-4.498
changes	(0.487)	(1.462)	(1.537)	(4.073)	(2.441)	(3.038)
Relative cost	0.691	12.124*	21.380*	29.781*	9.518	-5.828
	(1.441)	(4.568)	(6.708)	(13.585)	(8.896)	(9.585)
D_2012q4	-	-	-	-	1.287* (0.239)	-
R^2	0.838	0.654	0.594	0.636	0.619	0.160
Excess variance ν	0.010* (0.002)	0.052* (0.009)	0.062* (0.020)	0.045 (0.027)	-0.027 (0.017)	0.294* (0.044)

Notes: "NZ #" refers to total personal insolvencies while other labels refer to corporate insolvencies. Estimated parameters are from the negative binomial model if the excess variance parameter is significant or from the Poisson model if it is not. The dependent variable is the number of insolvencies per quarter. White's heteroscedasticity robust standard errors are shown in parenthesis. * denotes statistically significant at the 5 percent level.

Our preferred estimates of β for New Zealand corporate insolvencies and total personal insolvencies, and for corporate insolvencies in the four regions of Auckland, Waikato, Wellington, and Canterbury based on the full set of regressors discussed above are shown in

Table 5[21]. Note that we have included a dummy variable in the Wellington regressions to remove the effect of the outlier of 23 insolvencies in December 2012. We also sequentially removed insignificant variables to produce the restricted estimates of β reported in Table 6. Estimated parameters are from the negative binomial model if the excess variance parameter is significant or from the Poisson model if it is not. Thus, the Poisson model estimates are reported for Wellington in the restricted and unrestricted cases and Waikato in the unrestricted case.

Table 6: Restricted quasi-maximum likelihood estimates for the insolvency models

	NZ #	**New Zealand**	**Auckland**	**Waikato**	**Wellington**	**Canterbury**
Constant	6.459*	3.494*	2.939*	0.553*	1.291*	0.667*
	(0.098)	(0.132)	(0.191)	(0.178)	(0.145)	(.172)
Lagged insolvency	0.0005*	0.010*	0.016*	0.135*	0.038*	0.131*
	(0.0001)	(0.002)	(0.004)	(0.023)	(0.015)	(0.041)
Employment growth	-2.507*	-	-	-	-	-
	(1.224)					
House price Inflation	-0.932*	-	-	-	-	-
	(0.269)					
Relative cost	-	13.136*	18.478*	32.630*	14.365*	-
		(3.917)	(6.484)	(11.954)	(7.195)	
D_2012q4	-	-	-	-	1.510*	-
					(0.149)	
R^2	0.818	0.637	0.530	0.565	0.568	0.107
Excess variance ν	0.086*	0.058*	0.070*	0.075*	-0.024	0.327*
	(0.022)	(0.010)	(0.018)	(0.031)	(0.019)	(0.063)

Notes: "NZ #" refers to total personal insolvencies while other labels refer to corporate insolvencies. Estimated parameters are from the negative binomial model if the excess variance parameter is significant or from the Poisson model if it is not. The dependent variable is the number of insolvencies per quarter. White's heteroscedasticity robust standard errors are shown in parenthesis. * denotes statistically significant at the 5 percent level.

The reported R^2 of our models of insolvencies (excluding Canterbury) are relatively high, with values implying that between 50 and 80 percent of the variation in insolvencies can be explained by macroeconomic factors. It does appear, however, that macroeconomic variables cannot explain any of the variation in insolvencies in Canterbury).

For corporate insolvencies, and for both the restricted and unrestricted regressions, the regression coefficient for our measure of cost shocks is significant at the five percent level for New Zealand as a whole and for all regions (except Canterbury and the unrestricted-model for Wellington). In contrast, costs are not significant in the regression for personal insolvencies. Sharply rising input costs relative to output prices are therefore the most important

[21] To check for any misspecification, we examined the correlogram of the residuals and found no evidence of serial correlation. The lagged insolvencies variable is statistically significant for all regions except Wellington and it is this variable that is soaking up any possible serial correlation. Excluding the lagged dependent variable leads to serious serial correlation problems in the specification. However, the size of the coefficient is extremely small. For example, consider the case of New Zealand: for every 100 extra insolvencies in the previous quarter there is approximately one extra expected insolvency in the current quarter.

macroeconomic factor influencing corporate insolvencies but are immaterial in determining personal insolvencies.

Figure 3 shows the ratio of producer price inputs to outputs or what we have referred to as relative costs. The salient features of this series are sharp increases in relative costs at the time of the GFC and the elevated costs around 2011 to 2013. Both are periods when higher rates of insolvencies occurred.

Figure 3: Relative Costs for Producers (ratio of prices paid to prices received)

The significant macroeconomic factors driving personal insolvencies are employment growth and house price inflation. Both these factors are important determinants for consumption spending by the household sector which is likely to play a large role in small business profitability. Also, employment conditions will be critical in a household's ability and willingness to repay debt obligations and thus be an important determinant of personal insolvencies.

It can further be noted that for our GFC-related sample, and in contrast to the effects found significant by Fabling and Grimes (2005) for their sample period incorporating the 1990-91 and 1997-98 recessions, neither CPI inflation nor business credit growth has been significant in explaining New Zealand or regional insolvencies[22].

[22] Fabling and Grimes found that economic activity, real private sector credit, CPI inflation, and at regional levels real property price inflation were all significant in influencing insolvency rates.

4 Conclusion

A salient feature of the monthly time series for our insolvencies data is that their properties are complex and need commensurately careful modelling.

Our structural break analysis using a Poisson model has established that the rate of corporate insolvencies in New Zealand and in Auckland started rising in January/February 2008, well before the collapse of Lehman Brothers in September 2008. The timing of this marked change in insolvencies is consistent with New Zealand's most recent business cycle peak of 2007q4 and its subsequent five-quarter recession. In contrast, though, the 90% confidence intervals for the break periods in Waikato, Wellington and Canterbury are very wide, providing little evidence that a single break took place.

For the post-GFC period, there is evidence of a further significant break between 2012 and 2014, for total personal insolvencies in New Zealand, corporate insolvencies for New Zealand, and corporate insolvencies in Auckland. The subsequent decline in the rate of insolvencies is then consistent with return to a normal rate of insolvencies after five or so years of elevated insolvencies following the GFC.

These findings led to our specifying Poisson and negative binomial regression models, so as to assess the extent to which GFC-related business insolvencies could be associated with key macroeconomic activity variables.

The most notable finding from our preferred models is that sharply rising relative costs have been the most important macroeconomic factor influencing corporate insolvencies in New Zealand, Auckland, Waikato and Wellington, but have been immaterial in determining New Zealand's total personal insolvencies.

Also notable is that employment growth and house price inflation have been the two variables significantly explaining total personal insolvencies, i.e. lower rates of employment growth (and economic activity more generally) are likely to have been associated with small and medium enterprise failures, bankruptcies, and insolvencies, and increases in house price inflation (reflecting household net wealth/collateral), can be associated with a decline in the rate of insolvencies. Previous insolvencies have been a lesser factor significantly affecting both corporate and total personal insolvencies.

Further of interest is that for our GFC-related sample, and in contrast to the effects found significant by Fabling and Grimes (2005) for their sample period incorporating the 1990-91 and 1997-98 recessions, neither CPI inflation nor business credit growth has been significant in explaining New Zealand or regional insolvencies. The lack of significance of the CPI inflation variable is not surprising, given low and stable inflation throughout our sample period, and the non-significance of our credit growth variable is consistent with insolvencies not being attributable to either a lack of or an excessive accumulation of credit.

Overall, our results are consistent with the asymmetric behaviour of a normal rate of insolvencies in an expansion phase of the business cycle and a sharp increase in insolvencies around the onset of a relatively severe recession. One might also interpret the findings as insolvencies being largely a firm-specific event during expansions but a macroeconomic event in recessions.

Given the very limited number of monthly statistics available for monitoring the state of the New Zealand business cycle or building macroeconomic models, the series on insolvencies provides a valuable source of information. This will be increasingly so as the sample size grows. That said, their complex properties may require the use of nonlinear or nonparametric methods for some applications, or at least the judicious use of dummy variables that allow the interactions of insolvencies with the state of the business cycle.

We can envision three potential uses of insolvency data in models of the business cycle. Firstly, the data could be incorporated into nowcasting frameworks to improve our forecasts of the current state of the economy before the official quarterly data is released. Secondly, the data might be added to structural vector autoregressions to aid in our understanding of the dynamics of the macroeconomy. The very complex and non-normal nature of the insolvencies data would actually be an advantage in the identification of structural shocks in such analysis. Finally, insolvencies could aid the estimation of the probability of a future recession. A probit regression with insolvencies as an explanatory variable, along with other variables, could be an effective way to generate such probabilities. By way of illustration, insolvencies do add some explanatory power to such a regression (although one should be very cautious about this result given our sample only covers one recession).

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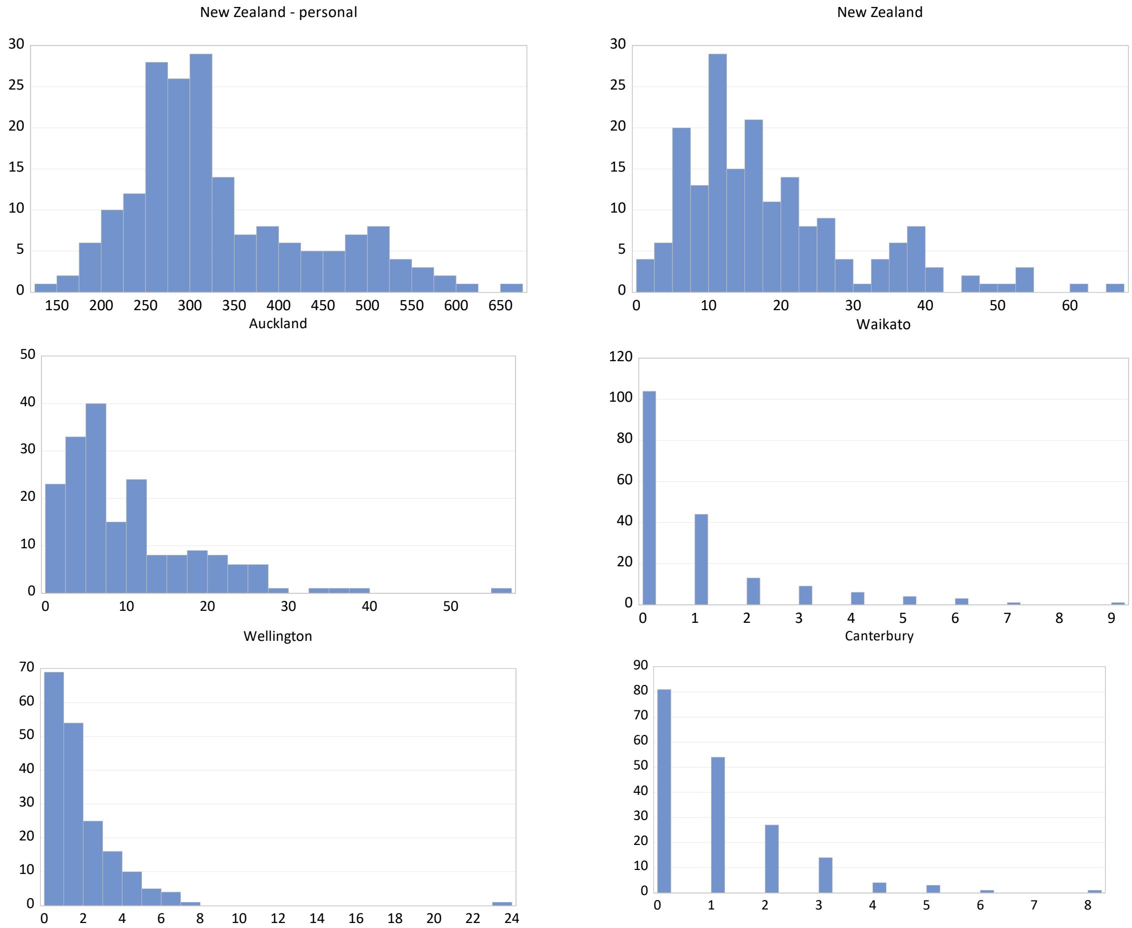
Appendix

Appendix Figure 1: Histograms of Insolvency data



Appendix Table 1: Bai-Perron test for a break in the mean rate of insolvencies

	Number of breaks	Bai-Perron test	Break dates
New Zealand #	2	277.9 (1 vs 2)	2008(3), 2011(12)
New Zealand	3	20.9 (2 vs 3)	2008(5), 2011(7), 2014(7)
Auckland	2	45.8 (1 vs 2)	2008(5), 2014(7)
Waikato	3	63.16 (2 vs 3)	2008(4), 2012(4), 2014(7)
Wellington	2	22.4 (1 vs 2)	2011(7), 2014(4)
Canterbury	2	20.5 (1 vs 2)	2008(7), 2010(12)

Notes: "New Zealand #" refers to total personal insolvencies while other labels refer to corporate insolvencies. The critical values for 0 vs 1, 1 vs 2, 2 vs 3, and 3 vs 4 are 8.58, 10.13, 11.14, and 11.83.

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