Ministry of Business, Innovation & Employment

MODELLING CALENDAR EFFECTS in MBIE's JOBS ONLINE VACANCIES TIME SERIES

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1 Abstract

The Ministry of Business, Innovation and Employment release Jobs Online reports every month. These reports discuss changes in job vacancies advertised online by businesses and organisations from the private and public sectors through the two main internet job boards - SEEK and Trade Me Jobs. Jobs Online presents its vacancy data in a Skilled Vacancy Index (SVI) and an All Vacancy Index (AVI). and a The SVI breaks down the data by industry[1] , occupation[2] and region[3]. The indices indicate the demand for labour.

This paper describes the change to the seasonal adjustment of the SEEK and Trade Me Jobs vacancies series that are used to calculate the monthly SVI and AVI. The change in the process is the result of an investigation into calendar effects in the series and comparisons of the performance of the day of the week and Easter effects regression models. The outcome of this modelling framework was a better identification of seasonal effects and a clearer picture of job vacancies, enhancing MBIE's capacity to monitor and report on job vacancies.

2 Background

Monthly time series like *Jobs Online* can be influenced by differences in the number of weekdays, weekends in each month or holidays. These calendar effects introduce volatility into monthly time series data and obscure important seasonal effects. These effects also make it difficult for *Jobs Online* vacancies to be compared across months or for movements in one series to be compared across other series. Job vacancies across industries, occupations and regions were also impacted in different ways by seasonal effects, making valid comparison an issue. These issues meant that accurately adjusting *Jobs Online* data for seasonal effects was important. For this reason, the Ministry, in consultation with Statistics New Zealand, introduced a new process into the seasonal adjustment of *Jobs Online* data.

Job advertisements tended to rise in months with more weekdays and working days relative to other months (see Figure 1). Job advertisements also vary according to the individual day of the week. A month with more Mondays than Thursdays will have a different impact compared to the other way around. In this case, months having different numbers of each day of the week from year to year, can explain short-term movements in the *Jobs Online* series. Generally, in each month there are four full weeks and additionally one, two or three days. Therefore, for each month, the given day of the week occurs at least four times, but some days will occur five times. If the number and composition of these extra days have an effect on data for the month, the days-of-the-week effect arose. This effect was significant for time series in which daily activity depends on the day of the week like advertisements of vacancies online.

[1] The industries are accounting, HR, legal and administration; construction and engineering; information technology; healthcare and medical; sales, retail, marketing and advertising; education and training; hospitality and tourism; and other.
[2] The occupations are managers; professionals; and trades and technicians.
[3] The regions are Auckland, Wellington, Canterbury, South Island (excluding Canterbury) and North Island (excluding Auckland and Wellington).

Figure 1. Skilled Vacancies Index- before calendar effects adjustment (May 2007 = 100), seasonally adjusted

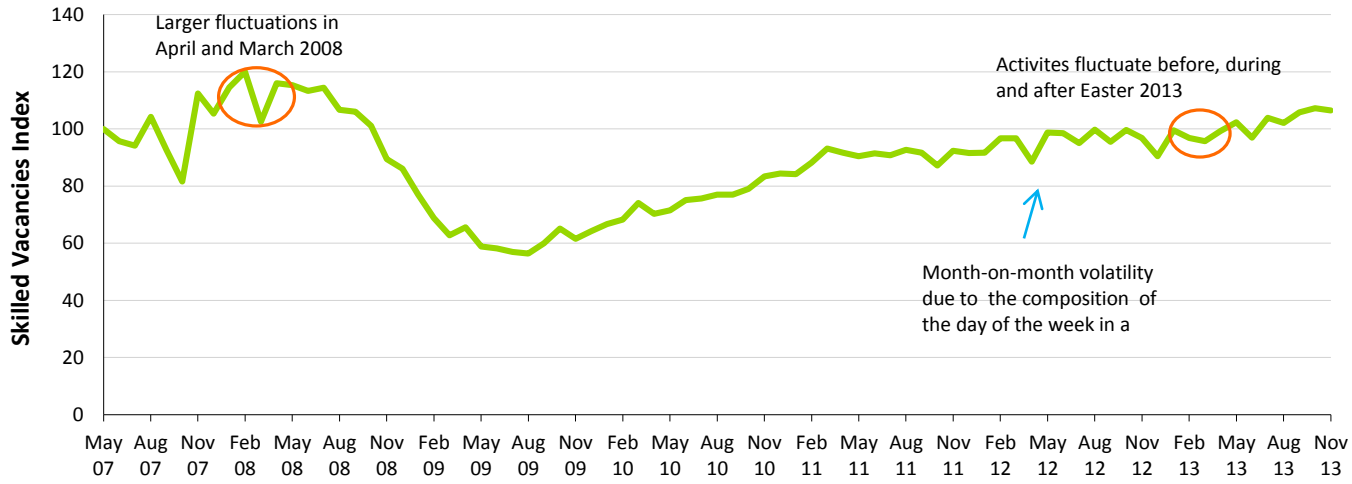
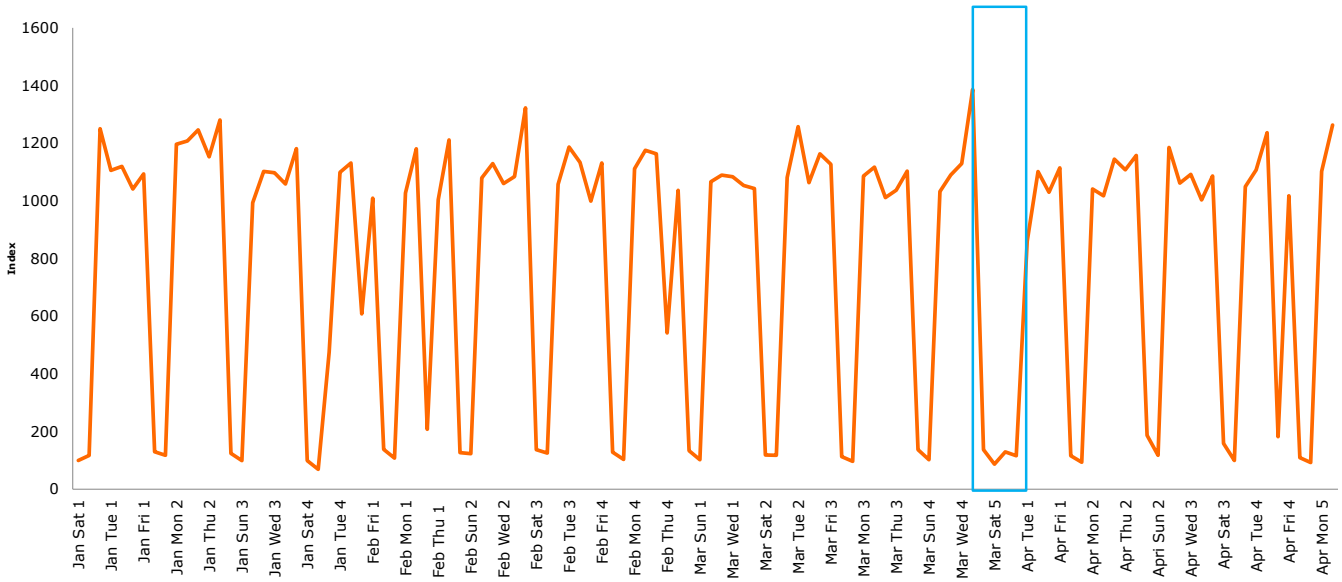


Figure 1 shows that in 2008 and 2013, there were large irregular components in March and April because the "normal" seasonal pattern (i.e. Easter falling in April) did not happen. Following an adjustment for the Easter effect, there was a slight improvement in the vacancies index in March 2008 and March 2013. A closer look at Figure 2, reveals that advertised vacancies spiked just before Easter 2013, and fell to a four-day low during Easter rather than the usual two-day low over a weekend.

Figure 2: All vacancies by submit date for January 2013 to October 2013 (original series, indexed to January 5 2013)



Source: MBIE *Jobs Online* vacancy series

Figure 2 shows the daily movements of all vacancies advertised online through Trade Me Jobs and SEEK.[4] The movements indicate that vacancies fell over weekends and rose over weekdays. Closer inspection reveals that Tuesdays and Fridays have the most vacancies, while Sunday has the least. This finding highlights the need to adjust the data for calendar effects from the day of the week.

[4] Michael Grun Rehomme, Amani Ben Rejeb, Institute for Labor Studies and Public Policies, 2008

In addition to weekday composition, other calendar effects such as public holidays may also affect monthly time series. Both fixed holidays (like New year and Christmas day) and moving holidays (like Easter) have an influence on the number of working days or non-working days in a month, and hence on the level of economic activity. However, moving holidays, may influence economic activity not only on the day that it falls but also before, during and after it. In the case of Easter, the length of this holiday, and the exact date of occurrence was important. In New Zealand, Easter can fall on different dates in either March or April. Job vacancy levels tend to fluctuate before, during and after Easter. Other holidays that fell irregularly were Waitangi day and ANZAC day. When a holiday regularly occurs in the same month each year, the monthly seasonal adjustment will detect and adjust for that holiday, such as Christmas which always occurs in December.

These periodic fluctuations in the vacancy data need to be identified and removed to allow for better comparison of the vacancy series over time. This paper presents a framework for improving the current seasonal adjustment of the SEEK and Trademe Jobs vacancies series. The modelling framework removes the effects of the different numbers of each day of the week in each month (the day of the week effect) and the effect of Easter falling on different dates each year (the Easter effect).

3 Methodology

We considered three standard tests for detecting and confirming calendar effects, and for comparing the performance of the models with calendar effect adjustments.

First, spectral plots were prepared from 34 series, representing 6.5 years of monthly vacancies series (221 observations) by industry, regions and occupations. "Visually significant" peaks in the spectral plots of the irregular component that were associated with day of the week effect were evaluated. These were spikes in the spectral plot of seasonally adjusted series and the irregular componet. "Visually significant" residual peaks were sufficiently higher than the immediately neighbouring spectral plots.[5]

Second, the comparison of Akaike Information Criterion that was modified for sample size (AICC)[6] was also used to detect days-of-the week effects in the series. This enabled the choice of a preferred model from among models that included calendar effect adjustments. The model with the smallest AICC value was chosen, as it was a good fit with the data. This was because AICC penalises the addition of parameters (in this case, inclusion of day of the week and Easter effect regressors). AICC selects a model that fits well, simple and parsimonious (e.g. minimum number of parameters).

Finally, the out-of-sample forecast error for the ARIMA and automodel procedures were compared using mean absolute percentage error[7]. For the purpose of this paper, this diagnostic enabled a choice between models. The criteria was applied when no "visually significant" residual peaks in any of the spectra associated with day of the week effects were identified or when models had significant residual peaks. The forecast errors were not used to evaluate the forecast abilities of the models. The accumulated sum of squares of the forecast errors were also inspected to compare models with calendar effect adjustments

[5] SAS' X-12 ARIMA has three default spectra: differenced, log-transformation, seasonally adjusted series and the spectrum of the irregular series. By default, the program prints a message warning whenever a "visually significant" day of the week peak in a spectra associated with day of the week effects is detected. Common frequencies for series with trading day is at 0.348 and 0.432 (Hood, C. (n.d).

[6] AICC is a version of AIC that is modified for the sample size.

[7] Forecasting, Time Series, and Regression, Bowerman, O'Connell and Koehler; MAPE is the "average of the absolute percentage errors".

To adjust for day of the week and Easter effects in the indices, a straightforward use of ARIMA models was insufficient. The X-12 ARIMA estimates the regARIMA[8] separately. The pre-adjustment for calendar effects involves removing from the time series calendar effects. It was achieved by including the appropriate regression variables to the RegARIMA. The RegARIMA included calendar effects as deterministic input variables. This part of X-12-ARIMA makes adjustments for calendar effects from the original series (Catherine C. Hood, Catherine Hood Consulting, 2013).

For the purposes of this report we considered eight different models, these were:

1) ARIMA
   a) No day of the week effect (NODWE)
   b) Day of the week effect (DWE)
   c) DWE and one part Easter regressor (one part Easter)
   d) DWE and two part Easter regressor – before Easter and during Easter.
2) Auto model
   a) No day of the week effect effect (NODWE)
   b) Day of the week effect effect (DWE)
   c) DWE and a one part Easter regressor
   d) DWE and a two part Easter regressor.

The vacancy series were decomposed by the calendar effect factor, a seasonal component and a non-seasonal component. The seasonal adjustment procedure included the day of the week and Easter adjustments as regressors. Online vacancies were modelled using a six-day coefficient effect for the day of the week (DWE) regressor, and a two-part Easter regressor. DWE estimates a separate regression coefficient for six day of the week and has an implied coefficient for Sunday.[9] Details in the detection and modelling of day of the week effects were given in Soukop and Findley (2000).

The other deterministic variable, the Easter regressor, adjusted for Easter. The Easter effect was modelled as two parts: a pre-Easter effect (days before Easter to Good Friday) and an Easter holiday effect starting on Good Friday and lasting until Easter Monday.[10] The approach using two Easter regressors was similar to the approach taken in Australia, which also has a Monday holiday over Easter (Norhayati Shuja, Mohd Alias Lazim, Yap Bee Wah, Department of Statistics Malaysia, 2007). Genhol[11] was used to generate Easter regressors.

The seasonal adjustment procedure using an automatic model[12] and ARIMA (0 1 1) (0 1 1) specifications were applied to 6.5 years of monthly data from Trademe Jobs and SEEK. The monthly data for skilled vacancies was broken down by industry, occupation groups and region. Comparing results from the two proceduces in SAS allowed for evaluation of a 'good fit' for individual series. The quality of the seasonally adjusted series was assessed on standard diagnostics for the presence of seasonality. M and Q statistics[13] were used to measure the stable and moving seasonality in each series. These diagnostics were also used to identify seasonality, as a seasonally adjusted series should

[8] A time series modelling (combines regression and ARIMA model) developed to identify and estimate outliers, trading day and holiday effects that may exist in the series.

[9] We initially used the "TD1coef" in the context of the SAS programmes. TD1 coef assumes that the weeks and weekends are the same. However, further investigation has revealed that the "TD" (trading day) coefficient should be used. The TD, which assumes six-coefficients, was selected as the weekends differed to the weekday structure in the underlying data.

[10] For details about this method, see Monsell (2010) and Monsell B, David F.Findley, Kellie Wills (2003).

[11] Genhol is a programme developed by the US Census Bureau for creating holiday regressors.

[12] This X-12 ARIMA procedure automatically selects the orders of differencing and ARIMA model. It is based largely on the TRAMO (time series regression with ARIMA noise, missing values, and outliers) method.

[13] The M tests and Q test from the SAS diagnostics assess the quality of the seasonal adjustment. The M7 is the most important diagnostic and compares the moving seasonality relative to the stable seasonality. The Q test is a weighted average of all of the M tests. The M tests indicate an issue if their value is greater than 1.

have no residual seasonal effects (Catherine C. Hood, Catherine Hood Consulting, June 18-21 2007). Residual seasonality was further inspected using spectral graphs to identify the outliers in the series.

4 Empirical results

4.1 Detection day of the week and Easter effects

To confirm the presence of day of the week effects, we looked at the spectral graphs of the seasonally adjusted and irregular series of 34 series were looked at. Spectral graphs were used to investigate the seasonality and day of the week effect in the data. The graph shows that the seasonal and irregular components of the *Jobs Online* series included day of the week peaks in the vacancy series. The spectral plots[14] shows that frequencies related to the day of the week effect were detected in skilled vacancies, total vacancies; Wellington region; trades occupation and; in industries of accounting, construction IT, sales, and hospitality (Catherine C. Hood, Catherine Hood Consulting, 2009); (Raymond J. Soukup, David F. Findley, US Census Bureau). The results from spectrum analysis were summarised in Table 4 and Table 5 in Appendix A. A sample of spectral plots showing seasonally adjusted and irregular components series for vacancies in the sales industry were also presented in Appendix B.

The results of the day of the week effect regressions in Table 2 also show that Tuesday and Friday have significant positive regression coefficients (more online vacancies are advertised on those days) while Sunday has a significant negative regression coefficient. In part, this was because most advertisements were submitted on these days and administrative offices tended to be closed on Sundays. This may coincide with ensuring the advertisements were available on Wednesday and Saturday. Earlier patterns observed in newspaper advertisements showed that Wednesday and Saturday were the peak days for advertising. The chi-squared tests for grouped day of the week effect also suggested that these grouped day of the week effects were significant.

Table 1 shows a sample output file showing the day of the week regression for the skilled Seek data. The model automatically identified and adjusted for outliers.

Table 1. Regression model parameter estimates for skilled Seek data, DWE and two part Easter model

Type	Parameter	NoEst	Estimate	Standard Error	t Value	Pr > |t|
Day of the week	MON	Est	-0.00212	0.00688	-0.31	0.7588
	TUE	Est	0.02325	0.00718	**3.24**	0.0021**
	WED	Est	0.00167	0.00688	0.24	0.8093
	THU	Est	-0.00573	0.00728	-0.79	0.4349
	FRI	Est	0.03294	0.00598	**5.51**	<.0001**
	SAT	Est	-0.01035	0.00699	-1.48	0.1444
	SUN(derived)*	Est	-0.03966	0.007	**-5.66**	<.0001**
User Defined	**Before Easter**	Est	0.0452	0.02176	2.08	0.0425**
	After Easter	Est	-0.09149	0.02241	-4.08	0.0001**
Automatically Identified	AO OCT2007	Est	-0.389	0.02673	-14.55	<.0001**

*For the day of the week and fixed seasonal effects, the derived parameter estimate is obtained indirectly as minus the sum of the directly estimated parameters that define the effect.

** Statistically significant at α=0.01

[14] According to C. Hood when the peak is higher by at least six stars than its neighbours it is important.

Results from identifying outliers through the automatic outlier detection function of X-12 ARIMA in SAS confirmed the decreases in the March/April months where Easter fell over the past seven years. March and April months at various years were often identified as additive outliers (ao), indicating a need to make Easter adjustments. Easter effects were statistically significant in industries such as sales, hospitality and accounting; in the Auckland and Canterbury regions; in trades occupation and; in skilled and total vacancies. The regressions results in Table 1 also show that the Easter regressors (a before and after user-defined regressors) were significant. The results of the chi-square tests on day of the week and Easter effects regressors were summarised by Table 9 and Table 10 in Appendix E.

4.2 Model Selection

AICC comparisons were undertaken among NODWE (no day of the week effect) and DWE (day of the week effect)[15] for the series. The DWE model resulted in smaller AICC values, favouring the inclusion of day of the week effect. DWE is the preferred model, especially for skilled and total vacancies, Auckland and Canterbury regional series, IT, hospitality and sales, and for trades occupation group.

The preference for DWE over the NODWE model reflects the fact that the job advertisements fell in the weekends, and that the offices were closed on Saturdays and Sundays. As expected the models with more variables in the regression model (such as DWE and Genhol 2 part Easter) may not always have the smallest AICC. This was because AICC penalises models using a larger number of parameters in the regression. The "final objectives of the analysis" should also be used to select a model (Josu Arteche, Renata Majovska, Petr, Mariel, Susan Orbe, 2011).

The actual model selected for total vacancies is DWE (day of the week effect) and a two part Genhol Easter using auto model and outlier correction (Richard Tiller, January 2012). The DWE model was selected as the weekends differed to the weekday structure in the underlying data. The two part Easter regressor was selected as this reflected the impact of trading before Easter and took into account the Monday and Friday holidays taken in both Australia and New Zealand.

Table 2: AICC values of skilled and total vacancies for Trademe Jobs and SEEK

Series	Default ARIMA Model				Automatic Model Selection		
	NODWE	DWE	DWE and one part Easter	DWE and two part Easter	NODWE	DWE	DWE and two part Easter
Total_ Seek	1071.8	1020.9	1090.2	1031.0	1112.3	1013.0	1000.3
Total_Trade Me Jobs	1045.6	1013.9	1013.7	1009.8	1035.2	1001.4	1001.7
Skilled_ Seek	1014.1	954.5	1035.7	971.6	1053.4	951.8	945.8
Skilled_Trade Me Jobs	967.1	939.1	940.4	930.0	961.3	931.8	930.0

Source: MBIE diagnostics of *Jobs Online* data

Evaluation of the forecast errors suggests that an automodel specification with automatic outlier detection was preferred over the default ARIMA (0 1 1) (0 1 1) model. As an example the results show that overall the automodel was better for skilled and total vacancies, with forecast errors for skilled vacancies and total vacancies using an automodel model specification was smaller compared to a default ARIMA (0 1 1)(0 1 1) for both SEEK and Trademe Jobs series. The accumulated differences in the squares of these forecast errors were trending upwards, suggesting that an automodel specification with day of the week effect and a two-part Easter regressors was preferred. See Appendix F for the forecast errors completed for this example. The mean absolute percentage error showed that SEEK vacancies clearly favoured the use of automodel, but that Trademe Jobs was more ambivalent.

[15] NODWE: No trading effect; DWE: Day of the week effect; TD1COEF: Day of the week effect with assumption that weekends and weekdays are the same.

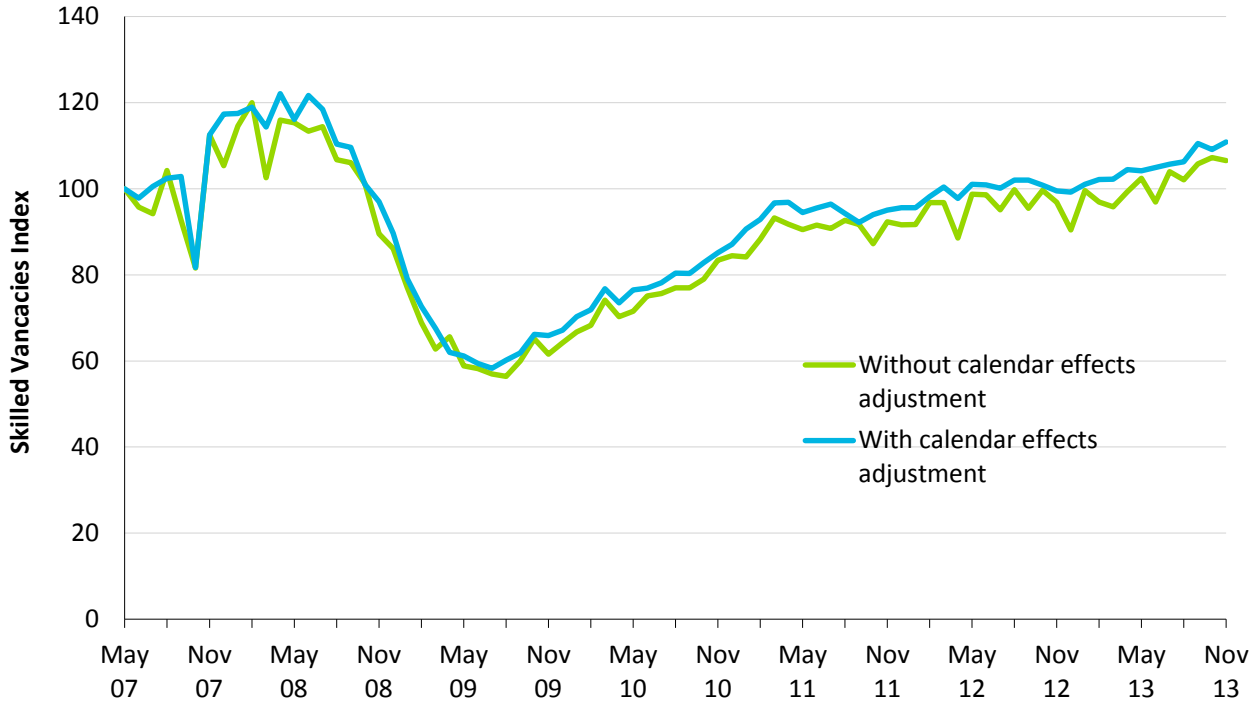
Table 3: Mean absolute percentage errors

MAPE		ARIMA	Automodel
Total	SEEK	0.3269	**0.2867**
	Trademe Jobs	**0.3067**	0.3294
Skilled	SEEK	0.3617	**0.3424**
	Trademe Jobs	**0.3567**	**0.3567**

4.3 Calendar effect adjusted job vacancies

Results from introducing day of the week effect and Easter effects regressors in the seasonal adjustment process reduced the month-to-month volatility of the vacancy series and provide a clearer picture of job vacancy trends (see Figure 3).

Figure 3. Skilled Vacancies Index (May 2007=100), seasonally adjusted series



Conclusion

This paper has presented a modelling framework to improve the current seasonal adjustment of the SEEK and Trade Me Jobs vacancies series that was used to calculate the monthly SVI and AVI. This framework was the result of an investigation into calendar effects in the series and comparisons of the performance of the day of the week and Easter effects regression models. The modelling framework removes effects of the differing numbers of day of the week in each month, and the effect of Easter falling on different dates each year.

The adjustments were implemented using SAS software X-12 ARIMA to produce a combined regression and the ARIMA model for the time series by all and skilled vacancies for industries, occupations and regions. The underlying Easter effect also used the Genhol package developed by the US Census Bureau. The seasonal adjustment process adopted the automatic model specification as it enables flexibility in the model selected and the length of the moving average filters. This means that the adjustment process adjust for each individual series' underlying data structure and behaviour.

The final model selected adjusts for individual day of the week effect in each month and before and during Easter effects. Standard statistical tests indicates that adjusting for these calendar effects in the vacancies series was consistent with the data in each month from Trade Me Jobs and SEEK.

The outcome of this modelling framework was a better identification of seasonal effects and a clearer picture of job vacancies, enhancing MBIE’s capacity to monitor and report on job vacancies.

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Appendix A: Detection of visually significant peaks and outliers

Table 4. Identification of visually significant peaks and outliers – Skilled vacancies, Total vacancies and occupation groups

Series	Visually significant peaks in comments				Noted in graph				Largest Outlier	Potential Outlier	Months for cyclical dominance	Remarks
	SEEK		Trademe		SEEK		Trademe Jobs					
	Seasonal	Trading	Seasonal	Trading	Seasonal	Trading	Seasonal	Trading				
Skilled									AO Oct 2007- SEEK	AO Mar 2008-Trade Me Jobs	3 months	Seasonality between months and year, present at 0.1 percent level
Original	3		4		6	3	5	2				No evidence of moving seasonality
Seasonally adjusted		1		1	6	3	6	3				No evidence of residual seasonality for the entire series at the 1 per cent level in the entire series, last 3 years
Irregular		1		1	6	3	6	3				No outliers identified
Total												Seasonality between months and year, present at 0.1 percent level
Original	4		4		6	3	6	3	LS Mar 2009- Trademe Jobs			No evidence of moving seasonality
Seasonally adjusted		1		1	6	3	6	3				No evidence of residual seasonality for the entire series at the 1 per cent level in the entire series, last 3 years
Irregular		1		1	6	3	6	3				No outliers identified
Managers									LS Nov 2007-Trade Me Jobs	AO Oct 2007- SEEK; LS Nov 7-Trade Me Jobs	3 months	Seasonality between months and year, present at 0.1 per cent level
Original	3		3		6	3	6	3				No evidence of moving seasonality
Seasonally adjusted		1			6	3	6	3				No evidence of residual seasonality for the entire series at the 1 per cent level in the entire series, last 3 years
Irregular		1			6	3	6	3				No outliers identified, ARIMA Model (0 1 1) (0 1 1)
Professionals									AO Oct 2007-SEEK	LS Nov 2007-Trade Me Jobs	2 months	Seasonality between months and year, present at 0.1 per cent level
Original	3		2		6	3	6	3	AO Dec 2012-SEEK; AO April 2008-SEEK	AO Dec 2012-Trade Me Jobs		No evidence of moving seasonality
Seasonally adjusted					6	3	6	3				No evidence of residual seasonality for the entire series at the 1 per cent level in the entire series, last 3 years
Irregular					6	3	6	3				No outliers identified, ARIMA Model (0 1 1) (0 1 1)
Trades									LS Mar 2011-SEEK	LS March 2011	3 months-seek	Seasonality between months and year, present at 0.1 per cent level
Original	3		5		6	3	6	3	Oct 2007-SEEK			No evidence of moving seasonality
Seasonally adjusted		1			6	3	6	3				No evidence of residual seasonality for the entire series at the 1 per cent level in the entire series, last 3 years
Irregular		1			6	3	6	3				No outliers identified, ARIMA Model (0 1 1) (0 1 1)

Note: There is evidence for significant monthly variation on the SI ratios, suggesting a stable seasonality is present.
LS: Level Shift; AO: Additive Outlier

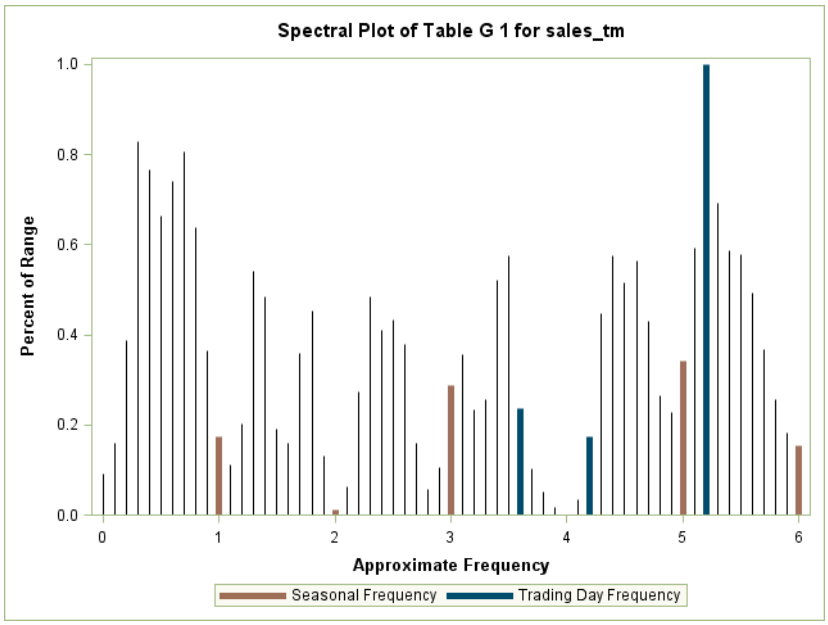
Table 5. Identification of visually significant peaks and outliers – Selected regions and industries

Variable	Visually significant peaks in comments				Noted in graph				Largest Outlier	Potential Outlier	Months for cyclical dominance	Remarks
	SEEK		Trademe Jobs		SEEK		Trademe Jobs					
	Seasonal	Trading	Seasonal	Trading	Seasonal	Trading	Seasonal	Trading				
Accounting												
Original	3		3		6	3	6	3			3 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted		1		1	6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular		1		1	6	3	6	3				There is one level shift outlier for both s and tm
Construction												
Original	1		2	1	6	3	6	3	LS NOV2007 - tm		3 months -tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted					6	3	6	3	AO OCT2007 -s		2 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular					6	3	6	3				There is one additive outlier for s and one level shifting outlier for tm
IT												
Original	2		1		6	3	6	3			2 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted					6	3	6	3			3 months - s	For s there is no evidence of an easter effect at the 5 percent level, but for tm there is evidence at the 5% level.
Irregular					6	3	6	3				There are no outliers
Education												
Original			1		6	3	6	3	AO OCT2007 - s		4 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted		1			6	3	6	3			12 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular		1			6	3	6	3				There is only one additive outlier for s and none for tm.
Sales												
Original	3		4		6	3	6	3	AO OCT2007- s		2 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted				1	6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular				1	6	3	6	3				There is only one additive outlier for s and none for tm.
Health												
Original	2		1	1	6	3	6	3	AO OCT2007 - s		4 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted					6	3	6	3	LS JUL2007 -tm		5 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular					6	3	6	3				There is one additive outlier for s and one level shifting outlier for tm
Hospitality												
Original	4		4		6		6		AO OCT2007 - s		3 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted				2	6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular				2	6	3	6	3				There is only one additive outlier for s and none for tm.
Other												
Original	4		4		6	3	6	3	AO OCT2007 - s		2 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted					6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular					6	3	6	3				There is only one additive outlier for s and none for tm.
SIOther												
Original	3		1		6	3	6	3	AO OCT2007 - s	AO sep 07	4 months - s	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted		1			6	3	6	3	AO MAR2008 - s	LS nov 07	3 months -tm	There is no evidence of an easter effect at the 5 percent level
Irregular		2			6	3	6	3				There are two additive outliers for s and none for tm.
NIOther												
Original	4		3		6	3	6	3	AO OCT2007 - s		3 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted					6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular					6	3	6	3				There is only one additive outlier for s and none for tm.
Auckland												
Original	3		4		6	3	6	3	AO OCT2007 - s		2 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted		1			6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular		1			6	3	6	3				There is only one additive outlier for s and none for tm.
Wellington												
Original	3		4		6	3	6	3	AO OCT2007 - s		2 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted		1			6	3	6	3			3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular		1			6	3	6	3				There is only one additive outlier for s and none for tm.
Canterbury												
Original	1		2		6	3	6	3	AO OCT2007 - s	AO Feb 11	3 months - tm	There is evidence of seasonality at the 0.1 and 1.0 percent level
Seasonally adjusted				1	6	3	6	3		LS Mar 11	3 months - s	There is no evidence of an easter effect at the 5 percent level
Irregular				1	6	3	6	3				There is only one additive outlier for s and none for tm.

Note:s=SEEK; tm=Trademe Jobs

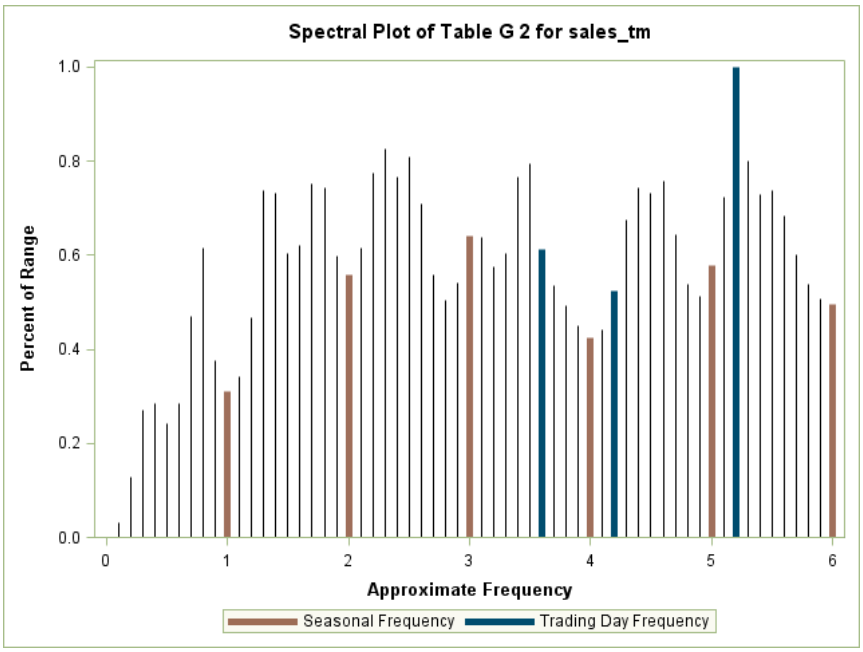
Appendix B: Spectral Analysis

Figure 4: Spectral plot for the sales industry-Trade Me Jobs - differenced, transformed seasonally adjusted



Source: MBIE diagnostics of *Jobs Online* data

Figure 5: Spectral plot of Sales Industry for Trade Me Jobs - modified irregular



Note: SAS uses TD notation to refer to day of the week effect, hence the plot shows trading day frequencies.

Source: MBIE diagnostics of *Jobs Online* data

Appendix C: AICC values

Table 6: AICC values for Seek and Trademe Jobs vacancy series

Series	Default ARIMA Model Model used			Automatic Model Selection Model used		
	NODWE	DWE	DWE and two part Easter	NODWE	DWE	DWE and two part Easter
Skilled_ SEEK	1014.1	**954.5**	971.6	1053.4	951.8	945.8
Skilled_ Trademe Jobs	967.1	939.1	**930.0**	961.3	931.8	**930.0**
Total_ SEEK	1071.8	1020.9	1031.0	1112.3	1013.0	**1000.3**
Total_ Trademe Jobs	1045.6	1013.9	1009.8	1035.2	**1001.4**	1001.7
Managers_ SEEK	850.6	826.9	824.5	893.5	**819.0**	824.5
Managers_ Trademe Jobs	786.0	754.5	**743.0**	787.1	753.9	767.3
Professionals_ SEEK	935.2	**866.9**	906.7	971.5	886.9	901.0
Professionals_ Trademe Jobs	885.1	871.2	864.4	890.2	**855.9**	860.3
Trades_ SEEK	772.1	749.6	716.7	796.5	723.1	**691.0**
Trades_ Trademe Jobs	783.2	773.2	769.8	805.3	773.9	**747.2**
Auckland_ SEEK	926.6	877.5	877.7	980.1	877.5	**876.4**
Auckland_ Trademe Jobs	866.7	833.4	835.3	859.9	**830.3**	832.6
Wellington_ SEEK	803.4	**750.7**	793.0	846.6	**750.7**	793.0
Wellington_ Trademe Jobs	806.0	785.0	787.5	819.6	783.3	**776.7**
Canterbury_ SEEK	759.6	742.7	**729.9**	784.0	742.7	**729.9**
Canterbury_ Trademe Jobs	762.3	740.7	736.4	767.4	738.3	**733.5**
SIOther_ SEEK	**670.1**	670.7	669.0	812.3	777.7	777.0
SIOther_ Trademe Jobs	656.0	655.4	660.5	**651.4**	655.4	660.5
NIOther_ SEEK	769.6	758.3	755.7	794.5	**745.0**	752.9
NIOther_ Trademe Jobs	744.2	744.1	**708.3**	750.1	741.6	739.8
Accounting_ SEEK	830.8	813.0	812.1	900.4	813.0	**802.4**
Accounting_ Trademe Jobs	769.6	**754.4**	763.1	802.8	**754.4**	760.0
Construction_ SEEK	764.0	**764.0**	767.1	953.6	**764.0**	767.8
Construction_ Trademe Jobs	762.3	**760.5**	763.2	902.1	**760.5**	763.2
IT_ SEEK	847.6	**813.6**	829.8	893.7	**813.6**	825.5
IT_ Trademe Jobs	818.5	801.3	811.1	833.3	801.3	**798.0**
Education_ SEEK	610.4	**595.9**	598.2	613.1	**595.9**	598.2
Education_ Trademe Jobs	607.2	619.5	621.8	**604.3**	619.5	624.9
Sales_ SEEK	787.7	747.4	770.0	820.7	747.4	**742.9**
Sales_ Trademe Jobs	717.2	718.5	712.4	727.0	718.5	**709.5**
Health_ SEEK	724.9	716.1	**710.0**	748.7	716.1	**710.0**
Health_ Trademe Jobs	**724.4**	725.4	730.0	857.0	725.4	730.0
Hospitality_ SEEK	636.8	**619.4**	631.1	821.2	**619.4**	637.4
Hospitality_ Trademe Jobs	637.7	632.2	**631.2**	636.4	632.2	**631.2**
Other_ SEEK	813.6	**782.2**	797.3	850.6	**782.2**	794.4
Other_ Trademe Jobs	797.8	**789.0**	790.3	810.1	**789.0**	790.3

Note: The bold figures have the smallest AICC values

Appendix D: Monitoring and Quality Assessment Statistics

Table 7. M and Q Statistics for Automodel specification (Day of the week and 2-part Easter regressors)

Series	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M-Statistics	Q-Statistics
Skilled_s	0.082	0.024	0	0.106	0.106	0.14	0.217	0.291	0.276	0.287	0.284	Accepted at the 0.15	Q(without M2)=0.16
Skilled_tm	0.046	0.019	0	0.106	0	0.128	0.204	0.171	0.151	0.18	0.178	Accepted at the 0.10	Q(without M2)=0.11
Total_S	0.053	0.012	0	0.318	0.107	0.046	0.202	0.264	0.245	0.247	0.237	Accepted at the level 0.14	Q(without M2)=0.16
Total_TM	0.044	0.016	0	0.212	0	0.187	0.19	0.212	0.201	0.221	0.217	Accepted at the level 0.12	Q(without M2)=0.24
Managers_S	0.162	0.053	0	0.318	0.178	0.243	0.249	0.369	0.354	0.384	0.378	Accepted at the level 0.22	Q(without M2)=0.15
Managers_TM	0.245	0.072	0	0.955	0.008	0.555	0.306	0.305	0.29	0.354	0.339	Accepted at the level 0.29	Q(without M2)=0.32
Professionals_S	0.168	0.037	0	0.106	0.143	0.461	0.342	0.445	0.457	0.47	0.462	Accepted at the level 0.23	Q(without M2)=0.26
Professionals_TM	0.089	0.041	0	0.106	0.072	0.064	0.312	0.346	0.294	0.334	0.315	Accepted at the level 0.16	Q(without M2)=0.18
Trades_S	0.063	0.014	0	0.743	0.04	0.271	0.158	0.269	0.266	0.295	0.295	Accepted at the level 0.18	Q(without M2)=0.20
Trades_TM	0.116	0.039	0	0.637	0	0.052	0.206	0.305	0.281	0.344	0.329	Accepted at the level 0.18	Q(without M2)=0.19
Auckland_S	0.092	0.028	0	0.849	0.192	0.238	0.22	0.299	0.29	0.276	0.266	Accepted at the level 0.25	Q(without M2)=0.20
Auckland_TM	0.148	0.055	0	0.318	0	0.402	0.209	0.273	0.245	0.293	0.284	Accepted at the level 0.18	Q(without M2)=0.20
Wellington_S	0.194	0.046	0	0.637	0.195	0.013	0.311	0.322	0.295	0.353	0.348	Accepted at the level 0.23	Q(without M2)=0.25
Wellington_TM	0.278	0.086	0	0.106	0.101	0.788	0.277	0.194	0.174	0.154	0.15	Accepted at the level 0.16	Q(without M2)=0.17
Canterbury_S	0.655	0.129	0.181	0.955	0.489	0.592	0.371	0.522	0.44	0.538	0.523	Accepted at the level 0.46	Q(without M2)=0.51
Canterbury_TM	0.477	0.135	0.05	0.425	0.262	0.061	0.388	0.61	0.601	0.642	0.642	Accepted at the level 0.34	Q(without M2)=0.37
SIOther_S	1.639	0.737	1.276	0.955	1.053	0.356	0.888	0.985	0.87	0.996	0.978	Conditionally Accepted at the level 0.97; Failed M1, M3 and	Q(without M2)=1.00
SIOther_TM	1.027	0.699	0.29	0.531	0.415	0.352	0.566	0.546	0.484	0.632	0.614	Accepted at the level 0.56; Failed M1	Q(without M2)=0.54
NIOther_S	0.559	0.194	0.201	0.106	0.294	0.582	0.317	0.419	0.413	0.485	0.48	Accepted at the level 0.35	Q(without M2)=0.37
NIOther_TM	0.342	0.216	0.098	1.061	0.355	0.294	0.357	0.391	0.359	0.458	0.447	Accepted at the level 0.3	Q(without M2)=0.39
Accounting_S	0.249	0.048	0	0.531	0.219	0.175	0.412	0.517	0.507	0.555	0.543	Accepted at the level 0.30	Q(without M2)=0.34
Accounting_TM	0.451	0.181	0.053	0.212	0.364	0.316	0.435	0.39	0.349	0.413	0.412	Accepted at the level 0.31	Q(without M2)=0.35
Construction_S	0.37	0.069	0	0.531	0.207	0.178	0.485	0.663	0.579	0.763	0.721	Accepted at the level 0.36	Q(without M2)=0.40
Construction_TM	0.53	0.075	0	0.106	0.187	0.135	0.818	0.834	0.795	1.024	0.995	Accepted at the level 0.45	Q(without M2)=0.49
Sales_S	0.177	0.066	0	0.637	0.235	0.506	0.282	0.298	0.286	0.288	0.283	Accepted at the level 0.24	Q(without M2)=0.26
Sales_TM	0.18	0.106	0	0.106	0.241	0.636	0.313	0.312	0.27	0.333	0.318	Accepted at the level 0.25	Q(without M2)=0.27
Health_S	0.641	0.629	0.88	0.106	0.721	0.538	0.376	0.474	0.445	0.469	0.419	Accepted at the level 0.53	Q(without M2)=0.52
Health_TM	0.748	0.383	0.338	0.106	0.518	0.013	0.528	0.725	0.679	0.74	0.726	Accepted at the level 0.47	Q(without M2)=0.48
IT_S	0.216	0.048	0	0.212	0.196	0.233	0.276	0.288	0.256	0.308	0.305	Accepted at the level 0.20	Q(without M2)=0.22
IT_TM	0.198	0.048	0	0	0.112	0.182	0.36	0.531	0.506	0.592	0.589	Accepted at the level 0.24	Q(without M2)=0.26
Hospitality_S	0.295	0.174	0.178	0.849	0.467	0.132	0.395	0.513	0.469	0.569	0.55	Accepted at the level 0.38	Q(without M2)=0.241

Note: TM-Trade Me Jobs; S-SEEK

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Table 8. M and Q Statistics for ARIMA (0 1 1) (0 1 1) (Day of the week and 2-part Easter regressors)

Series	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M-Statistics	Q-Statistics
Skilled_s	0.09	0.022	0	0.106	0.07	0.284	0.219	0.286	0.275	0.298	0.285	Accepted at the level 0.14	Q(without M2)= 0.16
Skilled_tm	0.046	0.019	0	0.106	0	0.127	0.204	0.172	0.152	0.18	0.178	Accepted at the level 0.10	Q(without M2)= 0.11
Total_S	0.045	0.009	0	0.318	0.07	0.04	0.201	0.219	0.202	0.209	0.198	Accepted at the level 0.12	Q(without M2)= 0.14
Total_TM	0.057	0.018	0	0	0	0.09	0.191	0.184	0.169	0.192	0.19	Accepted at the level 0.09	Q(without M2)= 0.10
Managers_S	0.162	0.053	0	0.318	0.178	0.243	0.249	0.369	0.354	0.384	0.378	Accepted at the level 0.22	Q(without M2)= 0.24
Managers_TM	0.226	0.065	0	0.955	0.039	0.336	0.275	0.313	0.296	0.363	0.352	Accepted at the level 0.26	Q(without M2)= 0.29
Professionals_S	0.172	0.036	0	0.106	0.146	0.228	0.314	0.374	0.359	0.401	0.394	Accepted at the level 0.21	Q(without M2)= 0.23
Professionals_TM	0.096	0.043	0	0.318	0.081	0.099	0.317	0.325	0.284	0.322	0.308	Accepted at the level 0.18	Q(without M2)= 0.20
Trades_S	0.051	0.018	0	0.106	0.035	0.742	0.244	0.64	0.615	0.726	0.717	Accepted at the level 0.23	Q(without M2)= 0.26
Trades_TM	0.117	0.042	0	0.212	0.057	0.242	0.221	0.29	0.272	0.355	0.353	Accepted at the level 0.17	Q(without M2)= 0.19
Auckland_S	0.094	0.027	0	0.637	0.194	0.128	0.221	0.298	0.292	0.279	0.269	Accepted at the level 0.21	Q(without M2)= 0.23
Auckland_TM	0.191	0.067	0	0.531	0	0.458	0.211	0.281	0.248	0.298	0.286	Accepted at the level 0.21	Q(without M2)= 0.23
Wellington_S	0.194	0.046	0	0.637	0.195	0.013	0.311	0.322	0.295	0.353	0.348	Accepted at the level 0.23	Q(without M2)= 0.25
Wellington_TM	0.331	0.11	0	0.318	0.123	0.985	0.288	0.192	0.168	0.154	0.15	Accepted at the level 0.19	Q(without M2)= 0.20
Canterbury_S	0.655	0.129	0.181	0.955	0.489	0.592	0.371	0.522	0.44	0.538	0.523	Accepted at the level 0.46	Q(without M2)= 0.51
Canterbury_TM	0.481	0.136	0.054	0.637	0.263	0.057	0.386	0.616	0.607	0.647	0.647	Accepted at the level 0.21	q(without M2)= 0.39
SIOther_S	0.929	0.431	0.518	0.531	0.483	0.053	0.649	0.743	0.686	0.81	0.798	Accepted at the level 0.57	Q(without M2)= 0.59
SIOther_TM	1.027	0.699	0.289	0.531	0.415	0.353	0.566	0.547	0.485	0.633	0.614	Accepted at the level 0.56; Failed M1	Q(without M2)= 0.52
NIOther_S	0.565	0.194	0.2	0.106	0.294	0.565	0.315	0.421	0.416	0.488	0.481	Accepted at the level 0.35	q(without M2)= 0.37
NIOther_TM	0.268	0.665	0.102	0.955	0.323	0.047	0.278	0.427	0.417	0.483	0.476	Accepted at the level 0.25	Q(without M2)= 0.26
Accounting_S	0.245	0.048	0	0.531	0.236	0.045	0.42	0.463	0.457	0.509	0.502	Accepted at the level 0.28	Q(without M2)= 0.31
Accounting_TM	0.452	0.181	0.053	0.212	0.363	0.317	0.435	0.39	0.349	0.413	0.412	Accepted at the level 0.32	Q(without M2)= 0.34
Construction_S	0.386	0.075	0	0.531	0.21	0.045	0.498	0.672	0.593	0.765	0.729	Accepted at the level 0.35	Q(without M2)= 0.39
Construction_TM	0.53	0.075	0	0.106	0.187	0.135	0.818	0.834	0.795	1.024	0.995	Accepted at the level 0.45	Q(without M2)= 0.49
Sales_S	0.32	0.088	0.17	0.212	0.448	0.72	0.34	0.305	0.274	0.309	0.296	Accepted at the level 0.28	Q(without M2)= 0.31
Sales_TM	0.18	0.106	0	0.106	0.241	0.637	0.313	0.313	0.271	0.334	0.319	Accepted at the level 0.25	Q(without M2)= 0.27
Health_S	0.641	0.629	0.88	0.106	0.721	0.538	0.376	0.474	0.445	0.469	0.419	Accepted at the level 0.53	Q(without M2)= 0.52
Health_TM	0.748	0.383	0.337	0.106	0.518	0.013	0.528	0.725	0.679	0.74	0.726	Accepted at the level 0.47	Q(without M2)= 0.48
IT_S	0.22	0.052	0	0.637	0.187	0.05	0.269	0.319	0.294	0.343	0.338	Accepted at the level 0.22	Q(without M2)= 0.24
IT_TM	0.195	0.047	0	0	0.116	0.196	0.359	0.507	0.484	0.557	0.544	Accepted at the level 0.23	Q(without M2)= 0.26
Hospitality_S	0.296	0.178	0.216	0.637	0.47	0.103	0.397	0.502	0.474	0.57	0.563	Accepted at the level 0.39	Q(without M2)= 0.39

Note: TM-Trade Me Jobs; S-SEEK

Appendix E. Testing day of the week effect and Easter effect regressors - automodel specification

Table 9. Chi-squared tests for groups of regressors-skilled, occupation and region series

Series	Regression effect	DF	Chi-Square	Pr > Chi-Square	ARIMA Model
Skilled_S	Trading Day	6	111.02	<.0001	(0 2 2)(0 1 1)
	NZ Easter	2	20.26	<.0001	
Skilled_TM	Trading Day	6	92.31	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	22.39	<.0001	
Total_S	Trading Day	6	112.35	<.0001	(2 2 0)(0 1 1)
	NZ Easter	2	15.47	0.0004	
Total_TM	Trading Day	6	101.31	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	10.61	0.005	
Managers_s	Trading Day	6	68.25	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	9.78	0.0075	
Managers_TM	Trading Day	6	41.93	<.0001	(1 1 0)(0 1 1)
	NZ Easter	2	13.22	0.0013	
Professionals_S	Trading Day	6	65.87	<.0001	(2 1 2)(0 1 1)
	NZ Easter	2	8.81	0.0122	
Professionals_TM	Trading Day	6	68.24	<.0001	(1 1 1)(0 1 1)
	NZ Easter	2	17.24	0.0002	
Technicians and Trades_S	Trading Day	6	186.81	<.0001	(2 1 2)(0 1 1)
	NZ Easter	2	31.74	<.0001	
Technicians and Trades_TM	Trading Day	6	64.64	<.0001	(1 1 1)(0 1 1)
	NZ Easter	2	20.56	<.0001	
Auckland_S	Trading Day	6	288.21	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	128.49	<.0001	
Auckalnd_TM	Trading Day	6	72.65	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	3.90	0.1422	
Wellington_S	Trading Day	6	63.91	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	4.96	0.0839	
Wellington_TM	Trading Day	6	53.05	<.0001	(0 2 1)(0 1 1)
	NZ Easter	2	2.65	0.2653	
Canterbury_S	Trading Day	6	71.25	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	15.31	0.0005	
Canterbury_TM	Trading Day	6	42.42	<.0001	(0 1 0)(0 1 1)
	NZ Easter	2	12.34	0.0021	
SIOther_S	Trading Day	6	28.80	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	6.99	0.0304	
SIOther_TM	Trading Day	6	15.30	0.018	(0 1 1)(0 1 1)
	NZ Easter	2	0.68	0.7129	
NIOther_TM	Trading Day	6	41.50	<.0001	(0 1 0)(0 1 1)
	NZ Easter	2	10.03	0.0066	
NIOther_S	Trading Day	6	13.38	0.0373	(0 1 1)(0 1 1)
	NZ Easter	2	12.59	0.0018	

Table 10. Chi-squared Tests for Groups of Regressors-Skilled, occupation and region series

Series	Regression effect	DF	Chi-Square	Pr > Chi-Square	ARIMA Model
Accounting_S	Trading Day	6	43.21	<.0001	(0 2 1)(0 1 1)
	NZ Easter	2	4.86	0.0879	
Accounting_TM	Trading Day	6	38.56	<.0001	(0 1 0)(0 1 1)
	NZ Easter	2	0.08	0.9588	
Construction_S	Trading Day	6	11.90	0.0641	(0 1 0)(0 1 1)
	NZ Easter	2	1.12	0.5717	
Construction_TM	Trading Day	6	16.18	0.0128	(0 1 1)(0 1 1)
	NZ Easter	2	3.62	0.1633	
Education_TM	Trading Day	6	41.86	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	3.91	0.1415	
Education_S	Trading Day	6	3.49	0.7456	(0 1 1)(0 1 1)
	NZ Easter	2	0.66	0.7186	
Sales_S	Trading Day	6	76.70	<.0001	(1 1 2)(0 1 1)
	NZ Easter	2	6.40	0.0407	
Sales_TM	Trading Day	6	11.51	0.0739	(0 1 0)(0 1 1)
	NZ Easter	2	14.48	0.0007	
Health_S	Trading Day	6	40.58	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	2.05	0.359	
Health_TM	Trading Day	6	12.74	0.0474	(0 1 1)(0 1 1)
	NZ Easter	2	1.39	0.4994	
Hospitality_TM	Trading Day	6	31.29	<.0001	(1 0 0)(1 1 0)
	NZ Easter	2	7.21	0.0272	
Hospitality_S	Trading Day	6	22.72	0.0009	(0 1 1)(1 1 0)
	NZ Easter	2	7.16	0.0279	
IT_S	Trading Day	6	37.69	<.0001	(3 1 1)(0 1 1)
	NZ Easter	2	21.96	<.0001	
IT_TM	Trading Day	6	20.59	0.0022	(0 2 1)(0 1 1)
	NZ Easter	2	8.34	0.0154	
Other_TM	Trading Day	6	47.51	<.0001	(0 1 1)(0 1 1)
	NZ Easter	2	1.49	0.4755	
Other_S	Trading Day	6	25.95	0.0002	(0 1 1)(0 1 1)
	NZ Easter	2	9.68	0.0079	

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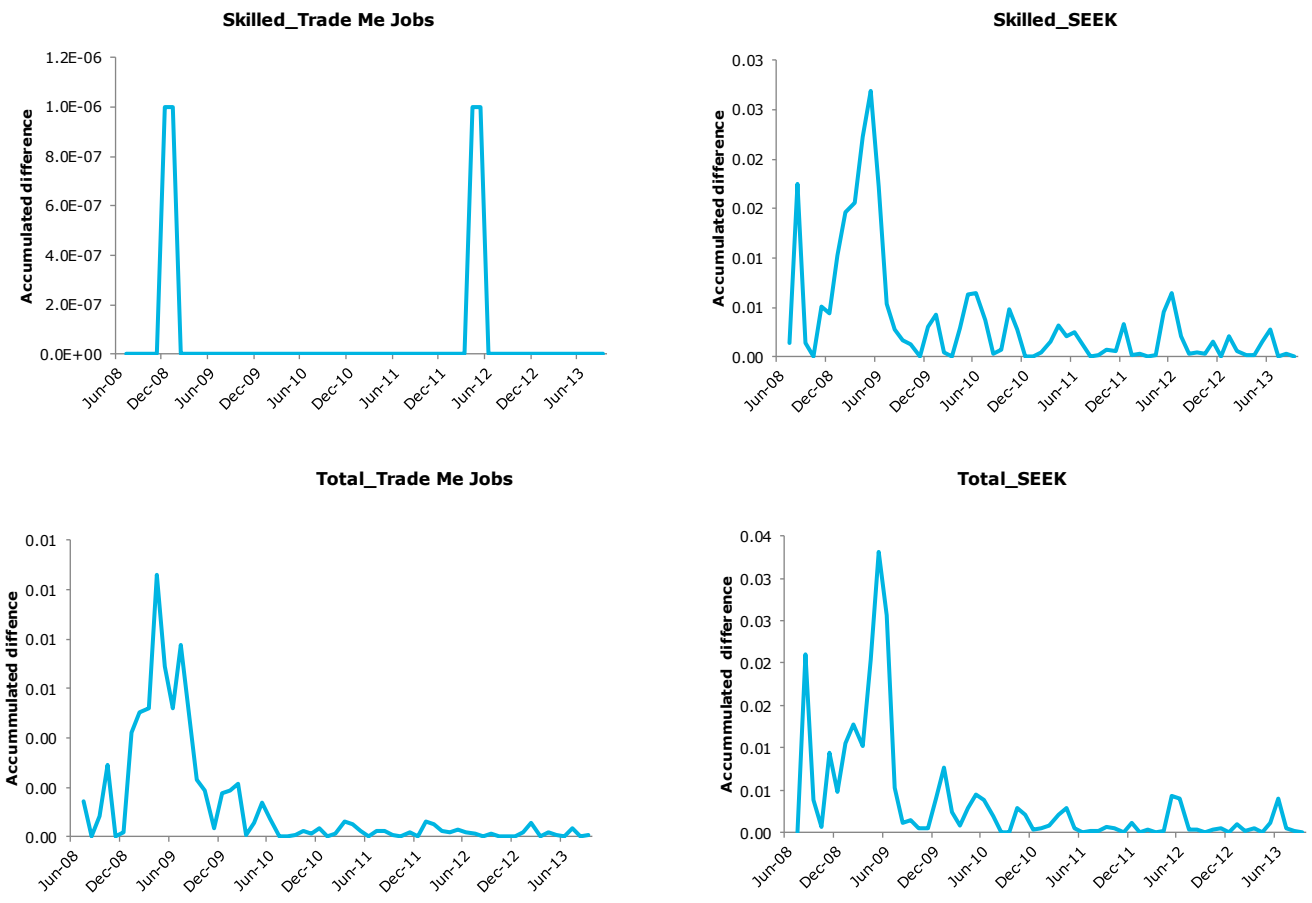
Appendix F: Out-of-sample forecast errors

Figure 6. Accumulated squared difference of forecast errors



Source: MBIE diagnostics of *Jobs Online* data

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