RESERVE BANK OF NEW ZEALAND

DP2009/06

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June 2009

JEL classification: C32, E24, E31

www.rbnz.govt.nz/research/discusspapers

Discussion Paper Series

ISSN 1177-7567

DP2009/06

Analysing wage and price dynamics in New Zealand*

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Abstract

This paper examines the relationship between wages and consumer prices in New Zealand over the last 15 years. Reflecting the open nature of the New Zealand economy, the headline CPI is disaggregated into non-tradable and tradable prices. We find that there is a joint causality between wages and disaggregate inflation. An increase in wage inflation forecasts an increase in non-tradable inflation. However, it is tradable inflation that drives wage inflation. While exogenous shocks to wages do not help to forecast inflation, the leading relationship from wages to non-tradable inflation implies that monitoring wages may prove useful for projecting the impact of other shocks on future inflation.

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* The views expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Reserve Bank of New Zealand. We thank Felipe Labbé for his valuable help and other colleagues at the Reserve Bank of New Zealand for constructive comments.
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ISSN 1177-7567

1 Introduction

Central banks are interested in the role of wages in the inflation process, and whether this is more consistent with a 'cost-push' or 'demand-pull' view of the wage-price dynamic. In a 'cost-push' inflation environment, changes in productivity adjusted wages will help to predict movements in prices as firms look to maintain profit margins. The 'demand pull' view of inflation, on the other hand, implies that excessive demand pressure will cause firms to raise their prices, prompting workers to demand higher wages.

One approach to examining the determinants of the inflation process is to directly survey firms on how they set prices. Behavioural research of this sort tends to indicate that firms increase prices more because of cost-push pressures than demand-pull pressures. These cost push pressures are likely to come from a combination of sources, including productivity adjusted wages. Consequently, there may be times when increases in wages lead increases in prices (see Blinder, 1991, Blinder et al. 1998 and Bewley 2007). Indeed, Coleman and Silverstone (2007) recently presented evidence that New Zealand firms adjust prices more in response to changes in costs than to changes in demand.

Another approach, and the one applied in this paper, is to examine the macroeconomic relationship between wages and prices. This paper uses New Zealand data from the last 15 years to examine the relationship between wages and prices. We aim to determine whether this relationship is more consistent with the cost-push or demand-pull view of the inflation process. In addition, we explore the nature of any in-sample gains from incorporating wages as an explanatory variable for predicting inflation.

Following Ghali (1999) and Mills and Wood (2002), we examine the interaction between wages and prices within a Vector Error Correction Model (VECM) framework. However, in contrast to these studies, we develop a model that takes account of the openness of the New Zealand economy, allowing for different price dynamics across the tradable and non-tradable sectors of the economy.[1] We are also careful to include controls for other influences on wages and prices, including the output gap and import

[1] Matheson (2008) shows that disaggregation of the headline price level into non-tradable and tradable inflation significantly improves out-of-sample forecasting performance in New Zealand.

prices. Our analysis suggests that previous studies have not included these controls appropriately.

Consistent with the international literature, we find that there is a joint causality between wages and prices.[2] The disaggregation of the headline CPI into tradable and non-tradable prices appears to be important in uncovering the nature of the relationship. Wages are found to predict increases in non-tradable prices (but not tradable prices) through the cost-push channel. In contrast, it is tradable prices that have the largest impact on wages through the demand-pull channel.

In addition to the causality tests typically employed in the literature, we also investigate the contribution of wages shocks to the forecast error variance of non-tradable and tradable inflation. This provides a direct measure of the importance of cost-push shocks sourced in the labour market for explaining inflation. The results imply that there are only small gains from identifying these shocks when formulating projections of future inflation. Nevertheless, the leading relationship from wages to non-tradable inflation suggests that monitoring wages may prove useful for projecting the impact of other shocks on future inflation.

The paper proceeds as follows. Section 2 specifies our theoretical model and our empirical model. Section 3 describes the data, and section 4 presents our results. We conclude in section 5.

2 The model

2.1 The theoretical model

The theoretical model is based on an expectations-augmented Phillips curve framework similar to that presented in Gordon (1982, 1985), Ghali (1999) and Mills and Wood (2002). This framework can be represented by the following system of equations:

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[2] The majority of studies find that wage and price changes are related. However, the direction of causation is often unclear and is frequently found to depend on the data used and the sample period chosen. In support of the demand pull view, Mehra (1991), Hess and Schweitzer (2000) and Mills and Wood (2002) find that growth in wages does not provide any consistently significant additional explanatory power for prices. A number of papers also find some evidence for the cost push view (see Mehra 1993, Braur 1997, Aaronson 2001 and Ghali 1999). We interpret these results as evidence that both channels can be significant.

$$\Delta p_t = c_1 + \lambda_1 \Delta w_t + \kappa_1 x_t + \theta_1 m_t \quad (1)$$

$$\Delta w_t = c_2 + \lambda_2 \Delta p_t^e + \kappa_2 x_t + \theta_2 m_t \quad (2)$$

where p_t is the (log) price level, w_t is the (log) productivity adjusted wage level, p_t^e is the (log) expected price level, x_t is a demand shock and m_t is a supply shock (Δ is the first difference operator).

This model provides a simple framework for motivating the joint causality between wages and prices. Equation 1 describes the behaviour of monopolistically competitive firms where prices are set as a mark up over productivity adjusted wages and are also a function of aggregate demand pressure and cost-push shocks. Equation 2 shows that this pricing behaviour in turn impacts productivity adjusted wages through inflation expectations and that wages are also driven by aggregate demand pressure and cost-push shocks.

This model is not ideal for modelling wage-price dynamics in a small open economy such as New Zealand. For example, a prevalence of imported goods in New Zealand means that domestic labour costs account for a far greater proportion of production costs in the non-tradable sector than in the tradable sector. Accordingly, we allow for the possibility that the coefficients in equation 1 will differ across the tradable and non-tradable sectors:

$$\Delta p_t^n = c_3 + \lambda_3 \Delta w_t + \kappa_3 x_t + \theta_3 m_t \quad (3)$$

$$\Delta p_t^t = c_4 + \lambda_4 \Delta w_t + \kappa_4 x_t + \theta_4 m_t \quad (4)$$

where p_t^n is the (log) non-tradable price level and p_t^t is the (log) tradable price level.

Inflation expectations are modelled as follows:

$$\Delta p_t^e = \sum_j \delta_j \Delta p_{t-j}^n + \sum_j \tau_j \Delta p_{t-j}^t \quad (5)$$

This equation is very similar to the assumption that expectations are a distributed lag of past inflation outturns that is commonly applied in the literature. Furthermore, we have allowed for the possibility that inflation expectations are formed through an asymmetric combination of past tradable and non-tradable inflation (which may be different to the relative weights in the headline price level).[3]

Following Ghali (1999) and Mills and Wood (2002), we proxy for demand pressure with a measure of the output gap and proxy for supply disturbances with the relative price of imports compared to equilibrium.

The backward-looking solution to the model is:

$$p_t^n = c_6 + \mathrm{A}_1 X_t + \mathrm{B}_1 M_t \tag{6}$$

$$p_t^t = c_7 + \mathrm{A}_2 X_t + \mathrm{B}_2 M_t \tag{7}$$

$$w_t = c_8 + \mathrm{A}_3 X_t + \mathrm{B}_3 M_t \tag{8}$$

where $X_t = \sum_i x_{t-i}$ and $M_t = \sum_i m_{t-i}$. The As and Bs are reduced-form coefficients that are functions of all of the parameters of the model. Note that our theoretical model predicts two stochastic trends (three cointegrating vectors) in the system of equations, one related to demand shocks and one related to supply shocks.

2.2 The empirical model

This simple characterization of the long-run relationships in the theoretical model can be used as a guide to the empirical long-run relationships that could be estimated from the data. Ghali (1999) and Mills and Wood (2002) postulate cointegration between the *level* of wages, prices, and the output and import gaps. It is clear, however, that the long-run relationship should contain the *cumulative sum* of the output gap and relative import prices, rather than their levels. Intuitively, equations 1 and 2 imply that demand and supply shocks have long-lasting impacts on prices and wages (as long as the λ coefficients are positive) so that the contemporaneous shock gives a poor reading on where the level of prices and wages will converge.

We will see in the next section that there are some important features of the New Zealand data that do not appear in our theoretical model, but which we should allow for in our empirical model.

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[3] Although in the simple model (equations 1 and 2) expectations only influence prices indirectly through wages, various motivations (such as the presence of some rule-of-thumb firms that index to past inflation) could be given to motivate a more direct role for inflation expectations in the pricing equation.

For example, the mid-point of the Reserve Bank of New Zealand (RBNZ) inflation targeting band has changed three times since the shift to inflation targeting in 1989, suggesting the potential for a positive drift in inflation over our sample period.[4] In addition, the average non-tradable inflation rate over our sample is higher than the average tradable inflation rate. This relative price trend is likely driven by productivity differentials across the tradable and non-tradable sectors of the economy (a Balassa-Samuelson-type effect) and suggests that we have an un-modelled trend in our long-run relationships. We treat this trend as being deterministic.

Thus, our empirical model allows for deterministic trends in our long-run relationships (accounting for relative price trends) and deterministic trends in the dynamic equations (accounting for inflation target shifts). Our VECM is thus:

$$\Delta y_t = c + \mu t + \alpha(\varphi + \rho t + z_t) + \sum_{i=1}^{k} \Gamma_i \Delta y_{t-i} + \varepsilon_t \tag{9}$$

where $y_t' = \left[w_t, p_t^n, p_t^t, p_t^e, X_t, M_t\right]$, k is the lag length, β is a matrix containing the long-run relationships, $z = \beta' y$ is a matrix containing the disequilibrium in these long-run relationships and α contains the corresponding equilibrium correction parameters, Γ_i is a matrix containing the dynamic adjustment parameters, c, μ, φ and ρ are vectors of constants, t is a time trend, and ε_t is a vector of reduced-form residuals.

[4] The three regimes are: 0 to 2 percent between 1989 and 1996Q4; 0 to 3 percent between 1997Q1 and 2002Q3; and 1 to 3 percent from 2002Q4 to the present.

3 Data

We use quarterly data from New Zealand for the period 1992Q4 to 2008Q1. All data are in logarithms.

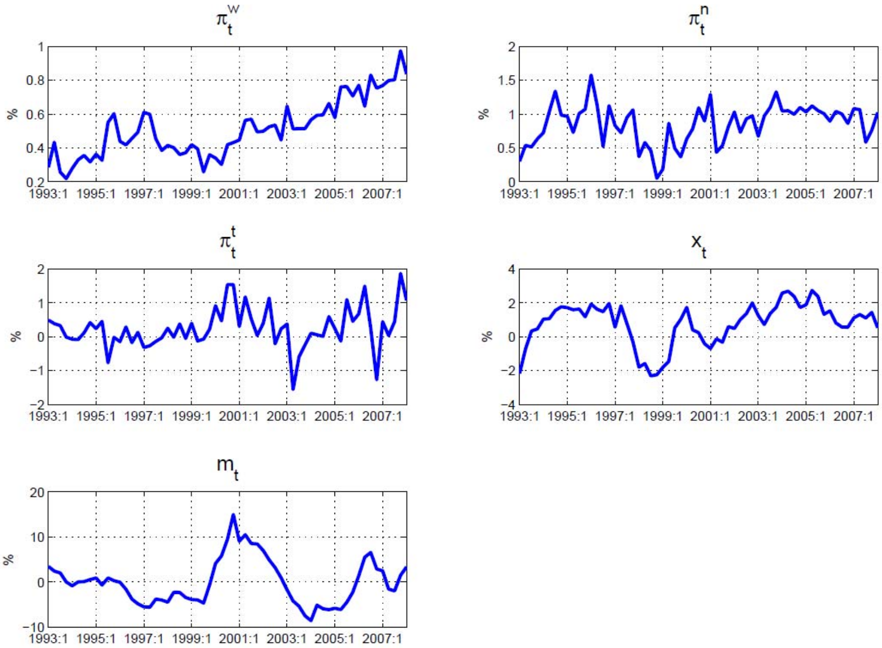
We disaggregate the headline CPI into non-tradable and tradable components.[5] The impact of a change in the way rents were measured in 2001Q1 is also excluded from the non-tradable component. Wages are defined as the Labour Cost Index (LCI) average hourly earnings for the private sector including overtime. This wage measure most closely resembles unit labour costs as it ensures that the composition of jobs sampled remains the same at the time of each survey and attempts to measure the same ‘quality’ of labour.[6] Relative import prices are defined as the HP filtered ratio of the total merchandise import price index to headline CPI, and the output gap is defined as the difference between real GDP and the RBNZ’s estimate of potential real GDP.

The inflation rates and output and import price gaps are displayed in figure 1. As mentioned in the previous section, non-tradable inflation was higher than tradable inflation on average over our sample period. We can also see that non-tradable inflation has tended to be higher than wage inflation. Inflation target changes discussed in section 2.2 are particularly noticeable in wage inflation, where there is a pronounced upward trend over our sample period.

[5] The classification of an item as a tradable or a non-tradable is conducted in two steps: the first step mechanically identifies the goods and services that have significant tradable components from input-output tables; the second step classifies the remaining items using a more subjective approach (see www.stats.govt.nz for a more detailed description of the classification algorithm).

[6] This is done by excluding those wage changes that employers indicate have resulted due to changes in the productivity of labour.

Figure 1
Data



Indeed, augmented Dickey-Fuller (ADF) tests (table 1) show that wage inflation is only stationary when a trend is included in the specification. Tradable and non-tradable inflation, on the other hand, are found to be stationary without a trend. (Note that the output gap and relative import price gap are omitted from the table because they are stationary by construction.)

Table 1
ADF tests

	Constant	Constant and trend
	t-stat	*t*-stat
$\Delta\ p^t$	-5.50*	-5.58*
$\Delta\ p^n$	-4.48*	-4.67*
$\Delta\ w$	-0.69	-3.70*

* indicates significance at the 1 percent level. MacKinnon (1996) *p*-values. Lag length selected with Schwarz-Bayesian information criteria.

4 Empirical Results

As a preliminary step, we specify the lag length *k* in our model to be 1, based on the Schwarz-Bayesian information criteria.[7]

We then test for the number of cointegrating vectors; the results are displayed in table 2. At a 1 per cent level of significance, the trace and maximum eigenvalue statistics suggest four and three cointegrating vectors respectively. We choose to proceed with three cointegrating vectors, the number predicted by our theoretical model.

Table 2
Cointegration tests

H0	H1	Trace	H1	Max
$r = 0$	$r \geq 1$	148.48*	$r = 1$	62.31*
$r \leq 2$	$r \geq 2$	86.17*	$r = 2$	41.38*
$r \leq 3$	$r \geq 3$	44.80*	$r = 3$	21.92
$r \leq 4$	$r \geq 4$	22.87	$r = 4$	18.24

* indicates significance at the 1 percent level. MacKinnon et al (1999) *p*-values.

The estimates of the cointegrating vectors are shown in table 3. The estimated parameters imply strong long-run effects on all price levels from an increase in the output gap. A one percent increase in the output gap (i.e. a permanent increase in the cumulative output gap) leads to an increase in the wage level of 0.49 percent, the non-tradable price level of 0.15 percent, and the tradable price level of 0.34 percent. We also find a significant effect of relative import prices on tradable prices and wages. A one percent increase in the relative price of imports increases the tradable price level by 0.14 percent and the wage level by 0.07 percent. In contrast, there is a negligible impact on non-tradable prices.

The estimates of the trends in the cointegrating vectors are also shown in table 3.[8] We find a positive trend in wages and a strong positive trend for non-tradable prices, but no significant trend in tradable prices. The implied

[7] The modified Portmanteau test for autocorrelation in the residuals (Lütkephol, 2007), finds no significant evidence of autocorrelation at a 5 percent level up to four lags. This implies that one lag is sufficient to capture most of the important dynamics in our system.
[8] As we incorporate a trend in both the dynamic and cointegration equations, it is not possible to obtain standard errors for these estimated trends.

trend in the ratio of non-tradable to tradable prices is consistent with the Balassa-Samuelson effect mentioned in section 2.2.

Table 3
Estimated long-run relationships

Δw_t	Δp_t^n	Δp_t^t	x_t	m_t	Trend
1	0	0	0.49*	0.07*	0.0015
0	1	0	0.15*	0.00*	0.0074
0	0	1	0.34*	0.14*	0.0000

Notes: * indicates significance at the 10 percent level.

Table 4 presents estimates of the dynamic parameters of the model. The results have the following implications for the wage-price dynamic:

i. Wages above the equilibrium predicted by past changes in the output gap and import prices leads to above average non-tradable inflation. In addition to this, lagged wage inflation has a direct positive impact on non-tradable inflation: a one percent rise in wages leads to a 0.70 percent increase in non-tradable inflation. These results are consistent with the ‘cost-push’ view of the inflation process.

ii. Tradable prices above the equilibrium suggested by past changes in the output gap and import prices leads to an increase in wages. This result adds support to the ‘demand pull’ view of inflation. In contrast, there is no significant evidence that increases in non-tradable prices leads to an increase in wages through any channel.

Overall, we find evidence for a bi-directional relationship between non-tradable prices and wages.

The adjustment parameters are informative for how the estimated long-run relationships are restored. In both the non-tradable and wage inflation equations, the adjustment parameter related to the own long-run relationship is statistically significant at the 5 percent level. This implies that wages (non-tradable prices) below the equilibrium predicted by past changes in the output gap and import prices leads to above average wage (non-tradable) inflation. Thus, a permanent increase in the cumulative output gap or import prices leads to an increase wages and non-tradable prices. These increases act to return the system to equilibrium.

In contrast, the adjustment parameter for the tradable long-run relationship is insignificant in the tradable inflation equation, but significant in the import price equation. Tradable prices below their equilibrium given past increases in the output gap and import prices predict a decline in import prices. Similar estimates are found for the adjustment parameters in the output gap and import price equations in response to the non-tradable cointegrating residual. These results suggest an important mean-reverting component in the cumulative relative import price and output gaps which is unrelated to the long-run trend for the CPI.

Table 4
Dynamic parameter estimates

	Δw_t	Δp_t^n	Δp_t^t	x_t	m_t
z_{t-1}^w	-0.05*	0.09*	0.07	0.15	-0.60
z_{t-1}^n	0.06	-0.58*	-0.28	1.04*	-2.16*
z_{t-1}^t	0.04*	-0.16*	-0.03	0.12	0.93*
Δw_{t-1}	0.13	0.70*	0.38	1.85*	2.52
Δp_{t-1}^n	-0.06	0.28*	0.34	-0.10	0.37
Δp_{t-1}^t	-0.01	0.01	0.20	-0.45*	0.09
x_{t-1}	0.02	0.03	-0.03	1.02*	0.04
m_{t-1}	0.00	0.02*	0.01	-0.01	0.75*
$\overline{R}^2$	0.85	0.63	0.20	0.77	0.87

* indicates significance at the 10 percent level. The parameters relating to the deterministic terms have been omitted for parsimony.

Finally, unreported estimates of the trend in the dynamic equations suggest that the only significant quadratic trend is in the wage level. This is consistent with the discussion in section 3.

Table 5 formally tests for a bi-directional relationship between wages and prices by applying joint Granger causality tests on the adjustment parameters and the short-run coefficients. For example, to establish if wages Granger cause non-tradable prices we jointly test both the adjustment parameter on the wages cointegrating residual and the coefficient on lagged wage inflation in the non-tradable inflation equation. Consistent with the results shown in table 4, we find significant evidence that wages Granger cause non-tradable prices, but not tradable prices. In addition, there is weaker evidence that tradable prices Granger cause wages, and no evidence that non-tradable prices Granger cause wages.

Table 5
Granger causality results

	Alternative hypotheses	*p*-value
Cost-push	Wages Granger cause non-tradable prices	0.05
	Wages Granger cause tradable prices	0.85
Demand-pull	Non-tradable prices Granger cause wages	0.23
	Tradable prices Granger cause wages	0.12

In light of the evidence for a leading relationship between wages and non-tradable inflation, we explore the nature of any gains from incorporating wages as an explanatory variable for predicting inflation. We do this by decomposing the forecast error variance of each series into a component that is attributable to a wage shock and a component due to other shocks. To identify the wages shock we partition y_t as follows:

$$y_t = [y_{1t}, w_t, y_{2t}]$$

y_{1t} contains variables whose time *t* values are a part of wage setters information set but are assumed not to respond contemporaneously to a wages shock. The vector y_{2t} contains all other variables. We assume that the output gap and import prices are not affected contemporaneously by the wages shock: $y_{1t} = [x_t, m_t]$. In contrast, we allow for a cost-push effect of contemporaneous wage changes on non-tradable and tradable prices: $y_{2t} = [pnt_t, ptr_t]$. Both of these assumptions are consistent with our theoretical model.

Figure 2 shows the impulse responses to a one standard deviation wages shock. The top left panel shows that this shock increases wage inflation by approximately 0.5 percent. This increase in wage inflation is associated with a protracted increase in non-tradable inflation. While wage inflation itself partly explains higher non-tradable inflation, an increase in the output gap in the year following the initial wages shock also plays a role.

Tradable inflation increases more sharply in the near-term, but declines rapidly over the following year before turning negative further out. This is associated with relative import price gaps that are positive in the near-term but negative further out (possibly reflecting an un-modelled response of the exchange rate). It is important to note that the near-term increase in tradable inflation, in contrast to the increase in non-tradable inflation, is entirely attributable to the positive contemporaneous correlation between wages and tradable inflation, rather than estimated dynamics.

Figure 2
Impulse responses to a wages shock

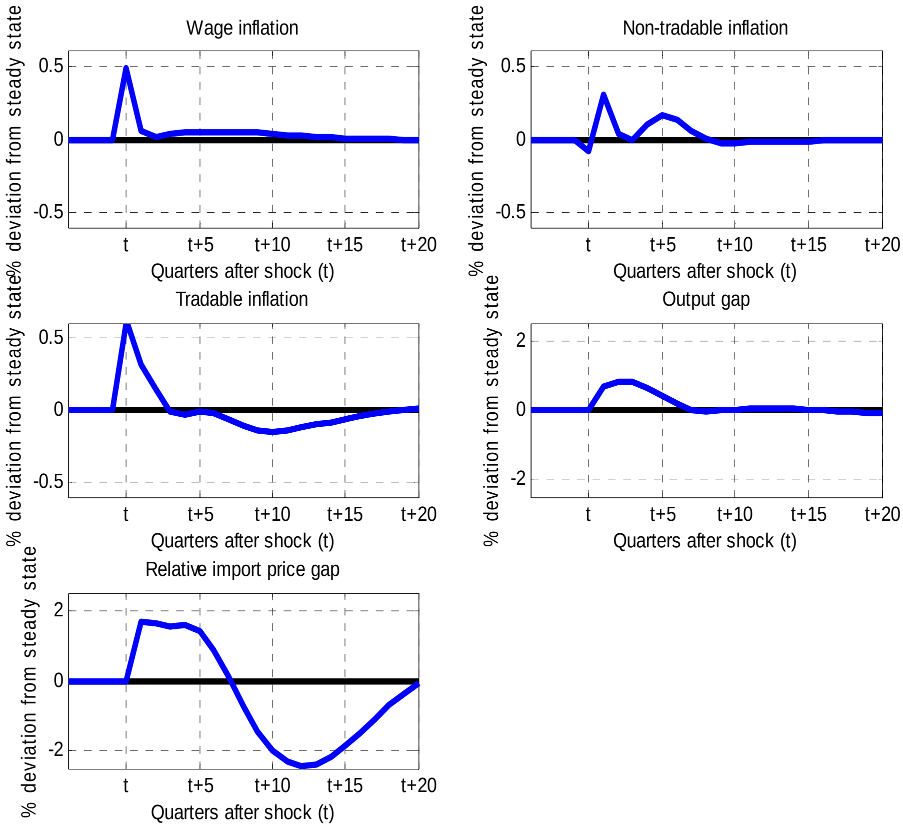


Table 6 shows the percentage of the *h*-step ahead forecast error variance that is explained by the wages shock for each variable in the model. The results show that wages can explain a significant portion of their own forecast error variance, although this proportion declines with the forecast horizon. More importantly, wages only explain a small portion of the forecast error variance for other variables. This suggests that our previous result that wages help to predict future non-tradable inflation does not reflect a strong role for wage shocks in helping to predict future inflation. Instead it seems that wages are useful in helping to predict the impact of other shocks on future inflation.

Table 6
Proportion of forecast error variance attributable to wage shocks

Horizon	Δw_t	Δp_t^n	Δp_t^t	x_t	m_t
1	0.83	0.01	0.03	0.01	0.00
4	0.62	0.01	0.04	0.02	0.01
12	0.28	0.03	0.02	0.03	0.01
20	0.24	0.03	0.01	0.04	0.01

5 Conclusion

We have investigated the relationship between wages and prices in New Zealand between 1992 and 2008. We have provided evidence for a joint causality between wages and disaggregate inflation. Wages were found to predict increases in non-tradable prices (but not tradable prices) through the cost-push channel. Meanwhile, tradable prices had the largest impact on wages through the demand-pull channel.

In light of the evidence for a leading relationship between wages and non-tradable inflation, we also explored the nature of the gains for in sample forecasting of inflation from incorporating wages as an explanatory variable. We provided evidence that exogenous shocks to wages do not themselves help to forecast inflation. However, our results suggest that monitoring wages should prove useful for projecting the impact of other shocks on future inflation.

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