December 2023 – AN2023/4

Reserve Bank of New Zealand
Te Pūtea Matua

Analytical Notes

Rational inattention to inflation among New Zealand households.

Gerelmaa Bayarmagnai

Reserve Bank of New Zealand *Analytical Note Series*

ISSN 2230-5505

Reserve Bank of New Zealand
PO Box 2498
Wellington
NEW ZEALAND

www.rbnz.govt.nz

Key findings

- This *Note* presents empirical evidence suggesting that New Zealand households are rationally inattentive to inflation, i.e., households tend to pay more attention to inflation when it is high, than when it is low.
- Rational inattention can result in a non-linear relationship between inflation and households' inflation expectations. Once the inflation rate crosses a certain threshold, household inflation expectations may become stickier.
- It is important for monetary policymakers to monitor this potential non-linearity in how households perceive and internalise inflation data.

Introduction[1]

Inflation expectations play a vital role in driving inflation dynamics, and hence, well-anchored inflation expectations are often seen as a metric of the credibility of inflation-targeting monetary policy (Bernanke, 2003; Adrian, 2023). When households expect higher inflation, they reflect it in their consumption and savings decisions together with wage negotiations. On the other hand, firms want to earn more but are constrained by an expected increase in labour costs. These complex interactions influence macroeconomic variables such as aggregate savings, investment, interest rates, and inflation. Hence, stable inflation expectations, that align closely to a central bank's inflation target, help improve the operation of monetary policy.[2]

Individuals make their decisions based on the availability of information and its costs. Rational expectations models with frictional information assume that either (i) people adjust their expectations sporadically as new information is slow to diffuse to the public, i.e., information is 'sticky'' (Gregory & Reis, 2002) - or (ii) people have limited attention to process noisy information (Woodford, 2001; Sims, 2003). In both scenarios, acquiring, processing, and using the information is costly, and our cognitive abilities are limited. Consequently, the problem that economic agents encounter is how to optimally allocate their attention to abundantly available information, prioritise problems, and intentionally ignore some of them. This phenomenon is known in the academic literature as 'rational inattention'.

In the context of monetary policy, Maćkowiak, Matějka, & Wiederholt (2021) find that most firms and households typically pay little attention to the aggregate state of the economy, including inflationary pressures and the stance of monetary policy, but pay more attention when inflation is high or volatile. Several theoretical studies show that inflation inattention is dependent on the level of inflation. When economic agents are less attentive, the Phillips curve is flatter (Afrouzi & Choongryul, 2021), and forward guidance is less powerful (Kiley, 2021). Pfäuti (2021) emphasises that a decline in attention moderates the inflationary impact of shocks and fluctuations in the output gap due to a muted response of inflation expectations.

[1] The author would like to thank colleagues across the RBNZ for their feedback.
[2] Stable inflation expectations also give a central bank more room to accommodate inflation fluctuations when setting monetary policy (Gáti, 2023).

In this study, I examine whether this phenomenon is evident in New Zealand by analysing household-level data. Note that, like many advanced economies, New Zealand experienced a prolonged period of low inflation before the surge in inflation since the second quarter of 2021. Results based on several measures constructed along the lines of Bracha and Tang (2019), suggest that New Zealand households are rationally inattentive to inflation. Specifically, when inflation increases above certain thresholds, the proportion of households that are aware of the current inflation rate increases. Moreover, their inflation forecasts become more accurate, and they make bigger corrections to their prior forecasting errors.

These findings imply that the Reserve Bank of New Zealand-Te Pūtea Matua (RBNZ) must be careful in shaping forward guidance in an inflationary environment, given the enhanced attention to inflation outturns. Furthermore, Weber et al. (2023) find that the impact of new information diminishes during these periods since households already hold relatively well-informed expectations, leading to stickier inflation expectations in several countries. Hence, household inflation expectations may become more difficult to anchor back to low inflation due to this increased stickiness. It is important for monetary policymakers to monitor this non-linear behaviour, especially during high inflationary periods, such as that experienced over 2022 to 2023 in New Zealand.

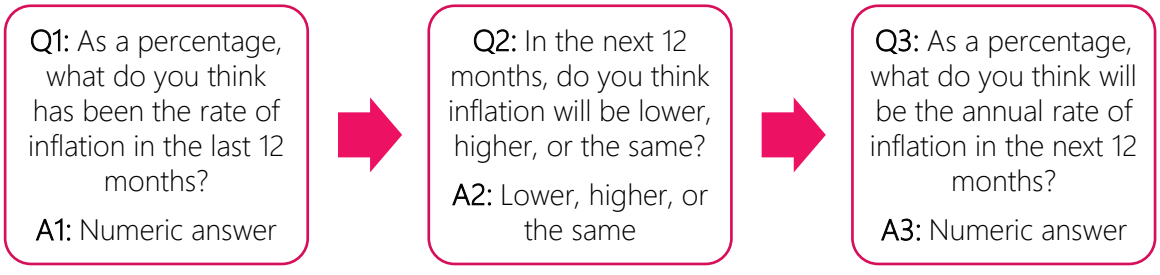
Data and Methodology

Data

Empirical evidence in support of the rational inattention hypothesis is scarce. The literature largely scrutinises survey data on inflation expectations and considers various indicators since it is extremely challenging to quantify rational inattention. Bracha and Tang (2019) construct a range of measures that investigate different aspects of rational inattention to inflation using US data. In this study, I adapt the methodology described by them to suit New Zealand data.

The RBNZ conducts a quarterly survey on households' inflation expectations. Records of survey participant responses start in the second quarter of 1998, while the aggregate dataset of average 1-year ahead inflation expectations starts in the fourth quarter of 1987. Even though the survey structure has changed over time, the fundamental questions and available answers have largely stayed consistent. Figure 1 describes the main survey questions that are relevant to the empirical analysis that follows.

Figure 1. Sequential questions in the Households expectations survey



If the answers to the questions on current inflation (A1) and 1-year ahead inflation expectations (A2 and A3) are inconsistent, the data points are discarded. That is, if respondents indicate that inflation will increase next year (A2), the numeric estimate of their current inflation (A1) cannot be higher than their 1-year ahead inflation expectation (A3), and vice versa. Furthermore, I remove

outliers in current inflation and inflation expectations, i.e., below -2% or above 15–15.5%[3]. There are approximately 1,000 participants in each quarter and the total sample size sums to 106,871 observations. After cleaning the original dataset, I reduce the sample by 19.1% to 86,455 observations.

The Bracha and Tang (2019) metrics

For the first measure of rational inattention, I compute the ratio of the number of people who do not know current inflation to the overall number of survey participants from the Household Expectations Survey. This statistic is labelled as the 'Don't know' or DK ratio in Equation 1 below.

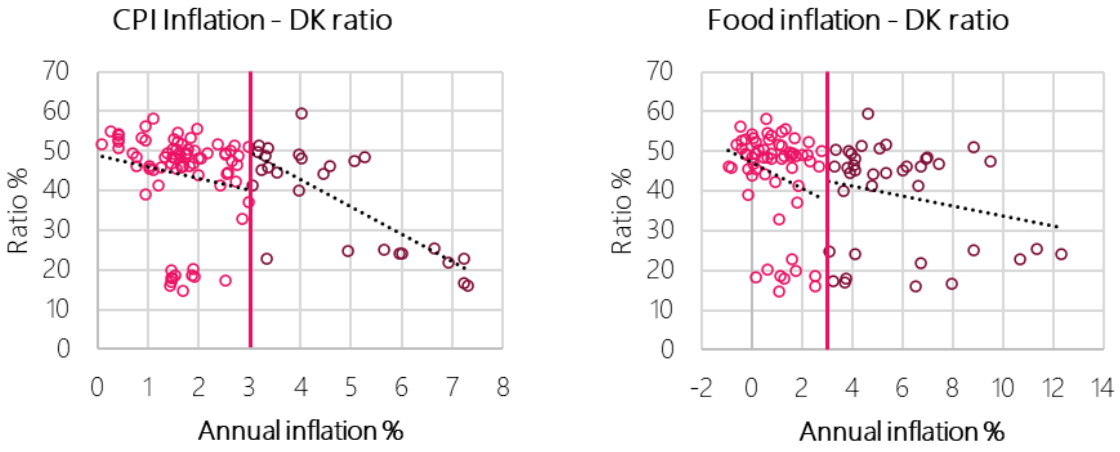
In any quarter t,

$$DK\ ratio_t = \frac{Number\ of\ DK\ responses_t}{N_t}\ , \qquad (1)$$

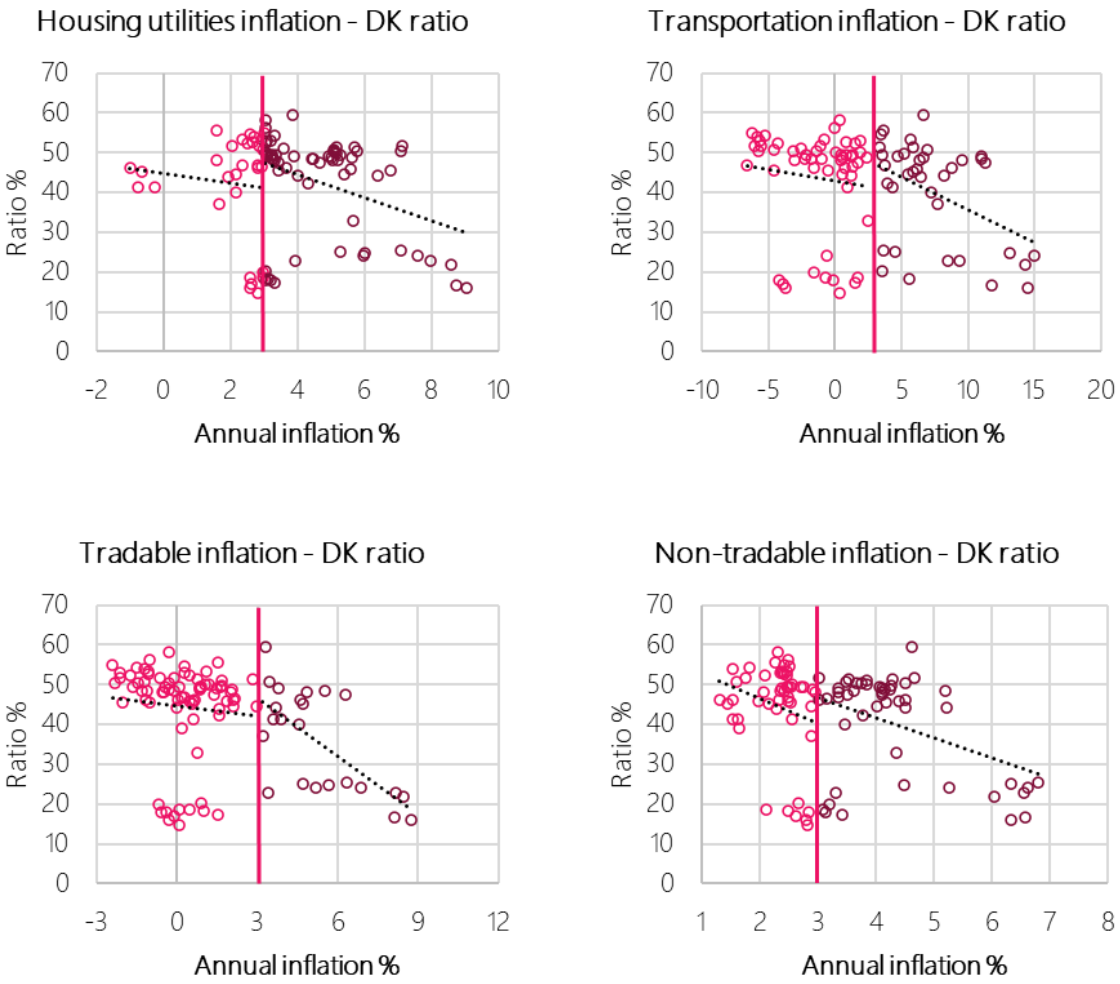
where N is the total number of respondents. The survey design does pose some challenges in computing the DK ratio. The available options for the response (Figure 1, A1) vary depending on which year the survey was conducted. For instance, during the second quarter of 1998, survey respondents could provide their estimates openly without predefined choices. In contrast, in the first quarter of 2009, there was a multiple-choice question for current inflation with a specified inflation range, and the more recent version of the survey added the choice "I am not confident enough to make a guess" with the open answer section. To make the calculation consistent throughout the survey, I assume that the number of people who did not answer the question or chose "I do not know current inflation" is the total number of 'don't know' responses.

Figure 2 highlights a negative relationship between the DK ratio and annual inflation, consistent with the rational inattention hypothesis. I split the sample into periods of low and high inflation, choosing a threshold of 3%. This threshold reflects the upper bound of the RBNZ's current target range of annual CPI inflation between 1% and 3%. In addition, the DK ratio correlates negatively with inflation at the CPI subgroup level, with the slope being steeper during inflationary periods. Specifically, the difference is noticeable in the case of the DK ratio and inflation related to housing and household utilities, transportation, and tradable inflation.

Figure 2: Correlation between inflation and the DK ratio*



[3] Upper limits vary depending on which year the survey was conducted.



Note: Here, each dot represents combinations of the annual inflation and the DK ratio, and the lines presented indicate the regression lines of best fit.
* The Household Expectations Survey structure changed in 2018 Q3, and it significantly altered the DK ratio after the change, but the correlation remained the same.

The potential criticism of the DK ratio is whether it truly reflects households' rational inattentiveness to inflation. It is possible that individuals might have chosen to abstain from answering the question for other reasons. On the other hand, is it appropriate to conclude that people are relatively more attentive to inflation merely because they gave their best guesstimate of current inflation? Can we infer that people are rationally attentive to inflation when individuals' survey responses to the question on current inflation were 15% while the actual inflation figure was -1%? Hence, we need to examine multiple indicators that empirically assess various implications of the rational attention hypothesis, rather than merely rely only on the DK ratio.

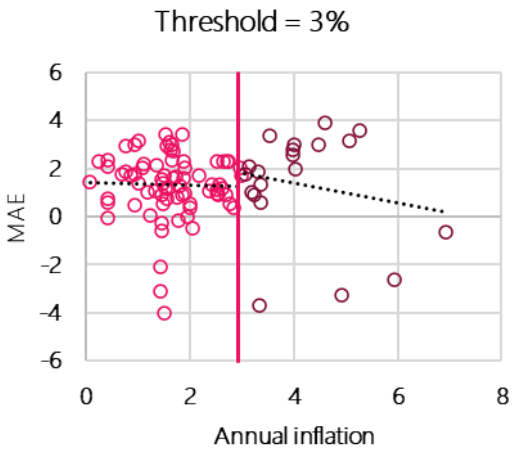
Complementary to the DK ratio, I calculate the absolute forecasting errors for individuals; if survey respondents expect inflation for the next year to be 2% but actual inflation turns out to be 3%, their absolute forecasting error is 1 percentage point. Then, the quarterly mean absolute error (MAE) adjusted for actual inflation is computed.[4] If π indicates annual inflation and E represents the conditional expectations operator, Equation 2 defines the MAE as an average across all respondents i such that, in any quarter t:

[4] The MAE is preferred to the root mean square error (RMSE) since the former is simple and increases linearly with the increase in the size of the errors. In contrast, the RMSE penalises bigger errors more since it takes the squares of the error values. See Schneider and Xhafa (2022).

$$MAE_{t-4} = \frac{\frac{1}{N_t}\sum_i [E_{t-4,i}(\pi_{t-4,t}) - \pi_{t-4,t}]}{|\pi_{t-4,t}|} . \quad (2)$$

When an economic agent is rationally inattentive to inflation, the MAE is expected to decline as inflation increases, much like the DK ratio explained above. This potentially implies that households become more attentive to inflation and forecast more accurately when inflation is relatively high. As shown in Figure 3, correlations between the MAE and actual inflation are somewhat weak.

Figure 3: Correlation between inflation and MAE



Note: Here, each dot represents combinations of the annual inflation and the MAE, and the lines presented indicate the regression lines of best fit.

Regression specifications

Several testable propositions emerge from rational inattention theory. The DK ratio defined above should decline as inflation increases if households are rationally inattentive to inflation. More formally, in the presence of rational inattention, the coefficient β_1 would be negative and statistically significant in the regression presented in Equation 3.

$$DK\ ratio_t = \alpha_1 + \beta_1 D_t + \epsilon_{1,t}, \quad (3)$$

where D_t is 1 when inflation exceeds the threshold of either 2% or 2.5% or 3%, and 0 otherwise, and $\epsilon_{1,t}$ is a white noise error term.

I also estimate Equation 4 to assess whether households get better at forecasting inflation on average as inflation increases, i.e., the MAE decreases once inflation is higher than specified thresholds. If the rational inattention hypothesis is valid, the estimated coefficient β_2 should be negative and statistically significant.

$$MAE_t = \alpha_2 + \gamma_2 MAE_{t-1} + \beta_2 D_t + \epsilon_{2,t}, \quad (4)$$

where the dummy variable D_t is defined as in Equation (3). However, it must be noted that predicting the future is rather difficult even for professionals, and hence variables other than attention could potentially explain forecast errors.

Another indicator of rational inattention to inflation is the speed at which households adjust their forecast errors. In general, people adjust their expectations based on past mistakes. If people are rationally inattentive, they are likely to adjust their inflation expectations and correct their mistakes to a greater extent when inflation is high. I test this proposition using two distinct regression specifications.

In Equation (5), the mean 1-year ahead inflation expectation π_t^e is expressed as a function of its own lag, and the latest observable forecasting error $(\pi_{t-4}^e - \pi_t)$. In other words, households' inflation expectations are partly determined by its own history and the households' adjustments to past expectation errors.

$$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-1}^e + \delta_2 (\pi_{t-4}^e - \pi_t) + \epsilon_{3,t} \,. \tag{5}$$

When households forecast overshoot or undershoot actual inflation, they correct their expectation error partially by the proportion implied by δ_2. Hence, δ_2 is expected to be negative and larger in absolute terms when inflation is relatively high if households are rationally inattentive to inflation.

In contrast to Equation 5 that is estimated for the high- and low-inflation states separately, Equation 6 presented below is estimated for the whole sample period with a high inflation dummy (D_t), and here δ_4 is expected to be negative and statistically significant in the presence of rational inattention.

$$\pi_t^e = \alpha_4 + \delta_1 \pi_{t-1}^e + \delta_2 (\pi_{t-4}^e - \pi_t) + \delta_3 D_t + \delta_4 D_t (\pi_{t-4}^e - \pi_t) + \delta_5 \pi_{t-1}^e D_t + \epsilon_{4,t} \,. \tag{6}$$

Estimation results

The coefficient estimates from all the regression specifications presented in the previous section suggest that New Zealand households may be rationally inattentive to inflation.

My findings indicate the following when inflation exceeds specified thresholds:

- A higher percentage of survey respondents can provide an estimate of current inflation;
- Households have lower forecasting errors on average; and
- Households display quicker correction of forecasting errors.

These results suggest that inflation expectations may exhibit a tendency to become stickier during inflationary periods; it is possible that households start shaping relatively better-informed inflation expectations and become less sensitive to more information as actual inflation increases. This delivers two crucial messages for policymakers: (i) the dynamics of inflation expectations might substantially differ between low- and high-inflation states. If policymakers set policy on the assumption that inflation expectations are formed in the same way irrespective of actual inflation, there is a higher risk of overshooting or undershooting the inflation target; (ii) it would be relatively difficult for policymakers to anchor down inflation expectations once they exceed the threshold due to their sticky nature.

MAE and DK ratio: Recall that to test for the presence of rational inattention more formally, the DK ratio and households' inflation forecast errors are regressed on a dummy variable that controls for high inflation environments, in Equations 3 and 4. It is worth noting that New Zealand historically experienced predominantly low and stable inflation, with only around 26 out of 101 quarters being considered 'high inflation periods' when the threshold was 3%.

Results suggest that the DK ratio declines on average during inflationary periods, regardless of whether the chosen threshold is 2% or 2.5% (Table 1). This result aligns with the conclusion from Figure 2. However, the coefficient is statistically insignificant when the threshold is set at 3%. This might be partly related to the fact that when we increase the thresholds, fewer data points are assigned to periods of high inflation. Interestingly, contrary to the findings of Bracha and Tang (2019), the value of the coefficients on the dummy variable get smaller as the high inflation threshold increases.

Table 1: The relationship between measurements and actual inflation (Equations 3 and 4)

	Don't know ratio			**Mean absolute error scaled by inflation**		
	(1) >2%	(2) >2.5%	(3) >3%	(4) >2%	(5) >2.5%	(6) >3%
High inflation dummy (β)	-2.082**	-1.909**	-0.617	-1.228**	-1.069*	-0.778
Structural change[#]	-28.322***	-28.187***	-28.288***			
MAE_{t-1} (γ)				0.284***	0.292***	0.307***
Constant (α)	49.111***	48.89***	48.314***	1.902***	1.774***	1.517***
R^2	0.852	0.851	0.846	0.138	0.131	0.119
AR^2	0.849	0.848	0.843	0.119	0.112	0.1
High inflation[1]	45	39	25	40	36	22
Low inflation	54	60	74	53	57	71
No. obs	99	99	99	93	93	93

[#] The structure of the Household Expectations Survey changed in 2018 Q3, and it significantly altered the DK ratio after the change.
[1] Depending on the measurements and the chosen lags, the sample size slightly varies. For instance, we have two missing quarters of observations for the DK ratio, while MAE is the forecast error that we can compute with a year lag. In other words, we can estimate MAE from the Household Expectations Survey until 2022 Q2, if the latest released actual inflation rate is 2023 Q2.
***, **, and * indicate 99%, 95%, and 90% statistical significance, respectively.

I find that the MAE in households' inflation expectations significantly decreases in an inflationary environment when the 2% and 2.5% inflation thresholds are used. Overall, the regression evidence (Table 1) is consistent with the theory that New Zealand households are rationally inattentive.

Forecasting error correction: As noted earlier, Equation 5 is separately estimated for high and low inflation periods, while Equation 6 is estimated using the complete sample. We assume that the error correction process of households is stronger in high inflation periods, and hence expect the estimated δ_2 coefficient in Equation 5 in the high inflation subsample to be more negative. In addition, δ_4 in Equation 6 is expected to be negative and statistically significant in the presence of rational inattention.

Table 2 presents the estimation results. Estimates of Equation 5 show that the speed of error correction is quicker (a more negative correction coefficient) in the high inflation environment, regardless of the threshold used. Similarly, estimates of Equation 6 (in columns titled 'Full sample') imply that the interaction between the correction term and the high inflation dummy is statistically significant and negative, except when the threshold is set at 3%. These results are again consistent with the hypothesis that New Zealand households are rationally inattentive.

Table 2: Inflation expectation and error corrections (Equations 5 and 6)

	Threshold = 2%			**Threshold = 2.5%**			**Threshold = 3%**		
	(1) High inflation	(2) Low inflation	(3) Full sample	(4) High inflation	(5) Low inflation	(6) Full sample	(7) High inflation	(8) Low inflation	(9) Full sample
Expectation$_{t-1}$ (δ_1)	0.96***	0.81***	0.81***	0.96***	0.81***	0.81***	0.96***	0.81***	0.81***
Correction (δ_2)	**-0.12*** **	**-0.01**	-0.01	**-0.11*** **	**-0.04**	-0.04	**-0.09****	**-0.06****	-0.06**
Inflation dummy (δ_3)			-0.24			-0.36			-0.41*
Correction* Dummy (δ_4)			**-0.11****			**-0.07***			**-0.03**
Expectation$_{t-1}$* Dummy (δ_5)			0.14*			0.15**			0.15*
Constant (α)	0.38**	0.62***	0.62**	0.36*	0.72***	0.72***	0.35	0.77***	0.77***
R^2	0.91	0.70	0.92	0.90	0.72	0.92	0.89	0.76	0.92
AR^2	0.90	0.69	0.92	0.90	0.71	0.92	0.89	0.76	0.92
No. obs	66	73	139	57	82	139	39	100	139

***, **, and * indicate 99%, 95%, and 90% statistical significance, respectively. Forecasting error correction coefficients are in bold.

Robustness checks: I conducted several sensitivity checks by considering variants of the Bracha and Tang (2019) metrics. Table A1 in the appendix indicates that inflation has a negative impact on the median absolute error, consistent with the baseline case of using the MAE. The RBNZ conducts inflation expectation surveys among both business entities and experts in the field. Interestingly, experts show modest signs of inflation inattention, whereas there is no such evidence for businesses (Table A2). In addition, I estimated Equation 6, using various lag structures for both inflation expectations and actual inflation (Table A3). Importantly, these robustness checks consistently point to signs of rational inattention to inflation among households.

Conclusion

Monetary policy effectiveness, particularly within an inflation-targeting framework, is directly related to the degree to which inflation expectations are firmly anchored. In this study, I estimate some measures that assess the presence of rational inattention to inflation in New Zealand households. If households are rationally inattentive to inflation, the dynamics of inflation expectations may differ significantly between low- and high-inflation states. Hence, understanding this nature will support formulating monetary policy that keeps inflation expectations well-anchored. Despite the extensive literature on inflation expectations, research on rational inattention theory and related empirical analysis is still nascent.

The empirical results presented in this *Note* suggest that New Zealand households pay more attention when inflation is higher. According to the Household Expectations Survey data, we observe the following during inflationary times:

- A higher percentage of survey respondents can provide an estimate of current inflation.
- Households have lower forecasting errors on average.
- Households display quicker correction of forecasting errors.

In conclusion, these findings imply that the RBNZ must monitor the potential non-linear behaviour of inflation expectations in an inflationary environment and be careful in shaping forward guidance given the enhanced attention to inflation outturns. Even so, if the central bank has a robust communication strategy, and has had a credible record of inflation stabilisation over a long time, household inflation expectations are likely to remain responsive to monetary policy signalling.

References

Adrian, T. (2023). The Role of Inflation Expectations in Monetary Policy. IBF / Deutsche Bundesbank Symposium. IMF Financial Counsellor and Director of the Monetary and Capital Markets Department.

Afrouzi, H., & Choongryul, Y. (2021). Dynamic Rational Inattention and the Phillips Curve. CESifo Working Paper Series 8840.

Bernanke, B. (2003). A Perspective on Inflation Targeting. Remarks before the Annual Washington Policy Conference. Washington, D.C.: National Association of Business Economists.

Bracha, A., & Tang, J. (2019). Inflation Thresholds and Inattention. Federal Reserve Bank of Boston Working Papers, No. 19-14.

Gáti, L. (2023). Monetary Policy and Anchored Expectations - An Endogenous Gain Learning Model. Journal of Monetary Economics.

Gregory, M. N., & Reis, R. (2002). Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve. Quarterly Journal of Economics, 117(4), 1295-1328.

Kiley, M. (2016). Policy Paradoxes in the New Keynesian Model. Review of Economic Dynamics, 21, 1-15.

Maćkowiak, B., Matějka, F., & Wiederholt, M. (2023). Rational Inattention: A Review. Journal of Economic Literature, 61, 226-73.

McKay, A., Nakamura, E., & Steinsson, J. (2016). The Power of Forward Guidance Revisited. American Economic Review, 106 (10): 3133-58.

Pfäuti, O. (2021). Inflation - Who Cares? Monetary Policy in Times of Low Attention. Papers 2105.05297, arXiv.org.

Schneider, P., & Xhafa, F. (2022). Chapter 3 - Anomaly detection: Concepts and methods. In *Anomaly Detection and Complex Event Processing over IoT Data Streams* (pp. 49-66).

Sims, C. A. (2003). Implications of Rational Inattention. Journal of Monetary Economics, 50 (3), 665-90.

Weber, M., Frache, S., Georgarakos, D., Candia, B., Meyer, B., Coibion, O., Ropele, T., Kumar, S., Kenny, G., Lluberas, R., Gorodnichenko, Y., & Ponce, J. (2023). Tell Me Something I Don't Already Know: Learning in Low and High-Inflation Settings. Chicago Booth Paper No. 23-14.

Woodford, M. (2001). Imperfect Common Knowledge and the Effects of Monetary Policy. No 8673, NBER Working Papers.

Appendix

Table A1: Robustness check: Median absolute error

	Median absolute error		
	(1) >2%	(2) >2.5%	(3) >3%
High inflation (β)	-1.07*	-0.93*	-0.65
$MedAE_{t-1}$ (γ)	0.27***	0.27***	0.29***
Constant (α)	1.55***	1.44***	1.22***
R^2	0.12	0.11	0.10
AR^2	0.10	0.09	0.08
High inflation	40	36	22
Low inflation	53	57	71
No. obs	93	93	93

Table A2: Survey expectations: Different sectors – Equation 5

	Household		Business		Professionals	
	Mean (1)	Median (2)	Mean (3)	Median (4)	Mean (5)	Median (6)
$Expectation_{t-1}$ (δ_1)	0.81***	0.85***	0.88***	0.87***	0.55***	0.53***
Correction (δ_2)	-0.01	-0.04	-0.07*	-0.07	-0.05	-0.04
Inflation dummy (δ_3)	-0.24	0.08	0.12	0.22	-0.52*	-0.56*
Correction* Dummy	-0.11**	-0.15***	-0.01	-0.01	-0.14*	-0.15*
$Expectation_{t-1}$* Dummy	0.14*	0.03	-0.02	-0.06	0.22*	0.24*
Constant (α)	0.62**	0.43**	0.27*	0.28*	0.79***	0.81***
R^2	0.92	0.92	0.90	0.88	0.92	0.91
AR^2	0.92	0.91	0.9	0.88	0.91	0.89
No. obs	139	106	141	141	45	45

Table A3: Robustness check: Error correction with different lag structures

No.	Different time structure	Threshold = 2%		
		High	Low	Total
1	$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-4}^e + \delta_2(\pi_{t-4}^e - \pi_t) + \epsilon_{3,t}$	-0.62***	-0.32***	-0.30***
2	$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-1} + \delta_2(\pi_{t-4}^e - \pi_t) + \epsilon_{3,t}$	-0.02***	0.15***	-0.17***
3	$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-1}^e + \delta_2(\pi_{t-4}^e - \pi_t) + \epsilon_{3,t}$	-0.12***	-0.01	-0.11**
4	$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-1}^e + \delta_2(\pi_{t-5}^e - \pi_{t-1}) + \epsilon_{3,t}$	-0.07**	0.02	-0.09**
5	$\pi_t^e = \alpha_3 + \delta_1 \pi_{t-1}^e + \delta_2(\pi_{t-1}^e - \pi_t) + \epsilon_{3,t}$	-0.27***	-0.05	-0.23***