South African inflation expectations: Non-rational heterogeneity

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Abstract

It is convention in most economic models to assume that agents form inflation expectations uniformly and rationally. The assumption of rational homogenous expectations formation is computationally convenient and allows for important simplifications in economic models. It is often justified by the idea that sufficient common experiences and observations will eliminate disagreements and aid convergence in the long-term**.** Results from this paper show that South African inflation expectations are not formed uniformly across respondents and also not across time. Surveyed respondents demonstrate various forms of heterogeneity and it is observed across demographic groups, methodologies applied, but more prominent is the difference in the processes that appears to govern their expectation formation at short-term horizons compared to longer-term horizons, i.e. intertemporal heterogeneity. South African respondents are empirically not rational when forming their inflation expectations, mainly due to their inefficient use of available information (see Ehlers (2015)). Contemporary monetary theories propose learning as an alternative to rational expectations formation and the results show that adaptive learning is observed but only over short-term horizons.

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South African inflation expectations: Non-rational heterogeneity

1. Introduction

It is convention in most economic models to assume that agents form inflation expectations uniformly and rationally. These assumptions about inflation expectations are convenient in allowing important simplifications in economic models and is often justified by the idea that sufficient common experiences and observations will eliminate disagreements and aid convergence in the long-term (see Acemoglu, Chernozhukov et al. (2006)). Gnan, Langthaler et al. (2011) explain that even if expectations differed at certain times, it was conventionally thought that they would converge through various mechanisms.

There are, however, several reasons and practical implications why the study of heterogeneous inflation expectations is relevant. Models that incorporate imperfect information (see Sims (2003) and Woodford (2001)), are believed to account for some of the slow price or wage adjustments in response to monetary shocks. Mankiw and Reis (2006) are able to closely reproduce empirical evidence by using a model that features staggered updating by consumers, workers and firms. Heterogeneous expectations can lead to disagreement among agents and speculative behaviour which, in turn, could distort monetary policy transmission channels (see Sims (2009)).

Since the start of the 2000's, there has been growing interest in the literature about heterogeneity of inflation expectations. One of these include a paper by Mankiw and Reis (2002) where the distinction between two groups are made with regard to the method of updating their forecasts. More specifically, in their article the staggered prices model of Calvo (1983) is replaced by a model of staggered information flows, where each firm can set their prices in each period, but only some firms will update their information set. It has been shown by Anderson et. al. (2010) that expectations formation by agents via learning is done heterogeneously. The authors indicate that

individual forecast accuracy is less diverse at the re-interview than at the initial interview, implying that the process of learning may reduce the initial heterogeneity.

In order to make appropriate policy decisions, policy authorities need to be aware of the degree and nature of heterogeneity present and more importantly what the sources thereof is. In the literature, sources of heterogeneity in the formation of inflation expectations can be ascribed to a number of reasons. Blanchflower and Mac Coille (2009) attribute these to include different models used by agents, different information sets incorporated and different methods for information interpretation. Macro level respondent characteristics such as demographics, gender, age and socioeconomic differences have also been indicated as differentiating factors in the formation of inflation expectations by some authors (see e.g. Pfajfar and Santoro (2009), Bryan and Venkatu (2001) and Gnan et al (2011)). The existence of heterogeneity in inflation expectations may also be an indication of perceived uncertainty (see Lahiri and Sheng (2010)).

In this paper, several sources of or contributors to heterogeneity in the inflation expectations processes of agents, are investigated. The results show that heterogeneity is present across different groups, their perceptions of the persistence of inflationary shocks, information diffusion from a more financial literate group, the degree of anchored expectations and the degree of learning. More prominent though is the difference in the processes that appears to govern agents' expectation formation processes during the short-term horizons compared to longer-term horizons, i.e. intertemporal heterogeneity. It appears that agents follow different inflation expectations formation processes in the short-term than in the longer-term.

2. Inflation expectations data for South Africa

Sources of South African inflation expectations survey data are rather limited and one of these analysed in this paper include the Reuters Inflation Expectations (RIE) Survey. This survey is conducted monthly and covers approximately 14 respondents who are mainly market analysts. Monthly data from this survey are available from

December 1999. In this survey, respondents are asked what rate of consumer inflation they expect will realise in the current as well as the following six quarters and what annual rate of inflation they expect for the current year and the following two years.

Another source of inflation expectations survey data for South Africa is the Bureau of Economic Research (BER) Inflation Expectations Survey. The BER Inflation Expectations Survey is available at a quarterly frequency from the first quarter of 2000. This survey covers four groups of respondents namely from the business sector (n=375), the financial sector (n=15), the trade union sector (n=12) and households (n=1898). (These sample sizes (n) are based on the number of respondents in the survey conducted in the first quarter of 2003.) This survey is similar to the Livingston survey conducted in the United States. For additional information on the Livingston survey see Roberts (1998) and on the BER survey see Kershoff and Smit (2002).

The realised consumer inflation numbers used in this paper is a measure that reflects real-time consumer inflation as targeted by the South African Reserve Bank's monetary policy framework. This definition was relevant at the time when these expectations were formed, i.e. consumer price inflation excluding mortgage interest rates up to end 2007 and headline consumer prices thereafter as published by Statistics SA (excluding the data revisions from January 2002 up to March 2003). It should be noted that the re-weighting and re-basing of consumer price inflation by Statistics SA that was introduced from January 2009, could have had an impact on the inflation expectations formation of agents, due to uncertainty about the magnitude of this effect. Furthermore, it should be noted from the onset that due to the small sample of available data, the results should be interpreted cautiously.

3. Heterogeneity of adaptive expectations

Expectations formation behaviour of agents can take on different forms, guided by backward-looking or adaptive behaviour, correction of recent errors or simply extrapolation of recent trends (see Curtin (2005)). The approach chosen will be influenced by the associated costs involved in collecting and processing information and the benefits realised from producing an accurate inflation forecast.

South African respondents are empirically not rational when forming their inflation expectations, mainly due to their inefficient use of available information (see Ehlers (2015)). An alternative approach to consider is the extent of adaptive behaviour. Support for adaptive behaviour can be found if current and past information impacts significantly on the expected inflation. The approach followed to estimate the extent of adaptive behaviour is suggested by Figlewski and Wachtel (1981), who use data from the Livingstone Inflation Expectations Survey to estimate the following adaptive expectations rule:

$$\pi_t^e - \pi_{t-1}^e = \alpha + \beta(\pi_{t-1}^e - \pi_{t-1}) + v_t \qquad (3.1)$$

The model is specified with an intercept (α) to reduce the impact of any systematic measurement or specification errors on the estimated coefficient. The β coefficient represents the adaptive coefficient of agents with respect to the forecast error they had made in the previous period. The intuition behind this coefficient is that agents adjust their expectation about future inflation by some proportion of every percentage point forecast error they had made in estimating inflation. The term v_t represents the stochastic error term.

Adaptive inflation expectations behaviour as estimated by Equation 3.1 will be analysed across all reported forecast horizons representing the short- to longer-term, to gauge the evolution of intertemporal behaviour changes. Intertemporal heterogeneity, i.e. different expectations formation behaviour in the short versus the longer term, has not received much attention in the literature.

A prominent non-zero longer-term adaptive coefficient indicates the respondents' perceived persistence of an inflation surprise of the previous period. However, some degree of co-movement between short- and long-term expectations can be expected, but the short-term impact should be more pronounced than the longer-term according to Dräger and Lamla (2014). In addition, they state that if a co-movement between short- and long-term expectations exists, it indicates that agents are uncertain about monetary policy targets.

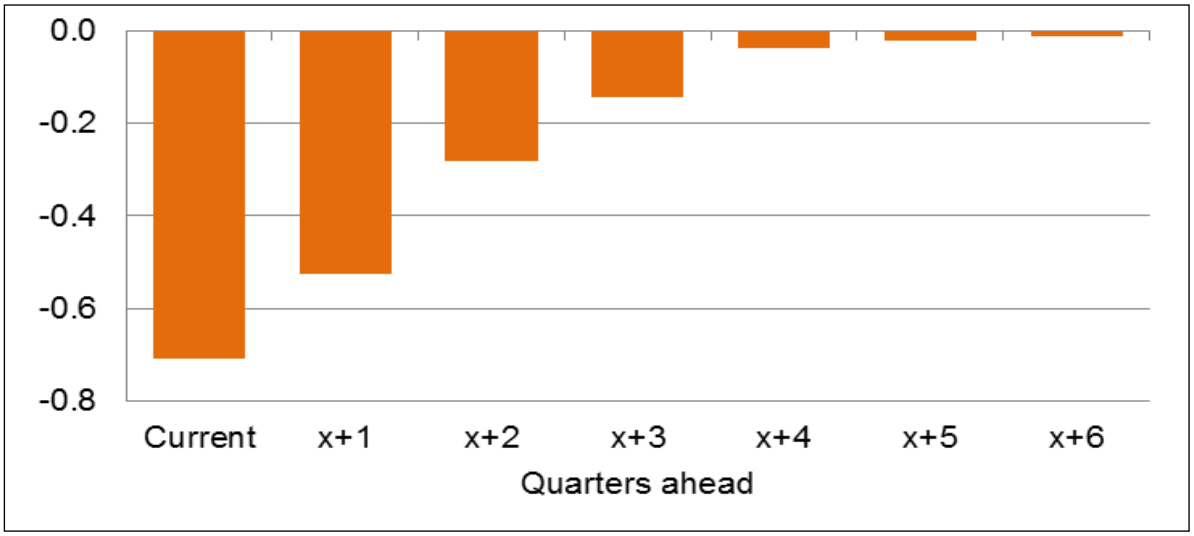
3.1 RIE Survey adaptive expectations

The adaptive behaviour of agents with respect to the forecast error they had made in the previous period, is estimated over all reported forecast horizons for the RIE Survey as well as the three respondent groups of the BER Survey[1]. Figure 3.1 presents the magnitudes of the adaptive expectations coefficients for the RIE Survey over the seven forecast horizons. For every percentage point error made in their expectation for the previous quarter, analysts participating in the RIE Survey adjust their expectations for the current quarter and one-quarter-ahead inflation with -0,7 and -0,5 percentage points, respectively. The adaptive coefficients for the two-quarter-ahead to five-quarter-ahead expectations decline over the horizon and the six-quarter-ahead adaptive expectation coefficient is not statistically significant different from zero. [2]

[1] The estimated coefficients with their accompanying t-statistics are reported in Table A1 and Table A2 in Appendix A.

[2] The financial analysts were affected by an information shock during 2003 and 2009, most likely related to exchange rate volatility observed at the time. This adverse effect was accounted for in the estimation of the adaptive expectations coefficients, where such a dummy variable were found to be statistically significant.

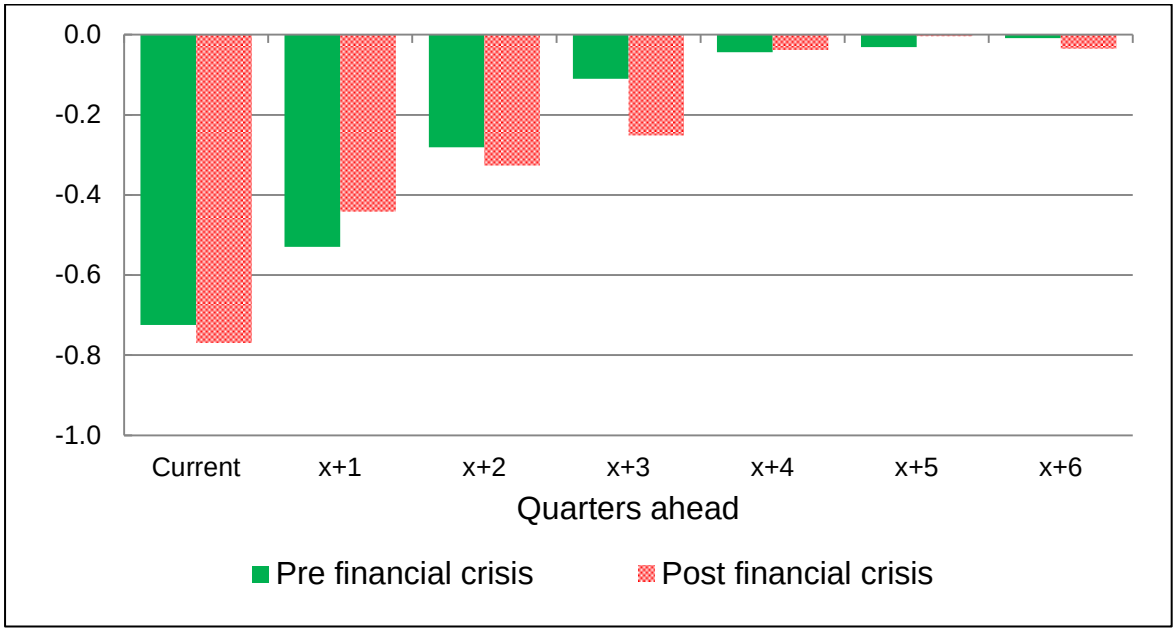
Figure 3.1: RIE Survey adaptive expectations coefficients



The fact that the shorter-term adaptive coefficients are larger than those of the longer-term horizons, indicates that the respondents believe that short-term inflation surprises are not persistent over longer-term horizons on average. In addition, they appear more uncertain about the short-term extent of the most recent surprises and tend to adjust more over the shorter-term.

Over the longer-term forecasting horizon this effect is much smaller, indicating that their longer-term views are not necessarily affected by current events, but rather based on other factors in their information set. It is not clear if this behaviour reflects the uncertainty of agents about future inflation or if their longer-term views are anchored on some rate. The absence of an announced numerical point inflation target clouds interpretations that the respondents have anchored their expectations on the inflation target over longer horizons. What is observed is that it appears that the Reuters respondents exhibit intertemporal heterogeneity where different processes govern their expectation formation at short-term horizons compared to longer-term horizons.

Figure 3.2: RIE Survey adaptive expectations coefficients: Pre and post financial crisis



The global financial crisis which commenced during the middle of the second half of 2008 infused great uncertainty into the global economic environment. The onset of unconventional monetary policies and the impacts thereof coupled with threatening zero lower bound interest rate environments, made economic agents anxious and cautious. To consider if the respondents' average sensitivity towards inflation surprises have changed over a shorter, more recent sample, the data prior to the global financial crisis (2000-2008q4) and afterward (2009-2014q4) are compared. When comparing the estimated adaptive coefficients prior to the global financial crisis and post, these appear to be similar and the decay over time is present in both (see Figure 3.2 and Appendix A, Table A.2). In particular, the average adaptive coefficient for the first four expectations horizons (i.e. first four quarters) is -0,41 prior and -0,45 post crisis. The average standard error increased only marginally from 0,11 to 0,16, pre and post crisis. Therefore it appears that the global financial crisis did not impute much uncertainty amongst the Reuters respondents.

3.2 BER Survey adaptive expectations[3]

A comparative analysis of the three BER Survey groups enables inference about the presence of heterogeneity between the groups and between short and longer time horizons. The adaptive coefficients (as estimated by Equation 3.1) of the BER overall inflation expectations imply that for every one percentage-point error made on the expectation for the previous year's inflation outcome, respondents adjusted their inflation expectations for the current year, one year ahead and two years ahead by -0,28, -0,09 and -0,04 percentage points, respectively (see Figure 3.3). For every one percentage-point error that business representatives in the BER Survey made in the previous period, they adjusted their expectations for the current year, one year ahead and two years ahead by -0,21, -0,05 and -0,02 percentage points, respectively. Financial analysts adjusted their expectations for the current year's inflation by -0,46 percentage points for every percentage-point-error made, while they adjust their expectations for one year ahead and two years ahead by -0,06 and -0,01 percentage points, respectively.

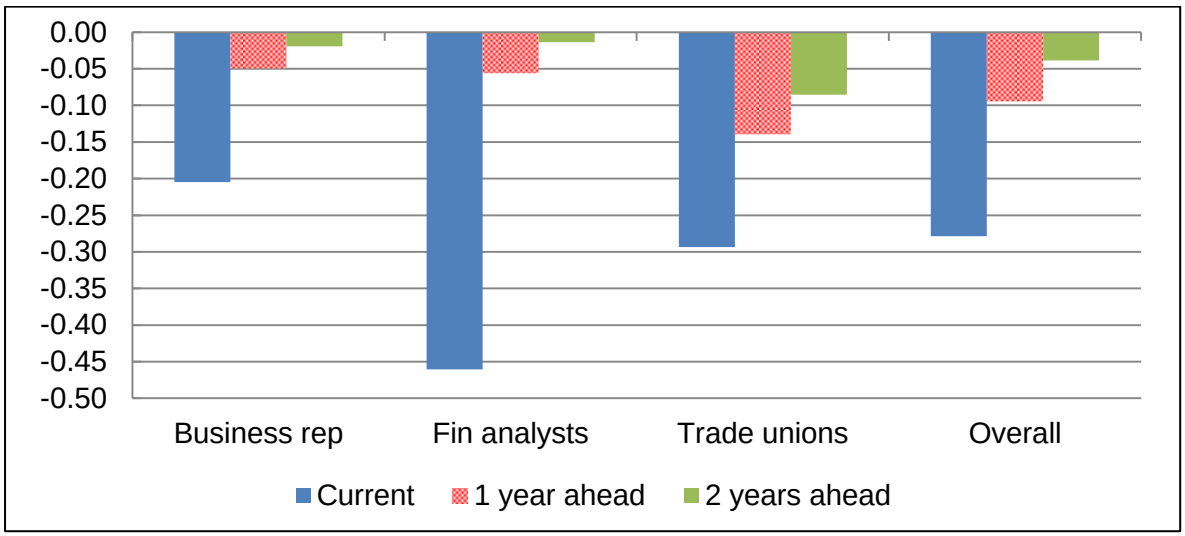
Trade union officials appeared to decrease their adaptive coefficient over longer-term forecast horizons at a slower pace than the other two groups. These respondents tend to extrapolate the impact of an inflation surprise in the previous period, as they adjust their expectations for the current year, while slowly decreasing their adjustment to their expectations for one year ahead and two-years-ahead horizons. It appears that the trade union officials are the least anchored on their longer-term forecast horizon following a forecast error, indicated by their large adaptive coefficient. This behaviour may indicate that they are on average more uncertain about the likely impact of an inflation surprise on future forecast horizons, and are also less anchored at some inflation outlook than the other two groups. The financial analysts and the business representatives did not notably change their

[3] The BER respondents were affected by an information shock during 2003 and 2009, most likely related to exchange rate volatility observed at the time. This adverse effect was accounted for in the estimation of the adaptive expectations coefficients, where such a dummy variable were found to be statistically significant.

longer-term adaptive behaviour following recent forecast errors and appear to be the most anchored over longer-term horizons.

The notable decay in the adaptive coefficients of all three groups from the short-term to the longer-term horizons, suggest that intertemporal heterogeneity is present and that different expectations formation processes are followed following the realisation of a previous period inflation expectation error.

Figure 3.3: BER Survey adaptive expectations coefficients



The results for the financial analysts are similar to those of the RIE Survey, in the sense that the adaptive coefficients for the first four quarters for the RIE Survey is -0,42 compared to the -0,46 for the financial analysts' current year expectation. Both groups portray much less adaptive behaviour over longer-term horizons when compared with the shorter-term expectations. This indicates that these respondents expect inflation surprises to have a notable short-term impact and they tend to adjust their shorter-term expectations much more than their longer-term expectations. These respondents' longer-term views are not affected much by current inflation surprises, but rather driven by other factors in their information set such as uncertainty or the degree of indexation to a particular inflation number, located inside the inflation target range.

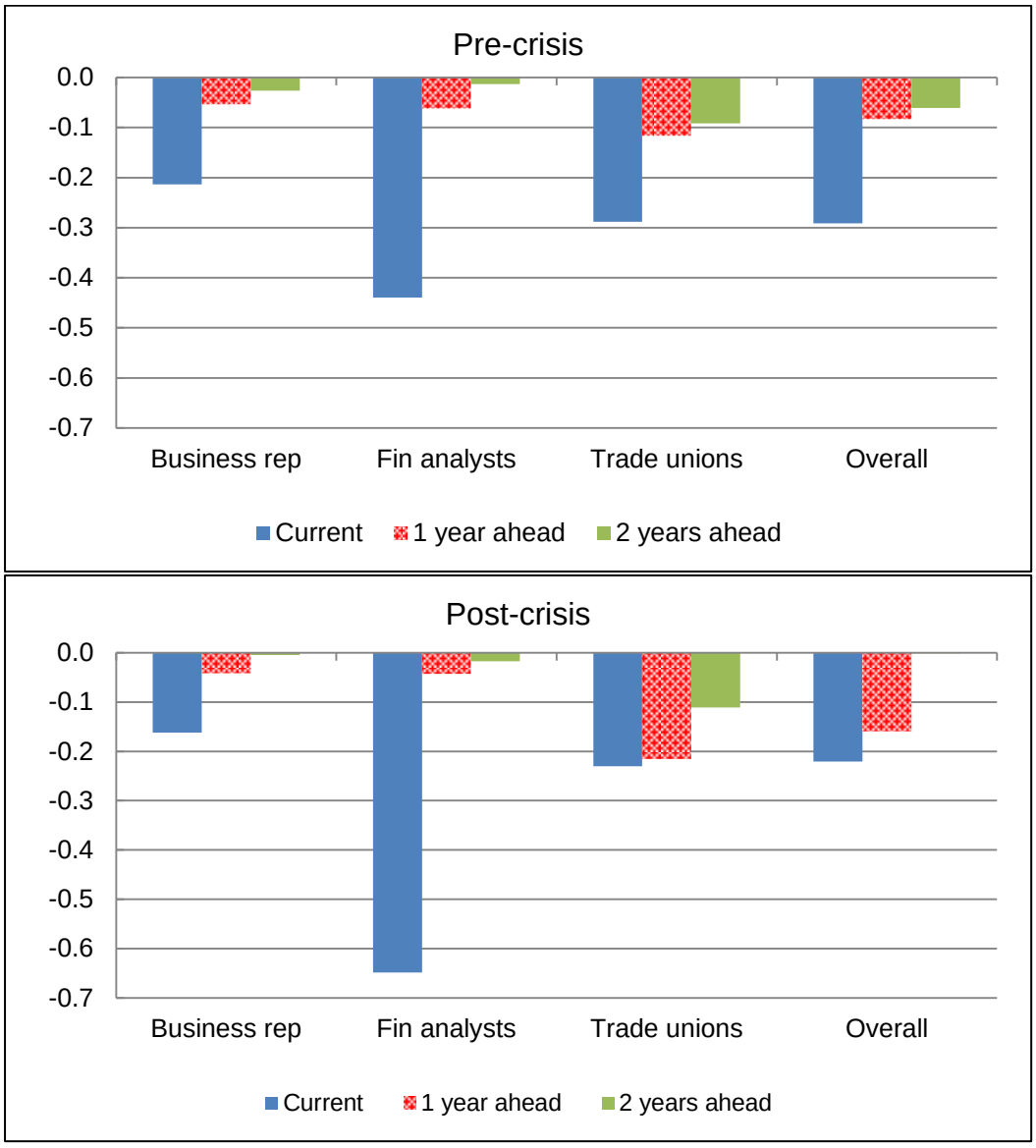
Even though the results for the RIE Survey respondents are similar to the BER financial analysts group there are differences in the dynamics of these adaptive

coefficients from the two surveys. Firstly, the difference in the survey frequency, where the RIE Survey respondents report their expectations regarding inflation on a monthly basis, while the BER respondents report their expectations on a quarterly basis. Therefore the respective information sets used when reporting their expectations differ. Secondly, the analysts in the RIE Survey report their expectation for quarterly inflation, whereas the BER Survey respondents report their expectation for annual inflation. Thirdly, individual forecasts of the RIE Survey are identified by the institution that produced them, thereby adding an element of accountability, contrary to the BER Survey where the respondents and their forecasting reputations remain anonymous.

Expectations formation processes are dynamic and it is of interest to investigate if the sensitivity of agents to inflation surprises has changed considering only recent data. To this end, the data is divided into two sub-samples, i.e. pre and post 2009q1, coinciding with the onset of the global financial crisis. When the results were analysed to measure a change in the average aggregate adaptive behaviour of agents following the global financial crisis, the financial analysts group appears to be more sensitive to inflation surprises. They have made a significant change by increasing their short-term adaptive behaviour, where the other two groups decreased their short-term adaptive behaviour slightly (see Figure 3.4). The trade union officials group increased their one-year-ahead adaptive behaviour by almost double the pre-crisis magnitude, indicating their increased uncertainty following the financial crisis. It appears therefore that the financial analysts are more vigilant about correcting their short-term expectations following an inflation surprise where the other two groups appear more confident by decreasing their adaptive behaviour.

The financial analysts and the business representatives show notable declines in their adaptive behaviour from the short-term to the longer-term horizons, indicating that they do not adjust their longer-term expectations by as much as they do their short-term expectations following inflation surprises. Therefore they appear to be more anchored over longer forecast horizons. This behaviour in not as pronounced in the trade union official group, who appear to be less anchored, particularly following the global financial crisis.

Figure 3.4: BER Survey adaptive expectations coefficients: Pre and post financial crisis



4. Heterogeneous information diffusion

Evidence shown in the preceding section indicate that the inflation expectations behaviour of the respondents appear to be anchored over longer-term horizons. There are several approaches in the literature that attempts to define and test for anchored inflation expectations (see Dräger and Lamla (2014) for an overview of these). Applicable to this paper is the approach where expectations formation behaviour is considered to be anchored if changes in the information set have a negligible impact on longer-term expectations. Of relevance then is to investigate to what these longer-term expectations are anchored to. Agents may choose to draw on the available inflation history or on available information and forecasts from financial literate agents.

The degree of financial literacy is an important source of heterogeneity in inflation expectations according to Gnan et al. (2011). If this is true, it is of interest to consider to what extent one group could be considered as a leader or anchor and the remaining groups as followers. Of additional interest is whether the followers incorporate information from a perceived leader heterogeneously. This leader should be regarded to have superior financial literacy, hence the behaviour.

In some cases even such leaders or experts find it difficult to outperform naïve type forecast processes. An example is Atkeson and Ohanian (2001) who show that the one-year-ahead inflation forecasts from the Federal Reserve's Greenbook has not been superior to naïve type forecasts in the form of the previous year's forecasts. However, evidence for South Africa (see Ehlers (2015)) show that inflation expectations by both the BER and Reuters respondents, in general do outperform naïve random walk models. This may be in part due to the higher volatility of South African consumer inflation relative to the United States' consumer inflation.

The BER Survey reports on three groups with differentiated levels of financial literacy where the presence of heterogeneous information diffusion can be tested. The financial analysts group of the BER inflation expectations survey contain

respondents that are the most likely candidate group to have superior financial literacy compared to the other two groups.

The concept engineered by Carrol (2003), where agents adopt experts' forecasts with a certain probability rather than their own, is applied to test the diffusion of information from one group that is considered to be more financial literate, to other groups. Therefore, the following equation format is estimated.

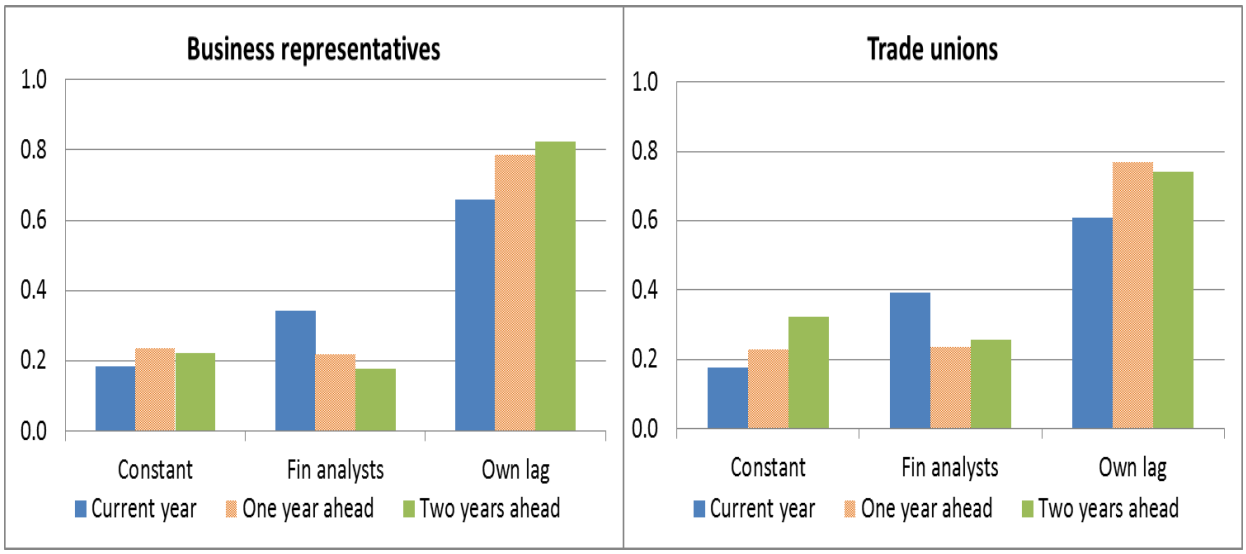
$$\pi_{t,j}^{e,k} = \alpha_0 + \alpha_1 \pi_{t,fin}^{e,k} + (1-\alpha_1)\pi_{t-1,j}^{e,k} \tag{4.1}$$

Where $\pi^{e,k}_{t,j}$ denotes the inflation expectation of group *j* (where *j* = 1 for business representatives or 2 for trade union officials) for *k* year(s) ahead at time *t*,
$\pi^{e,k}_{t,fin}$ denotes the inflation expectations of the financial analysts for *k* year(s) ahead at time *t*,
$\pi^{e,k}_{t-1,j}$ denotes the inflation expectations of group *j* for *k* year(s) ahead at time *t-1*.

The coefficients α_0 represents the constant term which is omitted in the work done by Carrol (2003). In the South African case where systematic bias in inflation expectations (see Ehlers (2015)) is often present, it is relevant to include a constant term in the estimation. The constraint imposed on the nominal coefficients relates to the concept that the equilibrium inflation rate should be equal to its expectation (see Curtin (2005)).

The following figure shows the results of the estimations where the differences between the groups are compared with each other and also over time.

Figure 4.1: Information diffusion from financial analysts to other groups



It has been noted by Branch (2004) that respondents choose a forecasting methodology by comparing its forecast accuracy with its sophistication and the costs to maintain it. Furthermore, in his article Branch (2004) provide evidence of inertia in the use of forecasting methodologies where the change between methodologies is slowed down by preferences and habits.

The results from Figure 4.1 indicate that both groups rely much more on their own previous period inflation expectations i.e. a naïve and inexpensive method of forecasting, than they do on the assumed expert group, namely the financial analysts. This finding agrees with Lombardelli and Saleheen (2003), Malmendier and Nagel (2009) and Ehrmann, Pfajfar et al. (2015) that an important determinant of inflation expectations is the individual's own inflation experience over their lifetime. Expanding on this, Madeira and Zafar (2014) finds that lifetime experience inflation contributes much more to near-term expectations, than to longer-term inflation expectations. This strengthens the case for backward-looking or adaptive behaviour of agents when forming inflation expectations.

Over the expectation horizon, the expert group influence on these two groups appears to decrease, even as the future becomes more uncertain, and they appear to rely more on their own previous period inflation expectation. This behaviour is in contrast to Carrol (2003) and Ehrmann, Pfajfar et al. (2015) who find that

respondents in the United States tend to converge towards professional forecasts over time, on aggregate.

The positive constant term could indicate that even while these respondents consider the expectations of a perceived expert group and their own lagged expectation, they include some upward bias for future risk. The trade unions in particular appear to add even more subjective bias from the current year's expectation to the two-year-ahead expectation, compared to the business representatives group.

Often in times of uncertainty, agents would be inclined to use random walk forecasting processes, as can be seen in these results. One of the possible reasons for this behavior could be that the business representatives and trade union groups are not yet aware or convinced about the potential benefits in obtaining expert forecasts. This lack of convergence of inflation expectations on one particular expert group, also contributes to the heterogeneity between these groups. However, this divergence away from an expert forecast is contrary to the findings of Carrol (2003) and Pfajfar and Santoro (2009) who find that US inflation expectations get updated closer to the professional forecasts.

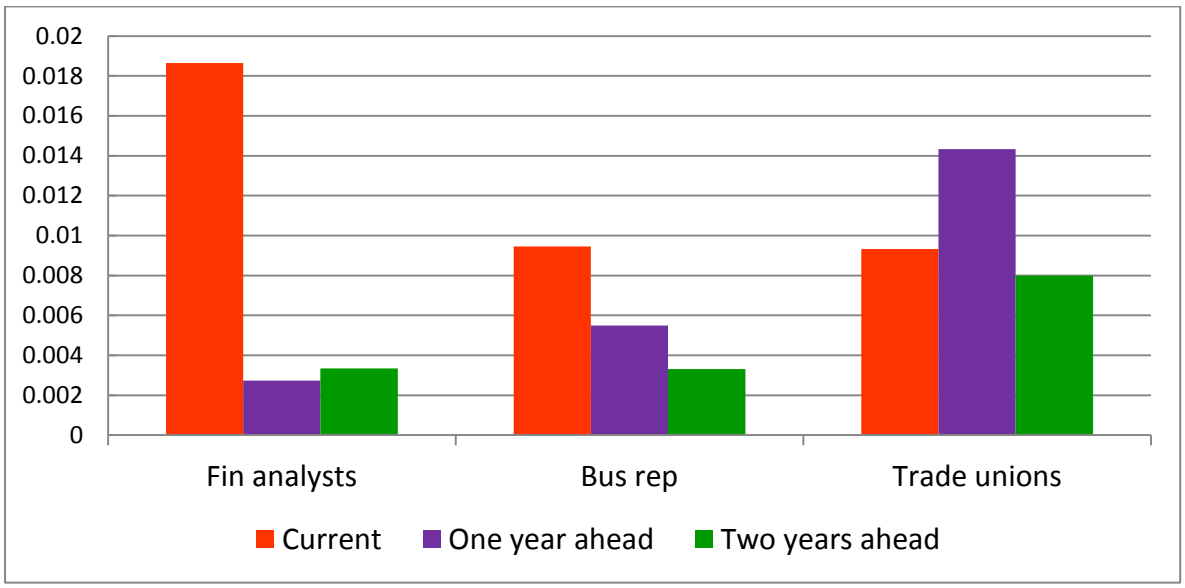
5. Open economy effects

Survey respondents' interpretation of the impact of available macroeconomic data on inflation, provides insights into potential divergence between different demographic groups about the magnitude and persistence of such information (see Mankiw et al. (2003)). Open economies, such as South Africa, are vulnerable to trade related shocks, especially through the impact of volatile exchange rates on domestic prices. To analyse the impact of such shocks on inflation expectation formation processes over different expectations horizons and per survey group, the following equation is estimated:

$$\pi^{e}_{x,t} = \alpha_0 + \alpha_1 \, exd_t + (1-\alpha_1)\, \pi^{e}_{x,t-1} \tag{5.1}$$

Where $\pi^{e}_{x,t}$ refers to expected inflation by financial analysts (x_1), business representatives (x_2) and trade union officials (x_3) at time t, exd refers to the year-on-year rate of change in the Rand/Dollar exchange rate at time t and α_0, α_1 represent estimated coefficients. The results are shown in Figure 5.1 (see also Appendix C, Table C.1).[4]

Figure 5.1: Coefficient of Rand/Dollar exchange rate



When confronted with exchange rate shocks, the financial analysts group appears to adjust their inflation expectation for the current year more than the other two groups, yet they discount these shocks more in the one-year and two-year-ahead horizons than the other two groups. It is interesting that the trade union group appears to handle exchange shocks quite uniquely by adjusting their inflation expectations for the next year by more than the current year, and only slightly lowering their two-year-ahead inflation expectation. It may be that they expect stronger and more lasting second round impacts from exchange rate shocks, or that they behave strategically

[4] The coefficients for the financial analysts group's one-year-ahead and the business representatives' two-year-ahead time domains were not statistically significant and should be interpreted as negligible.

in order to capitalize on positive price shocks to serve in defense of higher wage demands.

It seems reasonable to conclude that the financial analysts group considers exchange rate shocks to be more prominent, yet less persistent when compared to the business representatives and trade union officials. Trade union officials and business representatives behave similar in the current year forecast horizon, but the former group tends to compensate more by increasing their perceived exchange rate impact for the one-year-ahead horizon, where the business representatives decrease theirs.

The notable decay of the exchange rate impact for the financial analysts and business representatives groups from the short-term to the longer-term horizons, suggests that intertemporal heterogeneity is present i.e. they follow different expectations formation processes for different time horizons. In addition, it appears that following a supply innovation such as an exchange rate shock, the financial analysts and business representatives groups are more anchored over longer-term horizons than the trade union representatives group.

6. Adaptive learning

South African respondents are empirically not rational when forming inflation expectations, mainly due to their inefficient use of available information (see Ehlers (2015)). Contemporary monetary theories propose learning and adaptive learning in particular (see Evans and Honkapohja (2001), Bullard and Mitra (2002), Pfajfar and Zakelj (2015)), as alternative approaches to the rational expectations formation framework. This approach assumes that agents behave as econometricians by producing optimal forecasts based on the historical information available at that point in time, whilst having limited knowledge of the structure of the economy. Evans and Honkapohja (2001) present adaptive learning by allowing agents to adjust their forecast rule when they receive new information.

The process of inflation expectations formation involves estimating an initial expectation, but also involves opportunities to revise these for any appropriate reason. It has been shown by Anderson, Becker et al. (2010) that expectations formation by United States (US) agents are formed by engaging learning processes heterogeneously. The authors indicate that individual forecast accuracy is less diverse at the re-interview than at the initial interview, implying that the process of learning may reduce the initial heterogeneity.

To investigate if respondents of the BER inflation expectations survey follow a process of learning, the approach by Anderson, Becker et al. (2010) is followed. During the course of a calendar year, respondents of the BER Survey are approached four times, once per quarter, to submit forecasts of the current, the one-year-ahead and the two-year-ahead annual average consumer inflation number. Subsequent to the initial interview conducted during the first quarter of the year, the following three interviews provide respondents the opportunity to revise their previous reported expectations, especially since new information is available for them to include into their information sets. As a result, these four instances ask respondents for overlapping forecasts, but on each subsequent occasion, more information is available, which the respondents may use to improve their forecast errors. These subsequent interviews are considered in this paper as re-interviews.

An observed forecast change by the individual respondent upon subsequent re-interview alone does not imply learning. Respondents should incorporate the additional information such that their realised forecast error is smaller compared to the previous interview, to indicate successful learning. These re-interviews provide opportunities to examine if individual respondents update and re-consider their information sets and hence meaningfully update their forecasts such that their absolute forecasts errors are smaller from the first to the fourth interview for the year. Hence the test aims to observe if learning behaviour improved their forecast accuracy.

The following equation is estimated:

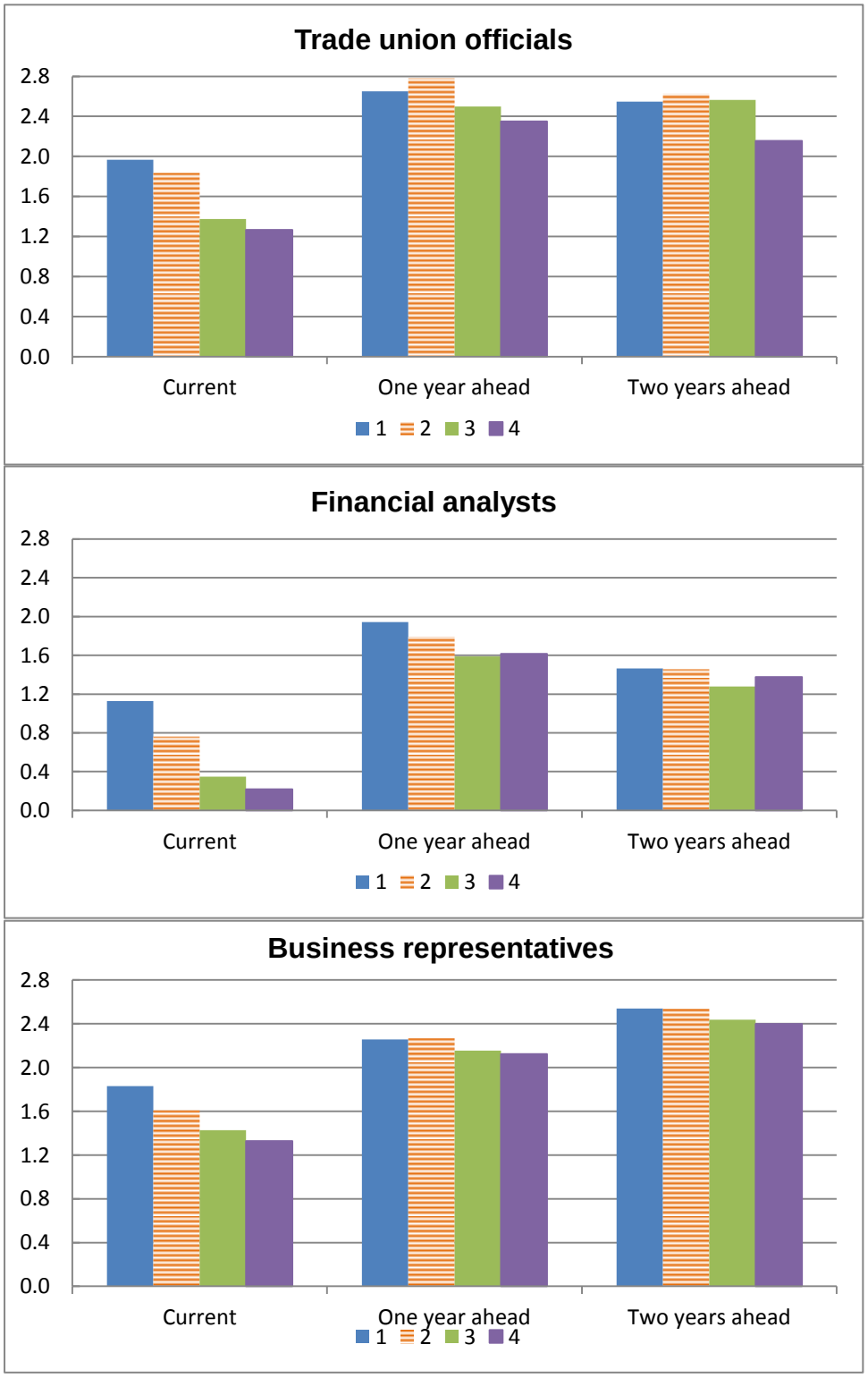
$$\left|E_{i,t}\pi^{q}_{i,t+k} - \pi_{t+k}\right| = \alpha_0 + \alpha_1\ Interview^{q}_{i,t+k} +\ \varepsilon_t \qquad (6.1)$$

Where q = interview number (1,2,3,4), k = forecast horizon (0,1,2), i = respondent 1,…,N and t = time. The parameter α_0 denotes the intercept, α_1 the average individual-specific adaptive learning parameter and ε_t the stochastic error term. In this equation individual respondents are tested if they do exhibit learning characteristics where the absolute forecast error per consecutive quarterly interview per individual is decreasing from their first to their fourth interviews. Where an individual did not provide all four expectations for a particular year, the incomplete data were discarded from the dataset.

The average absolute errors of the individual respondents per group and per interview number are shown in Figure 6.1. It appears that the mean absolute errors of the respondents do decline over the four interviews. According to maximum likelihood estimations, only the current year forecast horizons have a statistically significant decay for all the three groups considered. Financial analysts tend to have the best improvement in their forecast errors by declining by 0,31 per cent from the first to the fourth quarter on average. The trade union officials improve their absolute forecast errors by 0,26 per cent and the business representatives improve by 0,17 per cent on average per consecutive quarter. The one-and two-year-ahead horizons do show slightly lower absolute errors over the four interviews, but these are not statistically significant from each other according to F-tests (see Appendix D).

The short-term expectations formation processes of these respondents indicate that learning is indeed present, however, this is not the case for the one-year and two-years ahead forecast horizons. Therefore intertemporal heterogeneity is present with regards to how these agents learn.

Figure 6.1 Average absolute forecast errors per group and interview



7. Policy considerations

In an inflation targeting regime, it is important for the central bank to anchor inflation expectations at an explicit inflation target to achieve price stability (see Bernanke (2007)). When inflation expectations are anchored, it facilitates an environment where the central bank can achieve greater output stability in the short-term and price stability in the long-term (see Orphanides and Williams (2007)). Well-anchored longer-term inflation expectations essentially should not be influenced by new economic news or inflation surprises, but should remain relatively stable at its original estimate (see Bernanke (2007) and Nautz and Strohsal (2014)).

An inflation targeting central bank needs to understand the nature and behaviour of inflation expectations in its economy so that it can influence it to achieve price stability that promotes economic growth and stability at the lowest cost to society possible. The role of monetary policy in a heterogeneous expectations environment is complex.

Departures from homogeneity require monetary authorities to understand the nature of it to be able to take appropriate policy actions. In the case where heterogeneity exists between groups such as private agents and the central bank, Fukac (2008) shows that it is optimal for this central bank to not respond aggressively to inflation deviations from target in an attempt to improve economic stability and lower output variability in the short-run. Such a recommendation is in contrast to the case of heterogeneous or imperfect knowledge where more vigilant monetary policy responses are suggested (see Orphanides and Williams (2004)).

Heterogeneous inflation expectations cause subjective disagreements about ex-ante real interest rates amongst agents (see Fukac (2008) and Malmendier and Nagel (2009)). When a central bank responds aggressively in such an environment, this divergence in subjective real interest rates becomes even more pronounced. Increased volatility in both inflation and output occurs, since these rates are relevant to consumption and investment decisions of agents.

In a heterogeneous expectations environment it may be prudent for policy authorities to try to address some of the sources of heterogeneity such as informational inefficiencies of agents by enhancing communication strategies. The provision of a clear inflation target in a credible environment may also assist to converge longer-term inflation expectations of all agents to this anchor.

8. Conclusion

It is often assumed in economic theory that agents are homogenous with respect to information used, interpretation processes and the models used to generate expectations about future inflation. However, staggered information and model uncertainty may well be present and result in heterogeneity of inflation expectations (see Curtin (2005)). The South African respondents analysed here do demonstrate heterogeneity, but in multiple forms. Results from this paper show that South African inflation expectations are not formed uniformly across respondents, forecast approaches and also not across time.

Heterogeneity is observed between the groups surveyed in the BER Survey. The financial analysts and the business representatives show notable declines in their adaptive behaviour from the short-term to the longer-term horizons, indicating that they do not adjust their longer-term expectations by as much as they do their short-term expectations following inflation surprises. Therefore they appear to be more anchored over longer forecast horizons. This behaviour in not as pronounced in the trade union official group, who appear to be less anchored, particularly following the global financial crisis.

Over the short-term forecast horizons agents appear to rely much on their own past inflation experience rather than hedging towards a more financial literate group. Even though this information diffusion effect is not dominant, the respondents rely even less on the financial literate group over longer forecast horizons.

The short-term expectations formation processes of the individual BER Survey respondents indicate that they do learn and improve their forecast errors when re-interviewed. However, this is not the case for the longer forecast horizons. Therefore intertemporal heterogeneity is present with regards to how these individual respondents learn. The respondents analysed here, appear to follow a process of adaptive learning only in the short-term and seem to be anchored to their own past inflation experiences in the longer-term.

Appendix A: Estimated coefficients of adaptive expectations tests

Model: $\pi_t^e - \pi_{t-1}^e = \alpha + \beta(\pi_{t-1}^e - \pi_{t-1}) + v_t$

Estimated sample 2000q2-2014q4.

Table A.1: RIE Survey adaptive expectations coefficients

		B: n:2000q2-2014q4	Std. error	Dummy variables
Reuters consensus (quarterly averages)	Current quarter (x)	-0,710 (-2,58)	0,275	2009q1=1
	x+1	-0,524 (-8,25)	0,064	2009q1q2=1
	x+2	-0,283 (-9,12)	0,031	2009q2q3=1
	x+3	-0,143 (-3,35)	0,043	2009q3=1
	x+4	-0,039 (-4,22)	0,009	2009q3q4=1
	x+5	-0,023 (-2,82)	0,008	2009q3,2010q1q2=1
	x+6	-0,013 (-1,35)	0,010	2009q4=1

Note: t-statistics in parenthesis (Newey-West standard errors)

Table A.2: RIE Survey adaptive expectations coefficients: Sub-samples

		B: Pre-financial crisis n: 2000q2-2008q4	B: Post-financial crisis n: 2009q1-2014q4
Reuters consensus (quarterly averages)	Current quarter (x)	-0,724 (-2,72)	-0,769 (-2,29)
	x+1	-0,530 (-7,06)	-0,442 (-2,47)
	x+2	-0,281 (-7,71)	-0,327 (-4,73)
	x+3	-0,110 (-2,29)	-0,251 (-3,61)
	x+4	-0,044 (-3,78)	-0,038 (-2,69)
	x+5	-0,031 (-3,19)	-0,004 (-0,49)
	x+6	-0,009 (-1,07)	-0,035 (-1,90)

Note: t-statistics in parenthesis (Newey-West standard errors)

Table A3: BER Survey adaptive expectations coefficients

Estimated sample 2000q4-2014q4.

	Business rep	Fin analysts	Trade unions	Overall
Current year	-0,205 (-6,79) 0,030	-0,460 (-8,67) 0,053	-0,293 (-9,13) 0,032	-0,279 (-9,08) 0,031
1 year ahead	-0,050 (-2,98) 0,017	-0,056 (-4,33) 0,013	-0,140 (-4,23) 0,033	-0,094 (-4,73) 0,020
2 years ahead	-0,019 (-1,35) 0,014	-0,014 (-0,99) 0,014	-0,085 (-2,75) 0,031	-0,039 (-1,82) 0,021

Note: t-statistics in parenthesis (Newey-West standard errors), std errors thereafter

Table A3: BER Survey adaptive expectations coefficients: Sub-samples

Estimated sample 2000q4-2014q4.

		Business rep	**Fin analysts**	**Trade unions**	**Overall**
Pre-financial crisis	Current year	-0,213 (-5,95)	-0,440 (-7,39)	-0,288 (-7,70)	-0,291 (-7,99)
	1 year ahead	-0,053 (-2,74)	-0,061 (-4,23)	-0,116 (-2,78)	-0,083 (-4,40)
	2 years ahead	-0,026 (-1,46)	-0,013 (-0,66)	-0,092 (-3,26)	-0,061 (-2,61)
Post-financial crisis	Current year	-0,162 (-2,84)	-0,649 (-8,49)	-0,230 (-2,84)	-0,221 (-4,11)
	1 year ahead	-0,041 (-1,61)	-0,043 (-0,88)	-0,215 (-5,03)	-0,159 (-5,06)
	2 years ahead	-0,005 (-0,15)	-0,018 (-0,84)	-0,111 (-1,53)	-0,002 (-0,05)

Note: t-statistics in parenthesis (Newey-West standard errors)

Appendix B: Information diffusion from experts to business analysts and trade union officials

Table B.1: Comparison of coefficients between groups and over time, coefficients restricted

Model: $\pi^e{}_{x,t} = \alpha_0 + \alpha_1 \pi^e{}_{fin,t} + (1-\alpha_1)\pi^e{}_{x,t-1}$

Estimated sample 2000q4-2014q4.

	α_0	α_1	$(1-\alpha_1)$
Business representatives:			
Current year	0,183 (4,45)	0,342 (5,99)	0,658
One-year-ahead	0,234 (2,37)	0,217 (3,98)	0,783
Two-years-ahead	0,224 (1,74)	0,177 (2,25)	0,823
Trade union officials:			
Current year	0,175 (4,10)	0,391 (10,6)	0,609
One-year-ahead	0,227 (2,72)	0,233 (3,42)	0,767
Two-years-ahead	0,322 (2,48)	0,258 (3,06)	0,742

Note: t-statistics in parenthesis (Newey-West standard errors)

Table B.2: Comparison of coefficients between groups and over time, coefficients not restricted

Model: $\pi^e{}_{x,t} = \alpha_0 + \alpha_1 \pi^e{}_{fin,t} + \alpha_2 \pi^e{}_{x,t-1}$

Estimated sample 2000q4-2014q4

	α_0	α_1	α_2
Business representatives:			
Current year	0,063 (0,36)	0,348 (6,02)	0,670 (10,90)
One-year-ahead	-1,222 (-3,80)	0,444 (5,14)	0,807 (16,47)
Two-years-ahead	-1,066 (-1,27)	0,485 (1,88)	0,766 (7,15)
Trade union officials:			
Current year	-0,040 (-0,21)	0,404 (11,98)	0,629 (13,01)
One-year -ahead	-1,386 (-3,96)	0,488 (5,36)	0,791 (11,49)
Two-years -ahead	-2,128 (-1,48)	0,785 (2,31)	0,680 (6,99)

Note: t-statistics in parenthesis (Newey-West standard errors)

Appendix C: Open economy impacts

Table C.1: Comparison of coefficients between groups and over time, coefficients restricted

Model: $\pi^e_{x,t} = \alpha_0 + \alpha_1 exd_t + (1-\alpha_1)\pi^e_{x,t-1}$

Estimated sample 2000q4-2014q4.

	α_0	α_1	$(1-\alpha_1)$
Financial analysts:			
Current year	0,136 (1,430)	0,019 (4,571)	0,981
One-year-ahead	0,074 (1,567)	0,003 (1,087)	0,997
Two-years-ahead	0,022 (0,836)	0,003 (1,870)	0,997
Business representatives:			
Current year	-0,066 (-1,508)	0,009 (3,233)	0,991
One-year-ahead	-0,049 (-1,259)	0,005 (2,147)	0,995
Two-years-ahead	-0,048 (-1,251)	0,003 (1,319)	0,997
Trade union officials:			
Current year	-0,095 (-1,245)	0,009 (2,232)	0,991
One-year-ahead	-0,010 (-0,145)	0,014 (3,437)	0,986
Two-years-ahead	-0,065 (-1,190)	0,008 (1,742)	0,992

Note: t-statistics in parenthesis (Newey-West standard errors)

Appendix D: Adaptive learning: BER Survey respondents

Table D1: Average absolute errors: Financial analysts

Interview number	Fin x	Fin x1	Fin x2
1	1.13	1.94	1.47
2	0.76	1.79	1.46
3	0.35	1.59	1.28
4	0.22	1.62	1.38
F-test	4.86	0.38	0.55
n (set of four obs)	104	95	75

Table D2: Average absolute errors: Trade union officials

Interview number	Lab x	Lab x1	Lab x2
1	1.97	2.65	2.55
2	1.84	2.78	2.63
3	1.38	2.50	2.56
4	1.27	2.35	2.15
F-test	4.86	0.38	0.55
n (set of four obs)	67	55	54

Table D3: Average absolute errors: Business representatives

Interview number	Bus x	Bus x1	Bus x2
1	1.83	2.26	2.54
2	1.61	2.27	2.54
3	1.43	2.15	2.44
4	1.33	2.12	2.40
F-test	68.09	2.6	2.14
n (set of four obs)	2242	1805	1621

Model: $\left|E_{i,t}\pi^{q}_{t+k,j} - \pi_{t+k}\right| = \alpha_0 + \alpha_1 Interview^{q} + \varepsilon_t$

Table D4: Adaptive learning coefficients: Financial analysts

Interview number	**Fin x**	**Fin x1**	**Fin x2**
α_1	-0.314	-0.119	-0.045
p-value	0.000	0.067	0.262
F-test	122.77	2.2	0.41
p-value	0.000	0.139	0.524
n (set of four obs)	104	95	75

Table D5: Adaptive learning coefficients: Trade union officials

Interview number	**Lab x**	**Lab x1**	**Lab x2**
α_1	-0.256	-0.118	-0.124
p-value	0.000	0.190	0.170
F-test	13.65	0.77	0.92
p-value	0.000	0.380	0.338
n (set of four obs)	67	55	54

Table D6: Adaptive learning coefficients: Business representatives

Interview number	**Bus x**	**Bus x1**	**Bus x2**
α_1	-0.170	-0.052	-0.053
p-value	0.000	0.005	0.009
F-test	199.03	6.54	5.69
p-value	0.000	0.011	0.017
n (set of four obs)	2242	1805	1621

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