

Dispersion of Inflation Expectations - March 2015

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Abstract

We construct cross-sectional measures of dispersion in inflation expectations, based on the extent of disagreement in survey data (a rough proxy for inflation uncertainty); and document how these measures evolve over time. The good news is that dispersion of inflation expectations has reduced substantially since 2000. The bad news is that expectations are converging on the upper bound of the official target range. The inter-quartile range of expectations is systematically entirely above the mid-point of the official target range since at least 2008.

Keywords: forecast disagreement; inflation uncertainty; behavioural macroeconomics.

"(...) people are insufficiently sensitive to distributional data even when such data are available. Indeed, (...) people rely primarily on singular information, even when it is scanty and unreliable, and give insufficient weight to distributional information."
(Kahneman and Tversky (1977).)

1. Introduction¹

Survey data show considerable disagreement about inflation ahead. The degree of dispersion in beliefs about future inflation is a non-trivial indicator for monetary policy.² First, it may indicate how firmly expectations are anchored.³ Wide disagreement about inflation ahead means no convergence in the vicinity of the average forecast. If the inflation targeting policy is credible, not only should the central tendency of medium and long-term inflation expectations match the official target; but these expectations should also tend to converge on the target. Second, dispersion in inflation expectations is a rough proxy for uncertainty about future inflation. Inflation uncertainty affects the term premium in bond markets, which forces a wedge between short and long-term interest rates, beyond the effect of interest rate expectations. Third, high dispersion means that the expectations of a large number of economic agents will (necessarily) be proven substantially incorrect, once the level of realized inflation becomes known -- irrespective of what that level is. The consequent updating and revisions to plans may impact aggregate fluctuations.⁴

¹ With thanks to Alain Kabundi for helpful comments, and to staff at the Bureau for Economic Research for data.

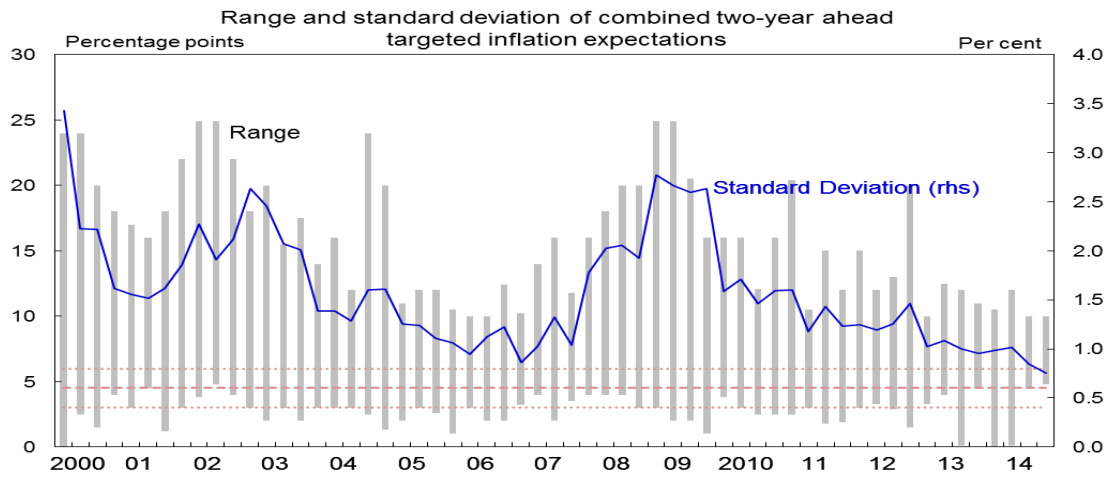
² Inflation expectations play a crucial role in an inflation targeting regime - they affect realised inflation, as well as the output cost of controlling inflation, and therefore monetary policy effectiveness. This is well understood, and reasonably studied in South Africa. The subject of this note is the extent of disagreement, or the dispersion, about these expectations. Interesting recent work recognizes heterogeneity in expectations, but is concerned with the evolution of group averages, rather than their dispersion. (Reid (2012), Walter, Johnson and Johnston (2013), Kabundi, Schaling and Some (2014).)

³ Inflation expectations are "well anchored" if long-term expectations are relatively impervious to temporary shocks. See Orphanides and Williams (2005) and Bernanke (2007) for generally accepted definitions.

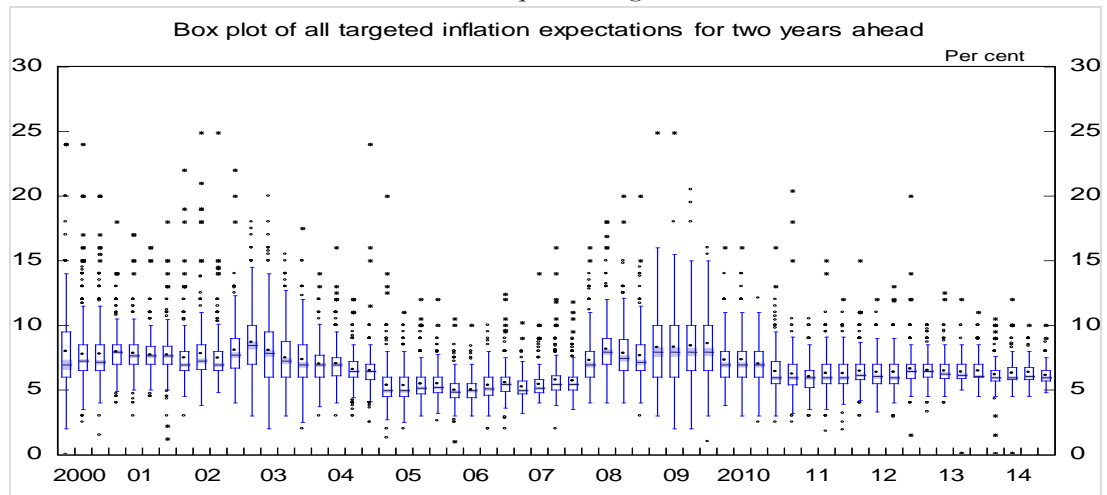
⁴ Mankiw, Reis and Wolfers (2004, p. 210, 242) go as far as suggesting that "disagreement may be a key to macroeconomic dynamics." See Mankiw and Reis (2002), Khan and Zhu (2002), and subsequent literature on sticky information. On disagreement as a proxy for uncertainty, see for example Giordani and Söderlind (2003), Bachmann, Elstner and Sims (2013).

Table 1: Range, standard deviation, and interquartile range for two-year ahead expected inflation, all respondents, from 2000 to 2014

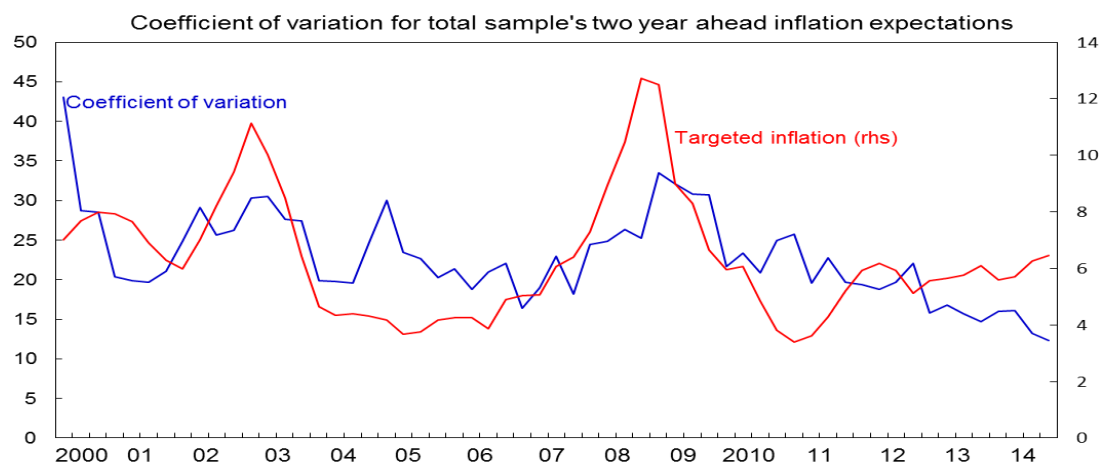
Full range and standard deviation



Inter-quartile range



Coefficient of variation and realised inflation



Source: authors' calculations; BER data

This note documents the extent of disagreement about expected inflation in South Africa, using simple and intuitive measures of dispersion. We show that the level of dispersion, within each group of respondents and overall, can be very high, with an average distance between the maximum and minimum expectation (the range) of 13 percentage points for the complete sample; that it varies significantly over time, with a maximum range of 24 percentage points (in early 2000), and a minimum of 5 percentage points (end of 2014); and that it is currently (latest available data) at its lowest level since the surveys began - for each group of respondents. The inter-quartile range, which represents the most likely spread of beliefs, is of course narrower, and quite stable in recent years. The cross-sectional standard deviation of inflation expectations is at a record low by the end of 2014.

In sum, dispersion has reduced, and substantially; observations are increasingly concentrated in the vicinity of the average (or median) forecast. The problem is that the likely (inter-quartile) range of expectations is *entirely* above the mid-point of the official target range (of three to six percent) since at least 2008; that of price setters (business and trade unions) expectations, since 2007. If we exclude an implausible forecast of inflation near zero (made in three quarters between 2013 and 2014), then for all but one of the past six quarters, the full range of expectations is above the mid-point of the target range -- i.e., statistically speaking, nobody expects inflation to hit the mid-point from above at the two year horizon.⁵ Consequently, and as documented elsewhere, the average (and median) expectations, which have been relatively stable, exceed the mid-point of the official target band by about 150 basis points. Disagreement has fallen and expectations are converging, but on the upper bound of the target range. This is true for all groups of respondents.

2. Dispersion of two-year ahead beliefs

We use the entire cross-section of each quarterly Inflation Expectations Survey, organized by the Bureau for Economic Research, on respondents' inflation expectations, from the second quarter of 2000 to the fourth quarter of 2014. Respondents are drawn from business and trade union representatives, and professional economists in the financial sector. The average number of observations per quarter is 366, with high predominance from business sector responses (average of 337 observations per quarter, compared to 13 and 16 from labour and analysts, respectively).

The extent of disagreement and its evolution are summarised in the exhibits in Tables 1, 2 and 3. The measures of dispersion are the following: the range of the distribution, which is the difference between the highest and the lowest forecast; the inter-quartile range, which excludes forecasts in the highest and lowest quartiles; the standard deviation, which is arguably the most widely used measure of dispersion; and the coefficient of variation which is the ratio of the standard deviation to the average forecast. These are all calculated for each quarter, using the survey data available for that quarter -- i.e., they are cross-sectional measures, and not based on the past observations.

We only report here the results for beliefs about inflation two years ahead. The other horizons for which historical BER data are available (inflation in the current year and one year ahead) are too short for monetary policy to have an effect on inflation; well-anchored medium and long expectations do not preclude high oscillation in short-term (less than one year ahead) expectations.⁶

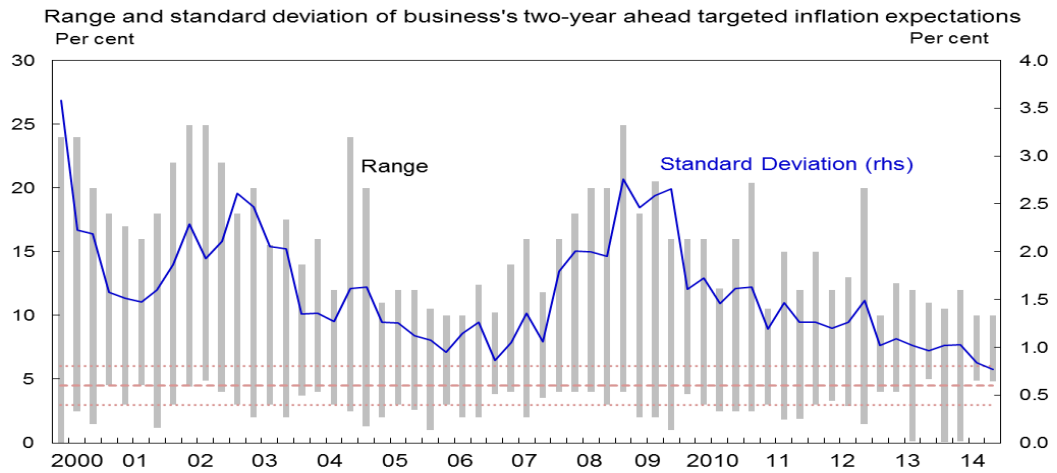
Table 1 shows the evolution of the different measures of dispersion using the full sample of respondents. Observe the gradual reduction in the standard deviation, the narrowing and stability of the inter quartile range, and relative stability of the median (the line segments inside the rectangles), towards the end of the sample period.

⁵ Note that 2014 saw an extreme reduction in the price of crude oil; this could have an effect on the distribution of forecasts reported in early 2015, but mainly for short-term horizons.

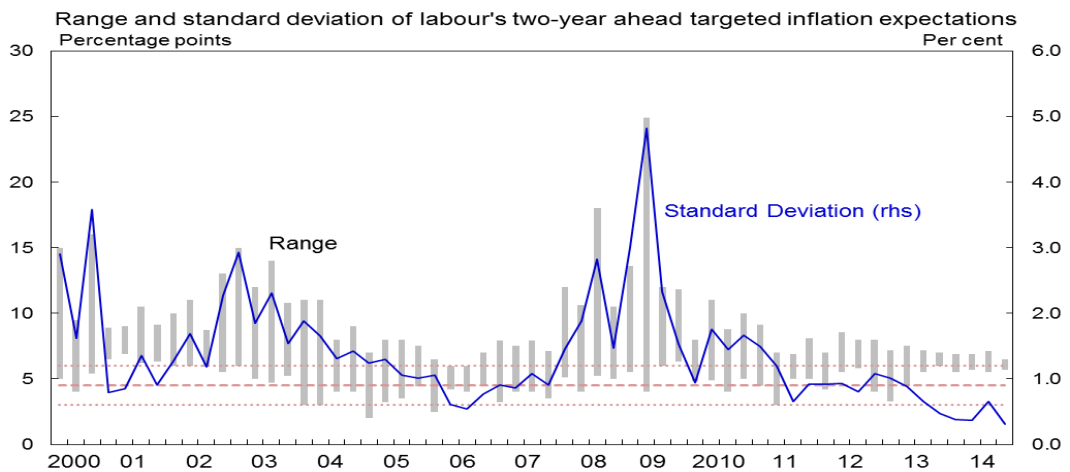
⁶ BER survey data on expectations for inflation five years ahead are also available, but only from 2011.

Table 2: Range and standard deviation of two-year ahead expected inflation, by business, labour, and financial analysts, from 2000 to 2014

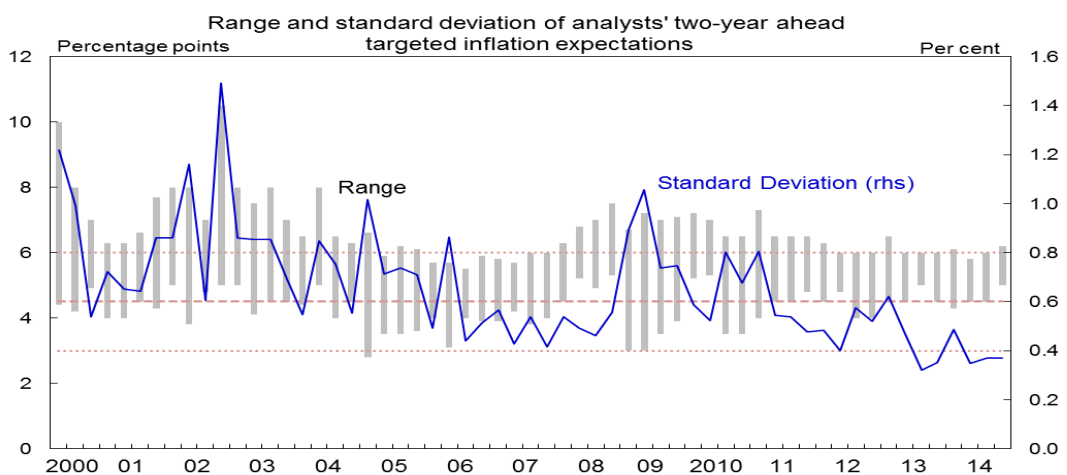
Dispersion of business expectations



Dispersion of trade union expectations



Dispersion of financial analysts' expectations



Source: authors' calculations; BER data

2.1 Range and standard deviation

The figures in Table 2 show the quarterly evolution of the range (outliers included) and standard deviation of inflation forecasts, by business, trade union and analyst respondents.⁷

The standard deviation of expected inflation is at its lowest level since the introduction of inflation targeting. This applies to each group of respondents. The same peak in standard deviation of expected inflation, at or near the end of 2008 was observed in advanced economies, especially the US and UK.⁸ It reflects variance in recent past inflation (oil and food price shocks); dispersion as a proxy for uncertainty; and of course, less than perfectly anchored expectations.⁹

The range oscillates, in central tendency, but remains wide. This is largely due to outliers (a few extreme expectations on the up and down sides) which distort the visual representation of the more likely range.

2.2 Box plots and inter-quartile range

The figures in Table 3 show the evolution of box plots for the same forecasts. The length of the central rectangle gives a visual representation of the location of the inter-quartile range, an indication of the more likely range of variation in expectations, excluding extreme observations.¹⁰ The outliers are shown outside the boxes, above and below the end of the vertical lines. The number of large outliers (among business respondents) calls for caution when reporting mean forecasts, as these can be weak indicators of central tendency. The number of extreme observations has reduced markedly.

Note how the inter-quartile range reduced (indicating increased convergence of expectations), and stabilized. This is a tentative sign of some degree of recent anchoring of expectations, given the observed evolution of inflation -- that is, we show declining dispersion and an increasingly stable range of expectations, despite some variability in observed inflation, and high variability in crucial drivers of inflation, especially the exchange rate and commodities prices.

Remark 1 *By all measures of dispersion, and for each group of respondents, we observe a significant reduction in disagreement about inflation two years ahead.*

This is very clear for all groups of respondents. However, the convergence is, for each group, at or very near the upper bound of the inflation target range. Indeed, observe that:

Remark 2 *The entire inter-quartile range (of expected inflation two years ahead) is systematically above the mid-point of the official inflation target range, since at least 2008, for each group of respondents; and since 2007 for price setters.*

That is, *to the extent* that median and mean long-term forecasts are relatively insensitive to the data and news flow, expectations are increasingly firmly anchored (there is less disagreement); but the emerging focal point is too high for a target range of three to six percent.¹¹ This finding corroborates and strengthens those in previous reports based only on the mean of each group's forecasts, regarding the Bank's implicit target (e.g., Walter, Johnson and Johnston (2013), Kabundi, Schaling and Some (2014)).

⁷ The survey data includes a decimal expectation from a business respondent in three recent quarters (expectations of 0.1, 0.07 and 0.1 percent in Q3-2013, Q1 and Q2-2014, respectively). We ignored these when illustrating the complete range, and replaced them by the next lowest forecasts. We preserve all observations as reported in the box plots however.

⁸ See Gerlach, Hördahl and Moessner (2011).

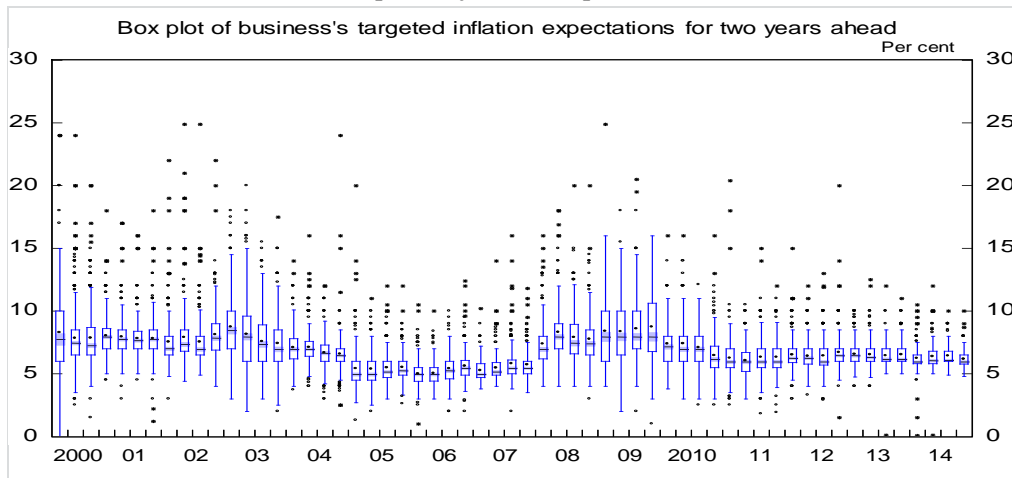
⁹ We also document the evolution of the coefficient of variation, a measure of dispersion which controls for the effect of changing mean levels - see the appendix.

¹⁰ The central boxes represent, at each point in time, the range containing the fifty percent of observations which span the first to the third quartiles of the distribution of forecasts. (See the appendix for detail.)

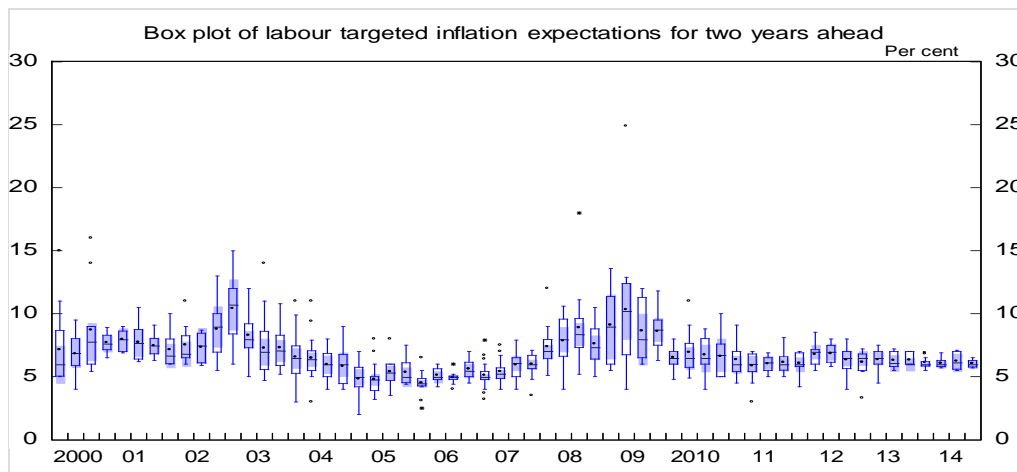
¹¹ It is not clear that expectations of price setters are well anchored. Realized inflation has been comparatively stable.

Table 3: Box plots for two-year ahead expected inflation, by business, labour, and financial analysts, from 2000 to 2014

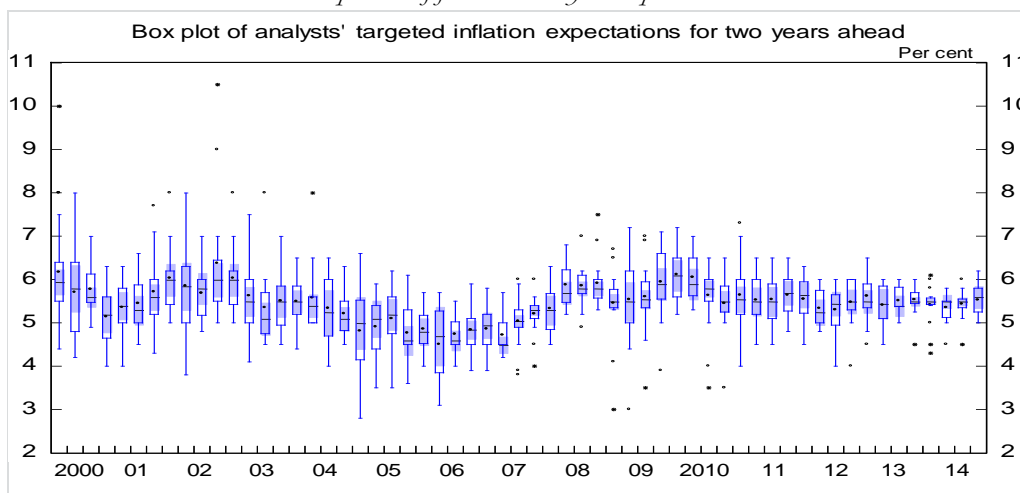
Dispersion of business expectations



Dispersion of trade union expectations



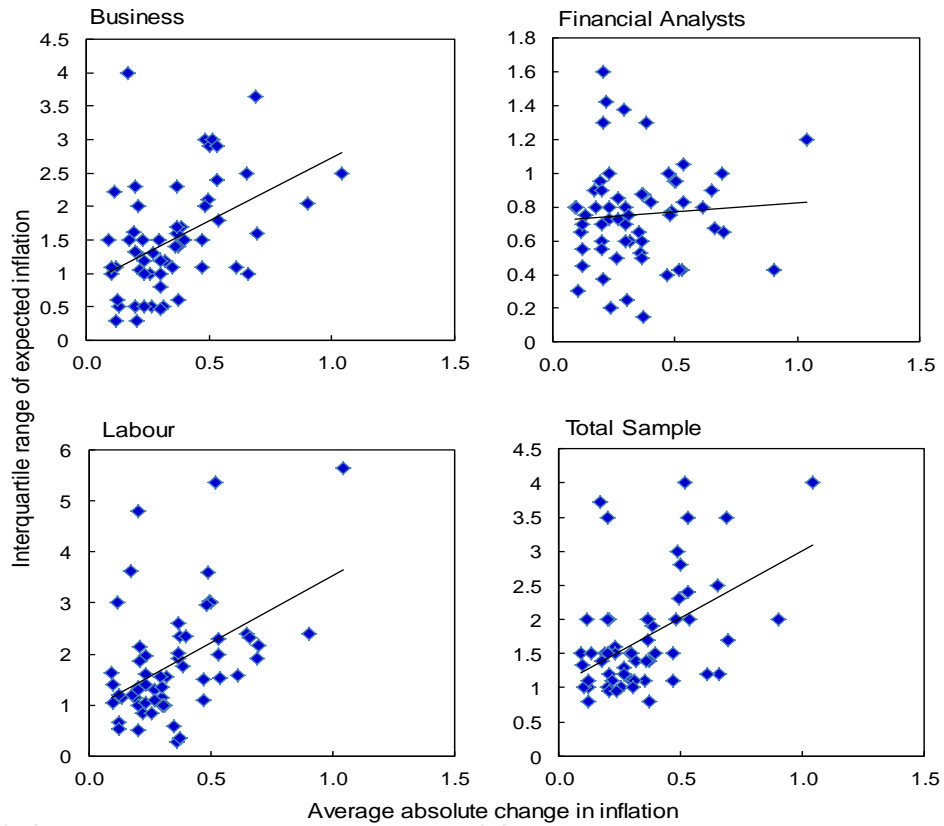
Dispersion of financial analysts' expectations



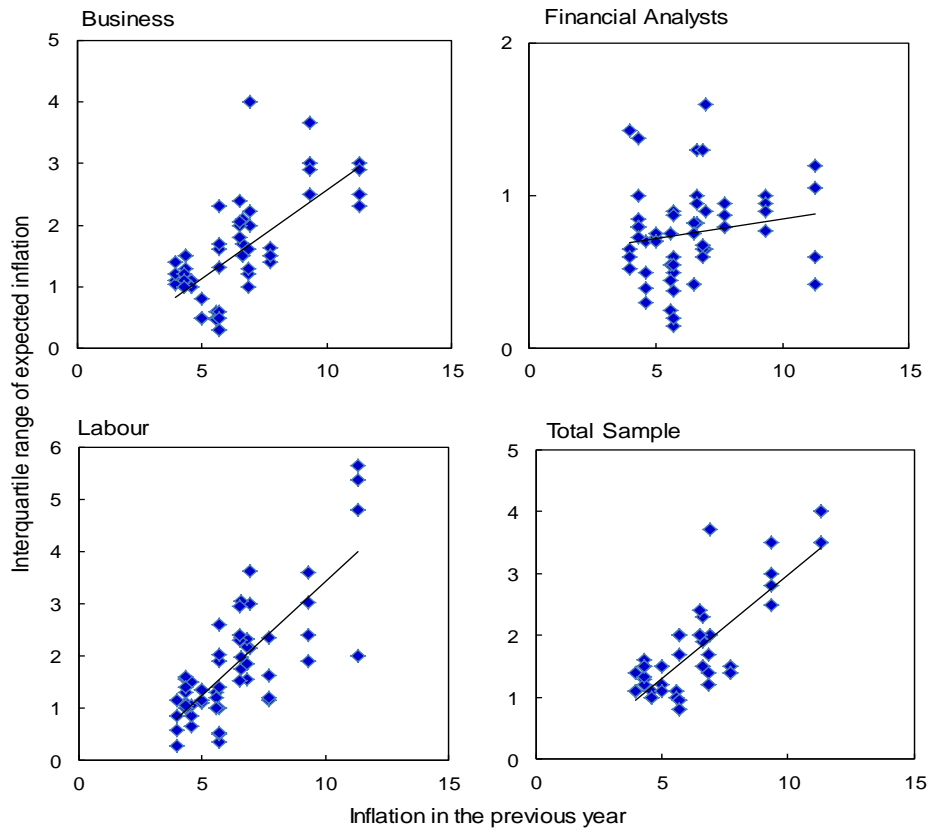
Source: authors' calculations; BER data

Table 4: Drivers of disagreement

A: inter-quartile range and past inflation variability



B: inter-quartile range and past inflation level



Source: authors' calculations; BER & SARB data

3. Past inflation and disagreement about inflation ahead

The figures in Table 4 suggest that past inflation (level and variability) affects current dispersion of expectations about inflation ahead. Intuitively, the higher and/or the more volatile the observed rate of inflation, the harder it is to anticipate future inflation. Hence the sharp increases in dispersion around 2002 and 2008. Set A (top four figures) shows scatter plots of quarterly dispersion against the average absolute change in inflation over the previous quarter. Set B (bottom four graphs) shows scatter plots of dispersion against realized inflation over the preceding year.

There is a clear difference between the effect of past inflation on dispersion among analysts, and on dispersion among price setters (business and labour). Dispersion among analysts is not affected by the past level of realized inflation, in sharp contrast to price setters. (Contrast the first and third quadrants against the second quadrant in set B of Table 4.) Dispersion among analysts is however partly responsive to variability of past inflation.

The relationships in Table 4 (see the fourth and eighth quadrants in particular) need further probing, but they are indicative, and consistent with: a) a degree of adaptiveness in domestic expectations formation, especially by labour and business; b) theoretic predictions on the determinants of disagreement; and c) available international evidence, based on United States data.¹²

Realized inflation is publicly observable, so it is an element of the common information set. Different beliefs about inflation ahead must therefore reflect differences in how respondents process this information, plus the effects of other determinants of inflation expectations. Clearer understanding of the determinants of dispersion or disagreement about inflation (and other macro variables) requires further work.

4. Conclusion

Trehan and Zorrilla (2012, p.2) observe that disagreement about the inflation target is "as problematic" as uncertainty about the central bank's commitment to its target. We document decreasing disagreement; therefore less uncertainty about the Reserve Bank's commitment; but with increasing agreement on commitment to an implicit target in the vicinity of the six percent upper bound of the target range.

5. References

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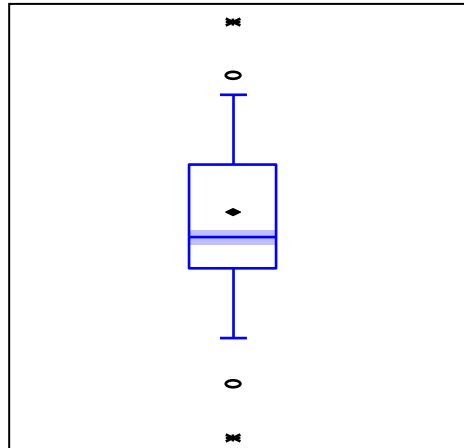
¹² See Ehlers and Steinbach (2007) on expectations formation in South Africa; and King (2004), Mankiw, Reis and Wolfers (2004), Williams (2004) and Capistran and Timmermann (2009), on theoretic predictions and US evidence.

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6. Appendix

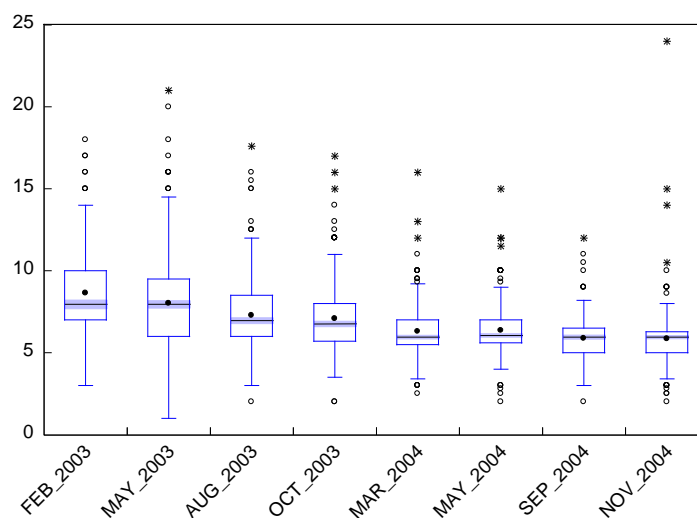
6.1 The information in box plots

A box plot is a graphic representation of a number of descriptive statistics for a dataset. It displays the mean, median, first and third quartiles, and outliers for the data. It is also a useful tool in understanding the dispersion and skewness of data and hence gives an indication of the distribution of the data.



The box (rectangle in the middle) represents the 50 per cent of observations falling between the first and third quartiles. Inside the box the median is indicated by a horizontal line (the median is the point at which the sample is split in half, such that half the sample is below the median and half above the median). The shaded area around the median indicates the 95 per cent confidence interval for the median. The solid black diamond indicates the mean of the data (this being the average value of all observations). The whiskers are the vertical lines that extend upward and downward from the box. They end at the last data point that falls within the first quartile minus 1.5 times the inter-quartile range (which is calculated as the difference between the third and first quartiles) and the third quartile plus 1.5 times the inter-quartile range (these are indicated by the "staple" at the end of each whisker). The circle indicates near outliers which are observations which fall between 1.5 times the inter-quartile range and 3 times the inter-quartile range below the first quartile and above the third quartile. Far outliers, as indicated by the star are further than the bounds for the near outliers.

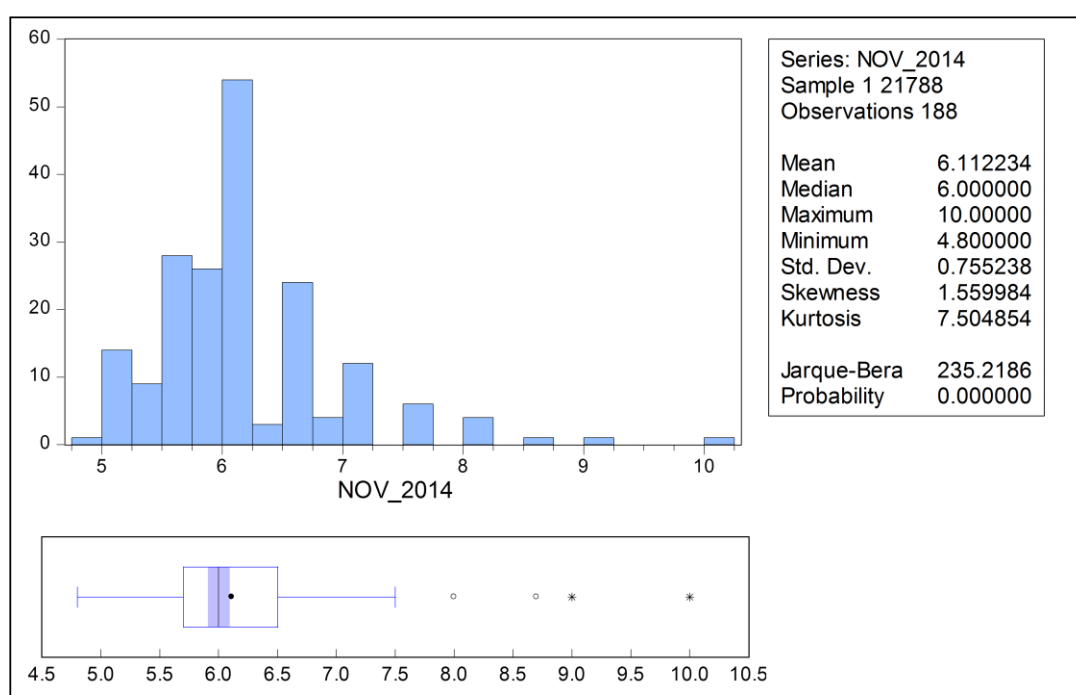
Figure 1: Box-and-whisker plots for the surveys held during 2003 and 2004



An advantage from the presence of the 95 per cent confidence interval as provided in the box plots is that it allows for comparison of the medians of multiple datasets. In the case of the expectations survey data, the differences in the medians across a number of surveys. The figure below shows the box plots for the surveys held during 2003 and 2004. During this period, the median expectation of CPI inflation fell from 8 per cent to 6 per cent. Comparing the 8 per cent median for the February 2003 survey and the 6 per cent median from the November 2004 survey, the fact that the confidence intervals do not overlap suggests that these medians are significantly different from each other.

6.2 A snapshot: the extent of disagreement in November 2014

The exhibit below illustrates the relationship between the box plot and the distribution of data. It shows a histogram and box plot (which has been rotated) for the same dataset. In this case, the dataset is the expectations for two-year ahead CPI inflation in South Africa for all participants in the Bureau for Economic Research's inflation expectations survey as reported in November 2014.



Distribution of data from the November 2014 survey of inflation expectations as shown as a histogram and box plot

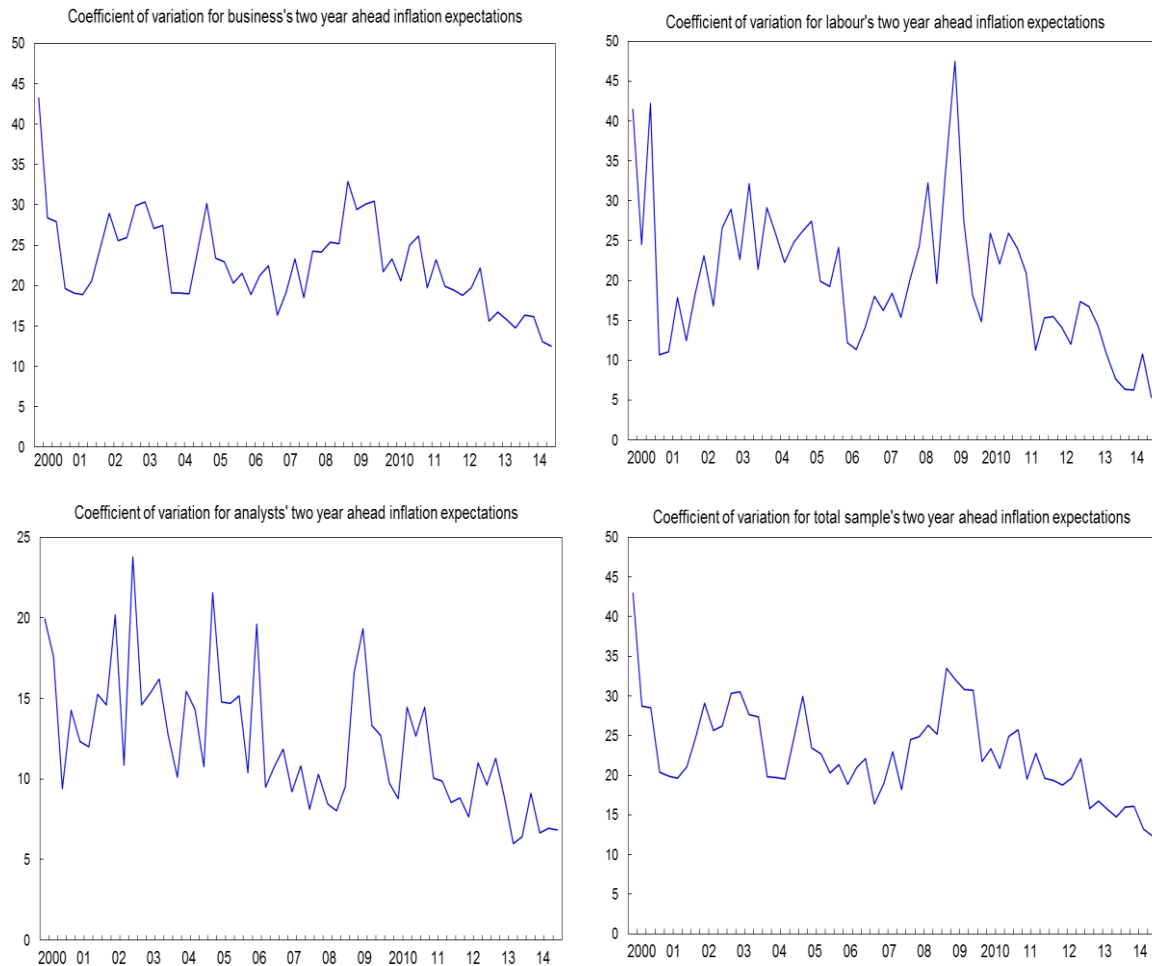
The existence of outliers only to the right of the distribution can be seen in both plots. The median is below the mean because the data are right-skewed, so the mean is upward biased due to the presence of outliers. Another observation when looking across the histogram and box plot is that the majority of observations fall between 5.5 and 6.25 (in the case of the histogram, with over 100 observations between these points) and in the case of the box plot between 5.7 and 6.5 (accounting for 94 observations). The box plot is slightly more accurate in this case as it pins down exactly where the data splits rather than the histogram which places observations within arbitrarily determined bins.

6.3 Coefficient of variation

Common statistics used to describe data include the median, mean, standard deviation, variance, minimum and maximum. As seen in the previous section the box-and-whisker plot provides a graphic representation of this information. When comparing different series, the use of these raw statistics can be misleading as they can be measured in different units, or in the case of the inflation expectations data used for this analysis, at different periods (with different means). One measure that is effectively unitless is the

coefficient of variation. It is calculated as the standard deviation of a series divided by its mean; and provides a measure of the variation of the data in relation to the data's mean. This measure is also comparable across different series and identifies series that display greater or less variation relative to other series. In the case of the expectations data, the total sample exhibits a pattern that suggests that the dispersion of inflation expectations during recent surveys is significantly lower than when the survey began in 2000.

Table 5: Coefficient of variation for two year ahead inflation expectations



The reported coefficients of variation for the financial analyst and labour samples are adjusted for the bias induced by their small cross-sectional samples, by multiplying the coefficient by $(1 + (1/4n))$ where n is the number of observations in that quarter.¹³

¹³ See Sokal, R., and F. Rohlf, 2012, Biometry, New York: Freeman and Co.