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# Measuring Expectations

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## MEASURING EXPECTATIONS

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# Measuring Expectations\*

David Kjellberg<sup>†</sup>

February 2006

## Abstract

To evaluate measures of expectations I examine and compare some of the most common methods for capturing expectations: the futures method which utilizes financial market prices, the VAR forecast method, and the survey method. I study average expectations on the Federal funds rate target, and the main findings can be summarized as follows: i) the survey measure and the futures measure are highly correlated; the correlation coefficient is 0.81 which indicates that the measures capture the same phenomenon, ii) the survey measure consistently overestimates the realized changes in the interest rate, iii) the VAR forecast method shows little resemblance with the other methods.

**Keywords:** Interest rates, expectations, futures, VAR forecasts, survey data

**JEL-codes:** E43, E44, E47

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# 1 Introduction

Expectations play a vital role as one of the basic building blocks of theoretical macroeconomic models. To correctly measure the *empirical* expectation on an economic variable is difficult since we cannot directly observe the true expectations of the agents in the economy. The true expectations exist in our minds, sometimes only as a feeling, and to consistently retrieve them from there seems like an impossible mission. This problem is particularly evident when we deal with aggregate market expectations, which is typically the case in macroeconomics. Hence, it is difficult to evaluate the methods used to measure expectations – there are no true expectations to which the measures can be compared. Despite all these problems, various methods are being used to measure expectations, simply because there is no way around including empirical estimates of expected variables in macroeconomic models.

There are many macroeconomic topics where aggregate expectations play a crucial role. Estimates of the Phillips curve, as for instance in Akerlof et.al. (2000), rely heavily on empirical estimates of inflation expectations. Another important area where inflation expectations are important is the estimation of the real interest rate (e.g. Lai, 2004). We can also use a measure of expectations to compute the surprise component, the shock, when an official macro variable is announced. The economic impact of different shocks has been studied in both financial and macroeconomic settings. Empirical financial studies frequently investigate how the return on investments in assets are affected by macroeconomic shocks (e.g. Bernanke and Kuttner, 2004), while macroeconomic studies often tend to focus on monetary policy transmission effects (e.g. Kuttner, 2001 or Gürkaynak, 2005). Expectations are important in economic decision making, and both policy makers and economists would benefit from a better knowledge about how to measure the true expectations.

In this paper I study three different methods which are commonly used to measure expectations empirically: the futures method, the survey method, and the VAR forecast method. The futures method derives market-based expectations implicitly from prices of traded futures contracts. The survey method measures expectations by asking a sample of people what they expect about a variable. The VAR forecast method estimates a VAR-model and uses the out-of-sample forecasts of the model to proxy expectations of the variables. By comparing these three methods with each other, and with the realized outcome of the variable, we can observe if the measures confirm or contradict each other.

The expectations studied in this paper are the expectations on the Federal funds rate target (FFRT). The FFRT is controlled and used by the Federal Reserve Bank (Fed) to implement U.S. monetary policy, and it is an important macroeconomic and financial variable that is monitored by markets all over the world. The FFRT is a suitable variable for this kind of investigation since we can readily measure its expectations with the futures method, the survey method and the VAR forecast method.

The expectations measures here refer to relatively short horizons, from expectations one day ahead up to expectations one month ahead. Expectations for such short time periods should have relatively small error components compared to expectations for longer time periods, and with less noise it should be easier to make fair comparisons of the different methods. The choice of horizon is also due to the nature of the data since the highest available frequency for the survey and the VAR variables is a monthly frequency.

To make sure the different methods measure the same expectations, I try to define them in such a way that they are conditioned on the same information set. The measures are then compared and analyzed in various ways. Descriptive statistics and autocorrelation patterns are discussed, forecasting properties are investigated and the measures are plotted against each other, together with correlation tests. While previous studies have mainly been interested in forecasting ability, I am more interested in analyzing similarities and differences between the measures. The true expectations are not necessarily good forecasts, which makes it appropriate not to focus too much on forecasting efficiency. The three approaches to measuring expectations differ fundamentally and finding strong similarities between the measures would indicate that they capture the same underlying phenomenon – most likely the true expectations. Each method has a different and theoretically plausible link to the true expectations. If we have accurate measures of expectations, we expect high correlations between these measures. A high correlation coefficient could also be due to correlated measurement errors, but since the methods are fundamentally different the measurement errors for each measure should be independent from one another.

The data material in this study covers the time period 1994 to 2004 and contains 88 scheduled Federal Open Market Committee (FOMC) meetings. Data for the statistical method, the VAR-model, is mainly collected from the real-time data supplied by the Federal Reserve Bank of Philadelphia. The futures method data are quotes from the Chicago Board of Trade, supplied through Hansson & Partners AB. The survey method makes use of the Michigan Consumer Survey.

Several studies have evaluated measures of expectations. Most of them investigate one measure at a time and focus on unbiasedness only, assuming rational expectations. Some studies suggest that the futures method of extracting expectations is an unbiased and appropriate measure of expectations for the FFRT, from a rational expectations point of view (see Söderström, 1999; Kuttner, 2001; Gürkaynak et. al., 2002). The futures measure has been used as a benchmark for the true expectations, by e.g. Evans and Kuttner (1998) and Durham (2003). The available evidence on the survey method is unclear, depending very much on the particular variable in focus. For instance, the Money Market Services (MMS) survey has generally been found to have reasonable properties as a measure of expectations. For most variables it is unbiased and outperforms naive time series forecasts (Balduzzi et. al., 2001). Gürkaynak and Wolfers (2005) show that the MMS survey has similar forecasting properties, for a couple of common macroeconomic variables, as a new market based measure of expectations derived from “economic derivatives”. However, Faust et.al. (2003) claim that the MMS survey does not pass the basic tests of unbiasedness for FFRT expectations. The VAR-model for monetary policy has been criticized by Rudebusch (1998) and Evans and Kuttner (1998) for having bad FFRT forecasting properties. These two studies also make a simple comparison between the surprise changes in FFRT derived from VAR forecasts and the futures method, and they find a low correlation between these two measures. Evans and Kuttner (1998) do find a higher correlation between the derived surprise factors when they modify the specification of the VAR-model. However, they also point out a weakness in only studying the correlation between the surprise factors, since this correlation is affected by the non-relevant sample correlation between one of the expectations measures and the FFRT change. In this study I do not focus on the surprise factor, but instead evaluate different characteristics of the measures of *expected changes* in FFRT.

Previous studies of measures of expectations do not thoroughly *compare* the different approaches. Hence, this paper contributes to the existing literature by performing a systematic comparative analysis of the methods. I investigate to what extent different measures of expectations capture the same underlying phenomenon and try to evaluate whether they pick up the unobservable true expectations. The main finding is that the expected interest rate changes as measured by the survey method and the futures method are highly correlated. The survey estimate of expectations overestimate expected changes relative to the true outcome as well as relative to the expectations derived from federal funds futures. Hence the survey measure is biased, in a forecasting sense, with high forecasting errors in comparison to the other methods. Except for the mean bias of the survey method, these two fundamentally

different ways of measuring the same expectations yield surprisingly similar estimates. The high correlation indicates that the futures method and the survey method most likely are measuring the true expectations in a fairly accurate way. The VAR forecast methods, however, generate quite different estimates of the expectations for the FFRT compared to the survey and futures methods.

The rest of the paper is organized as follows. In section 2 I describe the different methods for measuring expectations and section 3 describes the data material. Section 4 presents and analyses the empirical results. Section 5 concludes.

## 2 Methods for Measuring Expectations

The VAR forecast method, the futures method and the survey method are completely different in their approach to measuring expectations. The VAR forecast method uses econometric model forecasts of the FFRT to proxy the expected outcome of the FFRT. The futures method derives implicit expectations from the market price of the Federal funds rate futures. There are several surveys that include questions concerning what the respondents expect about the future changes in the FFRT. These methods are here applied to the practical problem of estimating the expected FFRT change for each scheduled FOMC meeting, which are the meetings that decide if the Fed will change the FFRT or not. The meetings are scheduled eight times per year, with approximately six weeks between each meeting.<sup>1</sup>

To make the comparison of expectations measures as exact as possible we need to equalize the information sets that the different measures are conditioned on. This is not trivial since the three methods are fundamentally different and are not fully comparable in the sense that they use the information available on exactly the same point in time. I let the measures be conditioned on information available at the end of the month previous to the FOMC meeting month. Since the meetings can be scheduled to take place during any weekday of a month, the theoretical expectations horizon then varies between one and 31 days. The futures method can easily be pinpointed to an exact day, which is chosen to be the last trading day of the month prior to a FOMC meeting. The VAR forecast method includes data theoretically available at the first day of the meeting month. The survey method uses survey data that was collected *during* the month prior to the corresponding FOMC meeting. The information sets of the

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<sup>1</sup> In turbulent times there can be unscheduled meetings in between the scheduled meetings.



methods cannot be *perfectly* equalized, but the difference between them is made as small as possible.

Below I discuss the methods and the calculation procedures for each measure. I also explain *how* each measure can be interpreted as a measure of the true expectation.

## 2.1 VAR Forecast Method

Time series models are often used as forecasting tools. By using historical time series data we can estimate statistical relations and use the most recent data to form a forecast. This forecast can be seen as an expectation if agents have access to the same information set that is included in our econometric model.

Forecasting monetary policy has been the subject of many empirical studies. One of the most common statistical approaches is to set up a VAR-system.<sup>2</sup> The only equation of interest for our purpose in the VAR is the FFRT-equation, which use lagged values of FFRT and other macroeconomic variables as independent variables, typically using monthly data. There are several suggestions as to what variables should be included in the VAR. Christiano, Eichenbaum and Evans (CEE) (1996) describe what can be called a benchmark model for Monetary Policy VAR on monthly data.<sup>3</sup> They set up a seven variable VAR in levels with twelve lags. The CEE-VAR is one of the two VAR-models used to make VAR forecasts of the FFRT in this paper:

$$\begin{aligned}
 FFRT_t = & \beta_0 + \sum_{i=1}^{12} \beta_{1,i} FFRT_{t-i} + \sum_{i=1}^{12} \beta_{2,i} \ln N_{t-i} + \sum_{i=1}^{12} \beta_{3,i} \ln CPI_{t-i} + \sum_{i=1}^{12} \beta_{4,i} GSCI_{t-i} \\
 & + \sum_{i=1}^{12} \beta_{5,i} \ln NBR_{t-i} + \sum_{i=1}^{12} \beta_{6,i} \ln TR_{t-i} + \sum_{i=1}^{12} \beta_{7,i} \ln M1_{t-i} + u_t.
 \end{aligned} \tag{1}$$

To avoid the discrete steps of FFRT the market traded FFR is used instead.<sup>4</sup> The other variables in this regression are payroll employment (N), Consumer Price Index (CPI), the

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<sup>2</sup> This is often used to study the effects of monetary policy shocks on other economic variables by using impulse-response functions. Here I am not interested in the monetary shock element but the whole innovation in FFRT changes.

<sup>3</sup> The CEE VAR is used in for instance Rudebusch (1998), Evans and Kuttner (1998), and Robertson and Tallman (1999). It can be seen as a representative benchmark model for a large part of the sample period 1994 to 2004.

<sup>4</sup> The monthly FFR variable is in fact an average over the daily FFR market quotes during a specific month.

growth rate of Goldman & Sachs Commodity Price Index (GSCI), non-borrowed reserves (NBR), total reserves (TR) and the monetary aggregate M1.<sup>5</sup> All variables are in logs and real-time values, e.g. the CPI-value for November 2004 is the number presented in the beginning of December 2004 and not a revised value presented several months later.

I first use the CEE-specification to produce out of sample forecasts of the FFRT.<sup>6</sup> The difference between the forecasted level of FFRT and the current FFRT gives the *expected change* of FFRT. I tried alternative specifications with first differenced variables, shorter lag lengths and fewer variables, but the qualitative results are generally the same as for the CEE-specification.<sup>7</sup> An exception was the specification with three lags of first differenced CEE-variables. This alternative specification gives interesting differences in the estimates of the expectations compared to the CEE-VAR. Therefore, both the standard CEE-VAR and this alternative VAR, named ALT-VAR, will be reported for comparison with the other two methods.

To get a VAR forecast measure of the expected change of FFRT to be comparable to the data for the futures and survey method, the forecasts start in the beginning of 1994. Using the first estimate of the VAR-coefficients and the current VAR-variables we can forecast the FFRT of January 1994. The data used to estimate the VAR models covers January 1985 up to the date of the forecast, i.e. the sample period will increase with time.<sup>8</sup> Forecasts are constructed for all months from January 1994 up until June 2004, covering the selected sample period for FOMC meetings. For every month I re-estimate the VAR model using the updated information set, and then make a forecast of FFRT for the upcoming month. I then select all forecasts for months with FOMC meetings and use them as expectations on the decisions about FFRT changes.

For the VAR model there are some difficult timing issues when estimating the model and making forecasts for certain FOMC meeting months. For instance, the employment report for the previous month is not announced until the first Friday of the current month, and the

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<sup>5</sup> These variables (except GSCI) all have long trends and are typically non-stationary when tested for a unit root. The commodity price index (GSCI) and regular price index (CPI) variables are not the same as used in Christiano, Eichenbaum and Evans (1996). Since the original series are either discontinued or not publicly available they had to be replaced by equivalent variables.

<sup>6</sup> I use real-time data instead of revised data, and also a different commodity price variable than Christiano, Eichenbaum and Evans (1996) did. The sample periods are also different. CEE (1996) used data from 1960 to 1992, while I am using data from 1985. Any attempts to reproduce the CEE-results would be futile with all these differences in data.

<sup>7</sup> I tried VAR-estimations with lag lengths of three and twelve lags, variables in levels and first differences, with three variables (FFR, N, and CPI) and seven variables (the CEE-variables).

<sup>8</sup> I also tried using a nine year moving time band of data, throwing out the oldest observation as a new observation is added, but this does not change any results or conclusions in the paper.

value of the CPI is announced the 13<sup>th</sup> of the current month. This creates forecasting situations where we might have access to last month's employment but not the CPI level of that month.<sup>9</sup> These timing issues are solved by simply assuming the relevant information is available at the start of the month. As a robustness test I check if the VAR measures of expectations are sensitive to this assumption by studying the difference between FOMC meetings that have taken place in the first and last half of the month. For the observations made in the last half of a month all information about the previous month is always publicly available and if there is a difference in results compared to the first half of the month it would indicate that the timing is important.<sup>10</sup> The difference in the bias test is tested by including dummies on intercept and slope coefficients for the first half of the month. Neither the CEE-VAR or the ALT-VAR shows any significant difference, i.e. the coefficients of the dummies are insignificant. Differences in the point estimates of the correlation coefficients between the VAR-measures of expectations and the futures and survey measures are small. This implies that the timing issue seems to have little impact on the qualitative results of the VAR measures.

## 2.2 Futures Method

The FFRT differs from most macroeconomic variables in that there are financial market prices connected to the FFRT that can be used to derive expectations of future monetary policy. A measurement method based on market prices is intuitively appealing since agents can be said to reveal their true expectations by acting on economic incentives. One of the financial instruments which can be used for this purpose is the Federal funds rate futures contract, traded on the Chicago Board of Trade. From the price of this futures contract we can implicitly derive what the participants on the futures market expect about the FFRT. Gürkaynak et. al. (2002) find that the Federal funds futures dominate other market-based measures of monetary policy expectations. The futures method allows us to estimate very short term expectations, as well as expectations for time periods up to at least six months.<sup>11</sup> There are several different derivation techniques available, mostly depending on which horizon the expectations are computed for. The differences are consequences of the

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<sup>9</sup> The value of FFRT and GSCI is available immediately after the last month. NBR, TR and M1 are reported every week, much like the employment.

<sup>10</sup> Out of the 87 observations 29 are made in the first half and 58 in the late half of the month.

<sup>11</sup> It might also be possible to use the 12- and 18-month futures contracts to derive expectations for even longer time periods.

construction of the futures contract. A contract's settlement price is based on the average effective Federal funds rate for the whole settlement month. The averaging needs to be accounted for when we want to derive expectations over time horizons shorter than a month. Another issue is that the futures contracts are based on the effective Federal funds rate and not the target rate itself. The Federal funds rate is the traded market rate that the Fed, by open market operations, keeps close to their stated target rate, the FFRT. The Federal funds rate and the FFRT are typically very close, but there are discrepancies that are sometimes quite large; see Figure 1.<sup>12</sup> For longer time horizons there may be a need to adjust futures-based expectations measures for systematic deviations between the effective rate and the target rate, as well as a possible risk premium in the futures price. These adjustments have been described by Söderström (1999) and Piazzesi and Swanson (2004).<sup>13</sup>

The derivation technique used in this paper is usually applied to derive expectations in the very short run, such as one-day-ahead expectations. This method is here extended to derive expectation for horizons up to 30 days. The technical procedure of this derivation is described in Krueger and Kuttner (1996), and in Kuttner (2001).<sup>14</sup> Kuttner (2001) calls this particular futures method a “market-based proxy” for expectations on Fed policy. This is an *ex post* measure, since we need to know the futures price after the FOMC meetings to calculate it. As such it cannot be used as a forecasting method, as opposed to the other two methods described in this paper. The advantage of this measure relative to alternative futures measures is that any time invariant risk premium in the futures price, that could distort the futures rate as an expectations measure, is differenced out.<sup>15</sup> There are *ex ante* futures measures, described by e.g. Söderström (1999) and Bernanke and Kuttner (2004), but these need to be adjusted for a possible risk premium and systematic deviations from the target rate (Piazzesi and Swanson, 2004). Such an adjustment could introduce further errors into the measure of expectations. Hence, the *ex post* futures measure is more appropriate to use in this study.

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<sup>12</sup> The correlation coefficient between the FFR and FFRT is 0.998 on monthly data from 1994:1 to 2004:12 and for the first differences of the same variable the coefficient is 0.793. On average there is no significant systematic divergence between changes of FFR and FFRT.

<sup>13</sup> Since I use measures with a rather short term horizon, these methods are not applied in my calculations.

<sup>14</sup> These references show the derivation of the one day horizon expectation.

<sup>15</sup> The risk premium is considered to change very slowly and only on a longer term, not from day to day according to Piazzesi and Swanson (2004). Using the first difference of the futures price to derive the unexpected change in FFRT will therefore not likely be influenced by changes in the risk premium and should not suffer from any risk premium bias.

The Krueger and Kuttner method of deriving the short term market expectation assumes that there is only one Fed decision about the FFRT per month.<sup>16</sup> The calculation is quite straightforward; one simply looks at how the spot-month futures rate  $f_{s,\tau}^0$  changes on the announcement day  $\tau$  of month  $s$  compared to  $x$  days before. If the futures rate is unchanged the Fed action was as expected and the unexpected change is zero. If there is a change in the futures rate we can derive the *unexpected change* in the target rate for an expectation horizon of  $x$  days,  $\Delta_x \tilde{i}_\tau^u$ , as

$$\Delta_x \tilde{i}_\tau^u = \frac{m_s}{m_s - \tau} (f_{s,\tau}^0 - f_{s,\tau-x}^0), \quad (2)$$

where  $m_s$  is the number of days in the spot-month  $s$ .<sup>17</sup> This is the measure for the  $x$ -day futures measure of unexpected changes in the FFRT. The expected change can then be derived by using  $\Delta_x \tilde{i}_\tau$ , the true change in FFRT during the  $x$ -day horizon period:

$$\Delta_x \tilde{i}_\tau^e = \Delta_x \tilde{i}_\tau - \Delta_x \tilde{i}_\tau^u. \quad (3)$$

I calculate the expected change of the FFRT for all FOMC meetings from the beginning of 1994 to 2004. To measure expectations for approximately the same time horizon as the VAR type of measures, I choose to let the day of the expectation be the last trading day of the month previous to the FOMC meeting. This means  $x$  can vary between one and 30 days. The futures contract I use for a specific expectation calculation is the contract which underlying asset refers to the month of the current announcement.

One problem with this particular method is that during the last days of the month, the adjustment for the averaging element goes to infinity, amplifying very small distortions in the futures rate (Kuttner, 2001). The futures measure of expectations on FOMC meetings during the last days of the month is therefore inexact. Kuttner (2001) considers the last three days of the month to be problematic, and therefore I exclude the observations that measure expectations on FOMC meetings taking place during the last three days of the month.

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<sup>16</sup> Since 1994 there has only been one month where the Fed performed two target rate changes and that was in January 2001. The first change came on the 3<sup>rd</sup> of January and was the result of an unscheduled meeting. The second change was decided upon at a scheduled meeting, the 31<sup>st</sup> of January.

<sup>17</sup> For a derivation of this formula, see Kuttner (2001).

## 2.3 Survey Method

An obvious method for measuring people's expectations is to simply ask them what they expect about the outcome of a variable. This method is intuitively appealing since we go straight to the source to measure the expectations. Surveys regarding macroeconomic variables are often in the form of expert surveys, directed at professional forecasters. There are also non-expert surveys directed at larger groups such as consumers or producers. Survey data might seem like an accurate and direct measure, but there are drawbacks. The people participating in a survey might not be representative for all agents of the economy, and this may introduce a bias when measuring aggregate expectations. There is also the possibility of respondents stating an expected value that does not coincide with their *true* expected value, either on purpose or unintentionally. For instance, Peterson (2001) shows that professional forecasters mimic other forecasters, possibly because they do not want to end up being more wrong than their competitors. Contrary to the futures method, there are no economic incentives for the survey respondents to state their true expectations and this might introduce measurement errors in the survey estimates of expectations.

There are several sources available for survey data regarding expectations about the FFRT. Two well known *expert surveys* are the MMS survey data and the Blue Chip Financial Forecasts survey data. The MMS survey has asked money managers about their forecasts of several macro variables every week since 1977. The Blue Chip Financial Forecasts is a monthly survey asking financial market experts about their quarterly forecasts of financial variables. The Michigan Consumer Survey performs a monthly survey about a wide array of topics, one of which is related to the future development of interest rates. The two expert surveys were difficult to obtain in sufficiently long and complete time series.<sup>18</sup> The Michigan Consumer Survey on the other hand is publicly available on the internet.<sup>19</sup> Due to these restrictions I use the Michigan Consumer Survey as the survey measure of the expected Fed interest rate policy, despite some drawbacks of that measure that are discussed below.

The survey question asked about interest rates in the Michigan Consumer Survey is:  
*“No one can say for sure, but what do you think will happen to interest rates for borrowing money during the next twelve months – will they go up, stay the same, or go down?”*

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<sup>18</sup> Another complication is that historical data for the MMS survey is not for sale anymore. Since I have not found a way to legally obtain the MMS survey from any other source I am not able to include it in this paper.

<sup>19</sup> <http://www.sca.isr.umich.edu/>

The Michigan Consumer Survey is a *qualitative* survey. To be able to compare the survey measure with the other measures of expectations the data has to be quantified. This is done using the Carlson and Parkin (1975) method. Under specific assumptions we can turn the discrete and qualitative response variable into a continuous and quantitative average expectations variable.

There are four possible responses to the survey question: “Up”, “Same”, “Down” and “Don’t know”. The survey data set contains the percentages of the respondents who choose each of these different categories. The first assumption needed to use this method is that a fraction  $\alpha$  of the respondents are incapable to form an expectation about future interest rates. This fraction is always classified as “Don’t know”, but does not necessarily exhaust that category. Another assumption is that within a certain boundary above and below zero, the expected change is so small that the respondent answers “Same”. The standard assumption in Carlson and Parkin (1975) is that these threshold values, expressed in percent and designated  $\delta$ , are symmetric and constant, i.e. the same over time for both positive and negative expected changes.

We also need to make an assumption about the distribution of expectations across the total population. Carlson and Parkin (1975) use the normal distribution in their calculations, but several other suggestions have been used and tested. The differences between the most common distributions are rather small according to Dasgupta and Lahiri (1992), Balcombe (1996) and Mitchell (2002). The normal distribution appears to provide similar estimates of expectations as for instance the logistic distribution or the  $t$ -distribution (Mitchell, 2002). For simplicity I choose to use the normal distribution.

With the assumptions above we can simply insert the data into the Carlson and Parkin (1975) formula to calculate the expected change of the interest rate:<sup>20</sup>

$$\Delta i_t^e = -\delta \frac{\Phi^{-1}\left(\frac{\hat{P}_{t-1}^+}{1-\alpha}\right) - \Phi^{-1}\left(\frac{\hat{P}_{t-1}^-}{1-\alpha}\right)}{\Phi^{-1}\left(\frac{\hat{P}_{t-1}^+}{1-\alpha}\right) + \Phi^{-1}\left(\frac{\hat{P}_{t-1}^-}{1-\alpha}\right)} + \varepsilon_t. \quad (4)$$

The expected change in the interest rate, denoted  $\Delta i_t^e$ , is a function of the inverted cumulative distribution function  $\Phi^{-1}(\cdot)$ , and an error term  $\varepsilon_t$ . Inserting a proportion,  $P$ , into the function  $\Phi^{-1}$

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<sup>20</sup> For different derivations of this formula see Carlson and Parkin (1975), or Nolte and Pohlmeier (2004).

<sup>1</sup>( $\cdot$ ) gives the corresponding standardized cumulative normal distribution value. The survey data provides us with the sample proportions for those who answer “Up”, denoted  $\hat{P}_{t-1}^+$ , and those who answer “Down”, denoted  $\hat{P}_{t-1}^-$ . The parameters are set to  $\alpha = 0.01$  and  $\delta = 1\%$ .<sup>21</sup> The value of  $\alpha$  is based on the observation that the “Don’t know”-fraction fluctuates between 0.01 and 0.05.<sup>22</sup> To check the sensitivity of data to changes in  $\alpha$  I calculated the expectations with different values of  $\alpha$ . The difference between the estimates turned out to be small, with differences within a couple of basis points, which indicate that the choice of  $\alpha$  is not critical. The choice of  $\delta$  is rather arbitrary since it will only change the scaling of the average expected change. The chosen value implies that individuals with an absolute expected interest rate change below one percentage point will answer “Same” in the survey. This value seems plausible for a twelve month expectation of the interest rate change.

This survey measure is associated with some problems that we need to address. First of all, the survey question concerns what the respondents think will happen to “interest rates for borrowing money”, i.e. the bank lending rates. This is a much broader definition of interest rates than what the futures and VAR forecast measures refer to. The survey definition refers to market interest rates, rather than the FFRT which is controlled by the central bank. However, the market rates are related to the FFRT through the expectations hypothesis of the term structure, indicating that market rate expectations can be used as a proxy for FFRT expectations. There is also a strong statistical relation between lending rates and the FFRT, with the correlation coefficient between the prime lending rate and the FFRT at 0.998 for monthly observations.

The second issue concerns the fact that the survey question refers to the expected development “during the next twelve months”, while the other measures of expectations in this paper has a horizon shorter than one month. This implies that the survey is measuring expectations over a longer horizon than the other methods. It also generates overlapping data since we have monthly observations of twelve month expectations. To obtain comparable expectations I divide the estimated change in the FFRT by eight, based on a naive but straightforward assumption about having the twelve month change executed by the Fed in equal steps at the eight different FOMC meetings during the upcoming twelve months. It can be argued that the expectations over a twelve months horizon should be front-loaded, i.e. that

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<sup>21</sup> Note that  $\alpha$  is a fraction, and  $\delta$  is expressed in the same units as the underlying variable,  $\Delta i_t^e$ .

<sup>22</sup> With  $\alpha$  constant it cannot be allowed to be larger than 0.01 since  $0 \leq \alpha \leq D_t$ , with  $D_t$  being the “Don’t Know”-fraction of the answers. This value is also supported by an OLS estimate of  $\alpha$  that I made, which is one of the estimation methods that Carlson and Parkin (1975) suggests. This estimate indicates  $\alpha = 0.01089$ .



a larger part of the expected twelve month change is expected to be implemented during the first month(s) than towards the end of the period. In practice, the appropriate factor for scaling the twelve month expectations is between eight and one. However, this scaling factor is irrelevant for the qualitative results of the investigation as it does not affect the correlations between the measures.<sup>23</sup>

### 3 Data

The FOMC has eight scheduled meetings per year, approximately every six weeks, where any changes to the FFRT are decided and announced. The sample period covers FFRT decisions made by the FOMC between February 1994 and December 2004. Pre-1994 data are excluded because there is a distinctive change in the Fed announcement policy, starting the 4<sup>th</sup> of February 1994. From this day the FOMC meetings have been followed by an official statement disclosing the decision about the FFRT. Pre-1994 there were no such official announcements and the changes in FFRT were not easy to pinpoint in time.<sup>24</sup>

The purpose of the study is to investigate how the expectations measures function during normal conditions. Therefore, I have excluded the five meetings during the sample period that were not scheduled ahead, since unscheduled meetings occur during crises or major unexpected events. I also exclude the observation of the 31<sup>st</sup> of January 2001, since this was a scheduled meeting that took place shortly after the unannounced meeting at the 3<sup>rd</sup> of January 2001 and the futures method is not valid with two meetings in the same month.<sup>25</sup> This leaves me with 87 observations for the sample period.

The Federal funds rate, the Federal funds rate futures prices and the Goldman & Sachs Commodity Index have been retrieved from Hansson & Partners AB. The real-time variables used in the CEE-VAR are collected from the website of Federal Reserve Bank of

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<sup>23</sup> The quantitative results for the slope coefficient of the bias test and the descriptive statistics will be affected since the scale factor changes the magnitude of the expected change. However, the point estimates of the correlation coefficients are not affected at all by changes in the scale factor.

<sup>24</sup> Söderström (1999) also argues that the trading volume in the federal funds rate futures was fairly low before 1994, which could imply more noisy price quotes for these futures contracts due to for instance large bid-ask spreads.

<sup>25</sup> Excluding the observations mentioned above has no significant impact on the results.

Philadelphia.<sup>26</sup> The Michigan Consumer survey data are publicly available at the website of University of Michigan.<sup>27</sup> More information on data sources is available in the appendix.

## 4 Comparing the Measures of Expectations

The different methods to measure expectations are compared to reveal differences and similarities. Since the three methods of measuring expectations are fundamentally different I expect the measurement errors from these methods to have low correlation between them. This implies that similarities between the measures indicate that the measures are picking up the same unobserved phenomenon, the true expectations. I compare the descriptive statistics for the measures of expected changes, as well as for the unexpected changes. I also plot the expectations measures against each other and compute pairwise correlations.

### 4.1 Descriptive Statistics Comparison

The time series characteristics of expected changes are displayed in Figure 2a-d and in Table 1, while those of unexpected changes are found in Figure 3 and Table 2. The results from the tests of a forecast bias for the expected changes are shown in Table 3.

Starting with the futures measure, we can see that the average unexpected change, i.e. the average forecast error, is not even two basis points from zero. The variation of the forecast errors goes between +68 basis points and -51 basis points, and the standard deviation is about 16 basis points. The bulk of the forecast errors are centred close to zero but a few observations are large, which is reflected in a kurtosis value of 8.437. Thus forecast errors are typically rather small, i.e. the futures measure of expectations is relatively successful in forecasting the true change in FFRT. The bias test regression in Table 3 confirms this observation. This test simply regresses the true change in FFRT on the expected change, as measured by each measurement method:

$$\Delta FFRT_t = \alpha + \beta \cdot E[\Delta FFRT_t] + \varepsilon_t. \quad (5)$$

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<sup>26</sup> <http://www.phil.frb.org/econ/forecast/readow.html>

<sup>27</sup> <http://www.sca.isr.umich.edu/>

A non-biased forecast gives a zero constant and a slope equal to one.<sup>28</sup> The constant term for the futures measure is not significantly different from zero, and the slope term is not significantly different from one, indicating that this is indeed an unbiased measure. This becomes even more apparent when we look at the plot in Figure 4, where it is clearly shown that a positive (negative) expected change is typically followed by a positive (negative) change in FFRT, or possibly no change at all. The observations line up nicely around the 45-degree line, which is reflected in the high  $R^2$  of 0.565 for the bias test regression.

The survey measure has an average unexpected change of -14.88 basis points, which is low compared to the futures measure at -1.15. The highest and lowest errors are +39.47 and -58.67 and the standard deviation is 16.30 basis points, which is similar to the futures measure. As we can see in Figures 2 and 5, the survey measured expectations consistently indicate more positive changes than the realized true change in FFRT, which leads to many negative forecast errors. The average expected change is +16.32 basis points, again indicating that the agents in the economy very often believe in an increase of the FFRT. The observation that survey expectations on average show positive expected changes in the FFRT is not dependent on the use of the Carlson and Parkin (1975) method, or the timing adjustment procedure. This characteristic can be observed in the raw data of the qualitative survey. Most of the time, the largest fraction of consumers are those who answer that interest rates will go up.<sup>29</sup>

The bias is also detected in the bias regression test for the survey measure, as the constant term is -19.53 basis points and significantly different from zero.<sup>30</sup> The estimated slope of this regression is a function of how the twelve month survey expectations are scaled down. With a downscaling factor of 8, the point estimate of the slope is 1.285 which is significantly different from unity at the ten percent significance level, but not at five percent.<sup>31</sup>

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<sup>28</sup> Since the true change in FFRT is a discrete variable, moving in steps of 25 basis points, this OLS-based test may be inaccurate. To control for that possibility and its impact on the inference I conduct the same regression test using a monthly average of the related market traded FFR, which is not limited to the 25 basis point steps. Both types of tests yield the same qualitative results for the futures measure.

<sup>29</sup> A conceivable explanation for this observation is that since the survey has a twelve month expectations horizon it can pick up expected changes in the FFRT beyond the next FOMC meeting. The spread between the one-year US government bond and the FFR has a mean of +16 basis points over the sample period, which is significantly positive at the one percent significance level. The median value is eleven basis points. According to the Rational expectations hypothesis of the term structure a positive spread indicates that the market expects increases in the short-term interest rates. The difference between the survey measure horizon and the time to the next FOMC meeting could therefore cause the constant bias we observe for the survey measure in Table 3.

<sup>30</sup> Since the survey expectations have an overlapping problem I use an 11-lag Newey & West covariance matrix for the survey bias test. The other tests have a Newey & West covariance matrix with 3 lags to counter possible serial correlation.

<sup>31</sup> The bias test using the FFR instead of the FFRT gives a slope point estimate that is significantly different from one at the 1% level.

The regression  $R^2$  is 0.469, which is slightly lower than what we observed for the futures measure. The feature of the survey measure that stands out in Table 3 is the constant positive bias, confirmed by both the plot and the statistical estimates.

The CEE-VAR measure has a fairly small average forecast error, only +4.79 basis points compared to -14.88 for the survey measure. However, the bias test in Table 3 and the plot in Figure 6 show that the CEE-VAR measure of expectations is a poor forecasting tool. The slope coefficient of the bias test regression is not significantly different from zero and the  $R^2$  is only 0.012. The span of the forecast errors go from -77.74 to +120.53 basis points, and the standard deviation is 40.37 basis points. This variation in the forecast errors is much higher compared to the survey and futures measures, which have standard errors of around only 16 basis points. The CEE-VAR expected change series also display large variation, with rather large expected changes and little resemblance with the realized change of the FFRT. The poor forecasting ability of the CEE-VAR has been noted in previous studies (Evans & Kuttner, 1998). By themselves, the results for the CEE-VAR method do not imply that this is a poor *expectations measure*, but when compared to the other two measures it seems unlikely that the CEE-VAR measure reflects the true expectations. The agents of the economy would have to be rather irrational to stick with expectations like those measured by the CEE-VAR method, that shows such poor forecasting properties in comparison to for instance the futures measure.

The ALT-VAR, the simple 3-lag VAR in first differences, has similar averages but a 22.50 basis points standard deviation of the forecast error, which is considerably lower than the standard deviation of the standard CEE specification. The bias test regression for this alternative specification gives somewhat different results compared to the standard CEE-VAR. The slope is now significantly different from zero, which was not the case for the CEE-VAR, but is still significantly different from one.  $R^2$  is much higher than for the CEE specification, 0.139 compared to 0.012, but still not very impressive compared to the  $R^2$  of the non-statistical measures, which are around 0.500.<sup>32</sup>

Both VAR measures are subject to the timing issue discussed in the method description. To control for the timing issue I exclude the FOMC meeting observations that take place during the first half of the month. The observations during the last half of a month would definitely have the full information set, i.e. all seven variables in VAR are publicly available.

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<sup>32</sup> Certainly we can find a particular VAR specification that is better at forecasting the FFRT during the time period of interest, but for an expectations measure we want a more robust and time invariant method that is not dependent on a very unique specification.

For the benchmark CEE-VAR there is no important difference between using all FOMC meetings and using only the FOMC meetings taking place during the last half of the month. The ALT-VAR specification seems to lose some of the forecasting ability when the sample is restricted. This indicates that the treatment of the timing issue could incorrectly improve the VAR measures; the forecasting ability of a VAR is even worse than what we see in Table 1 to 3.

## 4.2 Autocorrelations

Another characteristic of expectations that is often studied is the autocorrelation structure of the unexpected changes. The autocorrelation of the estimated *unexpected changes* is interesting from a rationality point of view. Rational expectations implies no serial correlation since all available information, including previous expectation errors, should be included in the information set of the agents forming expectations.<sup>33</sup>

The unexpected changes from the futures method show significant autocorrelation coefficients for the first three lags, as shown in Table 2. The autocorrelation is negative for lag one and three, while lag number two is positive. A Q-test for the nine first lags rejects the null hypothesis of no serial correlation at the five percent significance level.

Since the survey measure has overlapping expectations horizons the estimated unexpected changes will have positive serial correlation if the expectations for the next twelve months do not change between surveys. However, this strong positive serial correlation cannot be seen in the sample autocorrelation coefficients. In fact, the survey measure has an autocorrelation pattern similar to the futures measure, with lag one and three being *negative* and only lag two being positive. However, the significance level for the negative coefficients is only at ten percent. Another difference compared to the futures measure is that the fourth lag for the survey measure is positive and significant at the one percent level, while the futures measure showed no indication of autocorrelation for this lag. The joint test of autocorrelation for the nine first lags is significant for the survey measure of unexpected changes.

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<sup>33</sup> Rational expectations *can* result in positive autocorrelation if we have a small sample where there are extended periods of rationally expected changes that are not realized. This is often referred to as the Peso problem when applied to exchange rates.

The CEE-VAR specification does not show any obvious signs of autocorrelation.<sup>34</sup> The Q-test can not reject the null hypothesis of no serial correlation. The ALT-VAR specification shows significant signs of serial correlation, with the Q-test rejecting the null hypothesis at the 1% level. Lag one and two are individually significant at the five percent and ten percent level respectively. Both specifications show an individual significant autocorrelation for lag four at the five percent level. The patterns of sample autocorrelation coefficients for the two VAR specifications do not resemble the patterns we observe for the futures and survey measure.

### 4.3 Correlations between Measures

The most interesting analytical tools when comparing measures of expectations are the calculation of correlations coefficients and the pairwise plots. By plotting the different measures of expected change in FFRT against each other we can observe to what extent the measures appear to capture the same phenomenon. If two measures measure the same thing, ignoring measurement errors, we would expect the observations to line up around the 45-degree line in the scatter plots. We would also expect a high correlation coefficient when there is a linear relation between the two measures.

In the plots of the benchmark CEE-VAR measure against the other two measures, Figure 8 and 9, there seems to be no obvious relation between the standard CEE-VAR measure and the other measures. This implies that the CEE-VAR measure gives a different estimate of the true expectations than the futures and survey measures do. The sample correlation coefficients between all measures are presented in Table 4. The sample correlation coefficient between CEE-VAR and the futures measure is only 0.149. The correlation between the CEE-VAR and the survey measure is not much higher: 0.152.<sup>35</sup> In contrast to the CEE-VAR, the ALT-VAR measure seems to have some positive correlation with the futures and survey measure. The correlation coefficients with the futures and the survey measure are considerably higher than for the CEE-VAR, 0.348 and 0.379 respectively. This relation can also be observed in the plots of Figure 10 and 11.

As a more formal test of correlation I calculate the Spearman rank correlation coefficients, shown in Table 5. This non-parametric measure shows a significant positive

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<sup>34</sup> Note that this is not by construction since the VAR estimates of unexpected changes are out of sample forecasts.

<sup>35</sup> When I include the unannounced meetings in the data set, these correlation coefficients are even lower.

correlation between the futures measure and the ALT-VAR measure at the one percent significance level.<sup>36</sup> The ALT-VAR measure and the survey measure show a significant positive correlation at the one percent level.<sup>37</sup> The standard CEE-VAR shows *no significant* correlation with any of the other two measurement methods. Evans and Kuttner (1998) find a similar pattern when they investigated the correlation between forecast errors from the CEE-VAR and unexpected changes in FFRT measured with a futures method similar to the one used in this paper. They conclude that forecast errors from a VAR with fewer lags is more closely related to the forecast errors of a futures method than the standard twelve lag CEE-VAR. I show similar results, but for correlations between expected changes instead of unexpected changes.

The comparison of the futures measure versus the survey measure, plotted in Figure 12, reveals some interesting results. The plot displays what appears to be a linear relation between these two measures, but with a negative intercept. The slope of this linear relation is not one, but it is very much affected by the ad hoc time horizon adjustment of the survey measure. For instance, if the “next month expectation” is set to be one fourth, instead of one eighth, of the full year survey expectation, we get a relation which is close to one for one, as we can see in Figure 13.<sup>38</sup>

The correlation coefficient between the futures and the survey measure is 0.811 and indicates a strong linear relationship.<sup>39</sup> The Spearman rank correlation coefficient test indicates that there is a positive and significant correlation between these two measures at the one percent significance level. This high correlation is robust to including the five unannounced meetings during the sample period.<sup>40</sup> Hence, these two measures appear to capture the same underlying phenomenon. The most likely explanation is that they both measure the *true* expectations. A high correlation coefficient *could* be caused by a high correlation between the measurement errors from these two measures, without any of the measures picking up the true expectations. However, since the measures are fundamentally

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<sup>36</sup> The advantage of using a Spearman rank correlation coefficient test is that no assumption about joint normality is needed. The test is a one-sided test for a positive correlation coefficient.

<sup>37</sup> The inference for ALT-VAR correlations are changed when I control for the timing issue by excluding the FOMC meetings taking place in the first half of the month. The correlation coefficient with the survey measure is not significant, and correlation between ALT-VAR and the futures measure is only significant at the ten percent level.

<sup>38</sup> This type of adjustment could be justified by a “myopic agents”-argument where imminent events get a higher weight than more distant events.

<sup>39</sup> Note that the correlation coefficient is not affected by how we scale the survey expectations.

<sup>40</sup> It is also robust to excluding FOMC meetings in the first half of the month, with the correlation coefficient still above 0.75.

different in their construction I claim that such high correlation between their measurement errors is not likely.

These two measures of expectations are statistically related, but with a constant shift where the survey expectations are tilted towards positive changes in the FFRT. This bias towards positive changes in the survey measure of expectations was revealed already in the descriptive statistics and the bias test regression.<sup>41</sup>

The focus of the preceding analysis is on the correlation between the different measures of estimated *expected change*. However, a comparison of different measures can also be done by analyzing the correlation between the estimates of *unexpected changes*, even though this approach has a drawback. As, Evans and Kuttner (1998) pointed out, the correlation between unexpected changes is a misleading indicator since it includes different covariances between the true change in FFRT and the two different expectations measures.<sup>42</sup> To compare the two approaches of correlation measurement, and to make the analysis complete, Table 6 reports the correlation coefficients between the *unexpected changes* suggested by each measure. The correlation coefficient between the futures method and the survey method is 0.626, which is *lower* than the correlation coefficient between the survey measure and the ALT-VAR measure, 0.655. Otherwise, the pattern of correlations between unexpected changes is similar to the correlation pattern of expected changes, but the differences between the coefficients are less pronounced.

## 5 Conclusions

How can we evaluate the validity of the available measures of expectations when the variable to be measured, the true expectations, is not observable? This paper proposes a solution to the problem by comparing fundamentally different methods of measuring expectations. A comparison of measures will detect similarities and differences, and this helps us to evaluate whether the methods do measure the *true expectations*. This procedure is applied to the

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<sup>41</sup> I also find that the spread between the one-year US government bond and the FFR is correlated with both the survey and the futures measure, with correlation coefficients 0.746 and 0.767. These high correlations are not surprising since the spread is linked to interest rate expectations through the Rational expectations hypothesis of the term structure. When I orthogonalize both the survey and the futures measure to the spread, the correlation between these two measures is still significant with a correlation coefficient of 0.529.

<sup>42</sup> For instance, Evans and Kuttner (1998) showed that the forecast errors from a naive “no change” forecast had a high correlation with the forecast errors of a futures model forecast. These two forecast models give extremely different forecasts, and yet the correlation coefficient between the forecast errors is high, showing the weakness of using this kind of correlation to determine similarities between different expectations measures.



expectations on the target interest rate of the Fed, the FFRT, which is an appropriate variable since there are several methods available to measure expectations: VAR forecast measures, survey measures and futures market based measures.

The results show that the VAR forecast method can result in quite different expectations depending on what specification one use. In particular it turns out that a VAR in first differences and with few lags has both smaller variations in the forecast errors, and higher correlations with the other two methods in this study, compared to the benchmark twelve lag VAR in levels proposed by Christiano, Eichenbaum and Evans (1996). The VAR forecast measures all show inferior forecasting abilities compared to the survey and the futures measures. This could indicate that agents use more information than just the variables included in the VAR. The survey method indicates expectations with a significant constant bias. The survey respondents often claim to expect positive changes to the Fed target rate and on average they overestimate the FOMC decision on the change of the target rate. The measured expectations from the futures method have no significant bias and relatively small forecast errors. Despite this difference in forecasting ability, the survey method and futures method produce expectations that are highly correlated. The correlation coefficient for these two measures of the expected change in the target rate is 0.81. Another similarity between the futures measure and the survey measure is observed in the patterns of sample autocorrelations for estimated unexpected changes. Both measures have significantly negative autocorrelation for the first and third lag and positive for the second lag, which means both measures show the same pattern of irrationality in the expectations.

The implied market expectations derived from the Federal funds futures and the transformed responses from the Michigan consumer survey are fundamentally different methods to measure expectations. This makes it highly unlikely that the underlying relation between them is due to correlated measurement errors. I have not found any other likely explanation for this high correlation than the presumption that they both capture the *true expectations*.

The survey measure reflects the expectations of consumers, while the futures measure corresponds to market expectations. The true expectations of the consumers and of the futures market participants are not necessarily the same. Despite the possible difference between these two expectations measures the correlation is high. This indicates a remarkable coherence between the expectations of consumers and futures market participants.

These results can be further explored if we can obtain other survey data and refine the comparison method. By studying the measures of expectations for other variables we will be

able to learn and understand more about the nature of the true expectations, and thereby improve our ability to construct useful theoretical economic models.

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## **Data Appendix**

### **Federal Funds Rate and Target Rate**

The monthly data for the FFR and FFRT were supplied by the Fed through Hanson & Partners AB.<sup>43</sup> The FFR data are a monthly average over the daily rates, while the FFRT data consists of the prevailing target rate of the Fed at the last day of each month. In addition to the monthly data the Federal Reserve webpage provides the dates of the FOMC meetings as well as the exact changes in the target rate at each meeting.<sup>44</sup> Additional information about the exact timing of the FOMC meetings is available in Kuttner (2000).

### **Futures**

The Fed funds futures rate data were supplied by the Hanson & Partners AB. The futures contracts are traded at the Chicago Board of Trade (CBOT).<sup>45</sup> The underlying asset for these futures contracts is a 30 day average of the effective FFR for a particular month. I use the close daily rate for the spot futures rate of the month of the FOMC meeting of interest, i.e. the futures contracts with the settlement date at the end of that month. I also use the last close daily rate observation of a one-month futures contract before it turns into the spot contract.

### **Survey**

The Michigan Consumer survey data is supplied by the University of Michigan at their public website.<sup>46</sup> The survey observations are made at a monthly interval and present the proportions of the answers that reply “Up”, “Down”, “Same” and “Do not know”. Note that the survey question of interest in this paper is only one of many survey questions that the respondents are asked.

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<sup>43</sup> See <http://www.ecowin.com/> for the information webpage about the Ecwin database of Hanson & Partners AB. Note that Hanson & Partners AB was acquired by Reuters Ltd. in November 2005.

<sup>44</sup> See for instance <http://www.federalreserve.gov/FOMC/#calendars>.

<sup>45</sup> <http://www.cbot.com/>

<sup>46</sup> <http://www.sca.isr.umich.edu/>

## **VAR Variables**

All VAR variables are on a monthly frequency. The real-time announcements of seasonality adjusted payroll employment (N), Consumer Price Index (CPI), non-borrowed reserves (NBR), total reserves (TR), and the monetary aggregate M1, were supplied by the Federal Reserve Bank of Philadelphia.<sup>47</sup> The twelve month moving average of monthly growth rates of Goldman & Sachs Commodity Index (GSCI) was supplied by the Hanson & Partners AB. The monthly GSCI are monthly averages over the close daily return index.

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<sup>47</sup> <http://www.phil.frb.org/econ/forecast/readow.html>

## Tables and Figures

**Table 1**

**Descriptive Statistics: Expected Changes**

	<b>Futures- Expectation</b>	<b>Survey- Expectation</b>	<b>CEE-VAR Expectation</b>	<b>ALT-VAR Expectation</b>	<b>Actual Change</b>
<b>Mean</b>	2.7727	16.3220	-3.3483	-2.7386	1.4368
<b>Median</b>	0.7045	14.9875	-5.6300	0.4100	0.0000
<b>Maximum</b>	50.7273	46.2313	67.0800	29.0300	75.0000
<b>Minimum</b>	-68.2000	-9.0300	-157.2800	-100.3500	-50.0000
<b>Std. Dev.</b>	21.5170	11.8186	37.3578	18.1510	22.0189
<b>Skewness</b>	-0.3447	0.2048	-0.9878	-2.6997	0.1965
<b>Kurtosis</b>	4.3070	2.7917	6.1225	14.0320	4.7509
<b>Observations</b>	77	87	87	87	87

The expected changes are expressed in basis points. The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings.

**Table 2**  
**Descriptive Statistics: Unexpected Changes**

	<b>Futures</b>	<b>Survey</b>	<b>CEE-VAR</b>	<b>ALT-VAR</b>
<b>Mean</b>	-1.1493	-14.8853	4.7851	4.1754
<b>Median</b>	-0.5833	-14.9875	5.6300	2.3100
<b>Maximum</b>	68.2000	39.4713	120.5300	81.2700
<b>Minimum</b>	-50.7273	-58.6688	-77.7400	-52.1300
<b>Std. Dev.</b>	15.5070	16.2995	40.3693	22.4984
<b>Skewness</b>	0.6243	0.2153	0.4682	0.6030
<b>Kurtosis</b>	8.4371	3.9353	3.5078	4.6764
<b>RMSE</b>	15.449	22.004	40.421	22.369
<b>MAE (MAD)</b>	9.723	18.339	30.509	16.374
<b>Autocorrelation</b>				
<b>Lag 1</b>	-0.269**	-0.181*	0.081	0.263**
<b>Lag 2</b>	0.225**	0.275**	0.084	0.350***
<b>Lag 3</b>	-0.246**	-0.206*	0.194*	0.069
<b>Lag 4</b>	0.051	0.290***	0.249**	0.228**
<b>Q(9)</b>	18.015**	23.052***	11.698	26.724***
<b>Observations</b>	77	87	87	87

The unexpected changes are expressed in basis points. The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings. RMSE is the root mean squared errors and MAE is the mean absolute error. \*/\*\*/\*\* = indicates if a test is significantly different from zero at 10% / 5% / 1% significance level. The autocorrelation tests are individual tests for the first four lags and a joint Q-test for the  $\sqrt{n}$  first lags.



**Table 3**  
**Bias Test Regressions**

Regressors	Futures	Survey	CEE-VAR	ALT-VAR
<b>Intercept</b> <b>(H<sub>0</sub>: α=0)</b>	-0.59 (-0.3509)	-19.53 (-5.615) <sup>***</sup>	1.74 (0.543)	2.72 (0.908)
<b>Slope</b> <b>(H<sub>0</sub>: β=0)</b> <b>(H<sub>0</sub>: β=1)</b>	0.7969 (5.4979) <sup>***</sup> (-1.4007)	1.2845 (7.991) <sup>***</sup> (1.770) <sup>*</sup>	0.0898 (1.181) (-11.969) <sup>***</sup>	0.4676 (5.117) <sup>***</sup> (-5.826) <sup>***</sup>
<b>R<sup>2</sup> adjusted</b>	0.565	0.469	0.012	0.139

The regression is:  $\Delta FFRT_t = \alpha + \beta \cdot E[\Delta FFRT_t] + \varepsilon_t$

$E[\Delta FFRT_t]$  is the estimated expected change of the FFRT (federal funds rate target) in basis points. The values in parentheses are  $t$ -values. The standard errors are Newey & West adjusted. <sup>\*</sup>/<sup>\*\*</sup>/<sup>\*\*\*</sup> = indicates if a double-sided  $t$ -test is significantly different from the H<sub>0</sub>-hypothesis at 10% / 5% / 1% significance level. The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings.

**Table 4**  
**Correlation Coefficients – Expected Changes**

	<b>Futures Expectations</b>	<b>Survey Expectations</b>	<b>CEE-VAR Expectations</b>	<b>ALT-VAR Expectations</b>
<b>Futures Expectations</b>	1	0.811	0.149	0.348
<b>Survey Expectations</b>		1	0.152	0.379
<b>CEE-VAR Expectations</b>			1	0.371
<b>ALT-VAR Expectations</b>				1

The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings.

**Table 5**  
**Spearman Rank Correlation Coefficient Test – Expected Changes**

	<b>Futures Expectations</b>	<b>Survey Expectations</b>	<b>CEE-VAR Expectations</b>	<b>ALT-VAR Expectations</b>
<b>Futures Expectations</b>	1	0.818 <sup>***</sup>	0.074	0.287 <sup>***</sup>
<b>Survey Expectations</b>		1	0.114	0.292 <sup>***</sup>
<b>CEE-VAR Expectations</b>			1	0.522 <sup>***</sup>
<b>ALT-VAR Expectations</b>				1

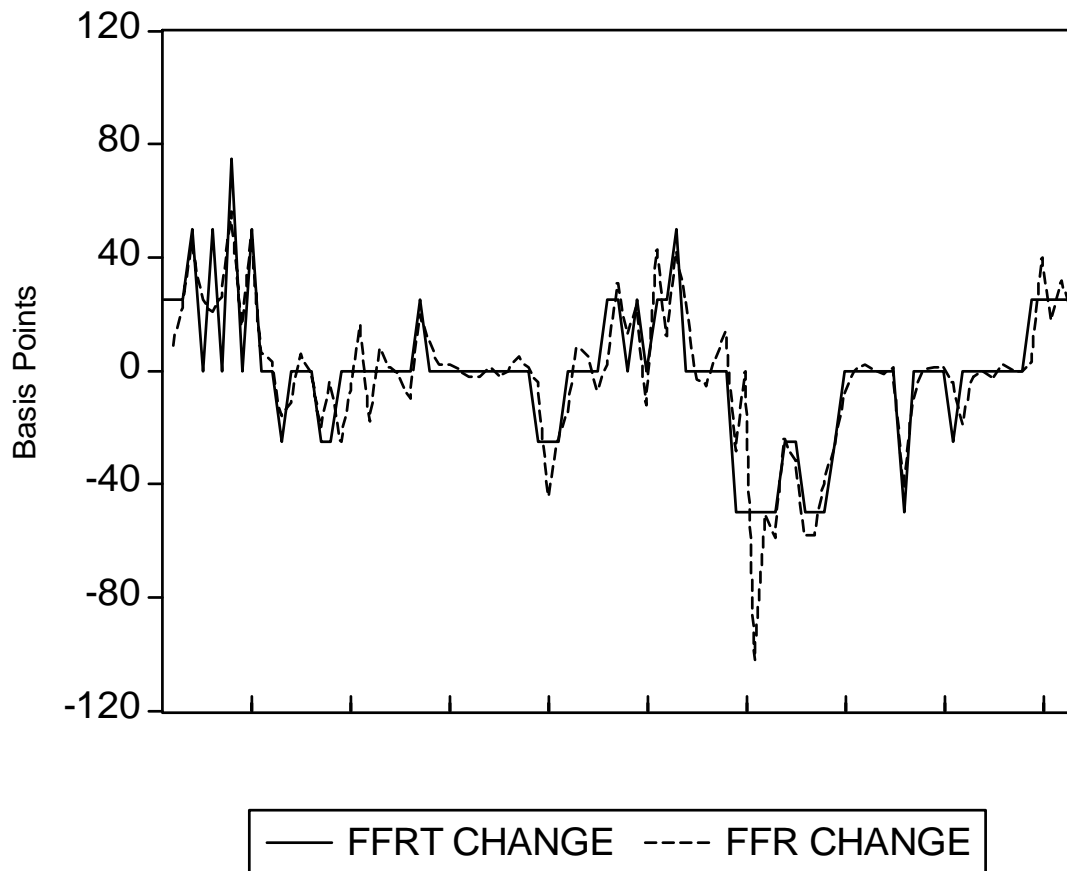
The Spearman rank correlation coefficient test use a *t*-test procedure with a zero correlation null hypothesis. <sup>\*/\*\*/\*\*</sup> = indicates if the point estimate is significantly different from zero at 10% / 5% / 1% significance level (single-sided test for positive correlation). The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings.

**Table 6**  
**Correlation Coefficients – Unexpected Changes**

	<b>Futures Expectations</b>	<b>Survey Expectations</b>	<b>CEE-VAR Expectations</b>	<b>ALT-VAR Expectations</b>
<b>Futures Expectations</b>	1	0.626	0.186	0.334
<b>Survey Expectations</b>		1	0.375	0.634
<b>CEE-VAR Expectations</b>			1	0.503
<b>ALT-VAR Expectations</b>				1

The sample is from January 1994 to December 2004 and the observations are pre-scheduled FOMC-meetings.

**Figure 1**  
**Federal Reserve Rate vs. Target**

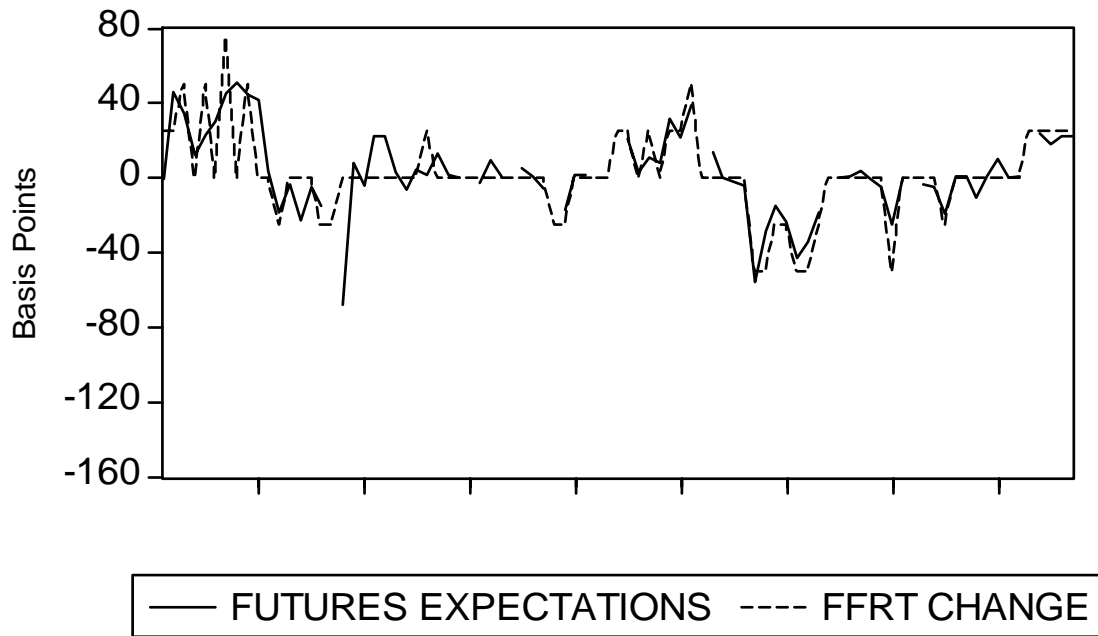


The sample contains all FOMC meetings from January 1994 to December 2004. FFR is the Federal funds rate and the FFRT is the Federal funds rate target. The numbers are in basis points.

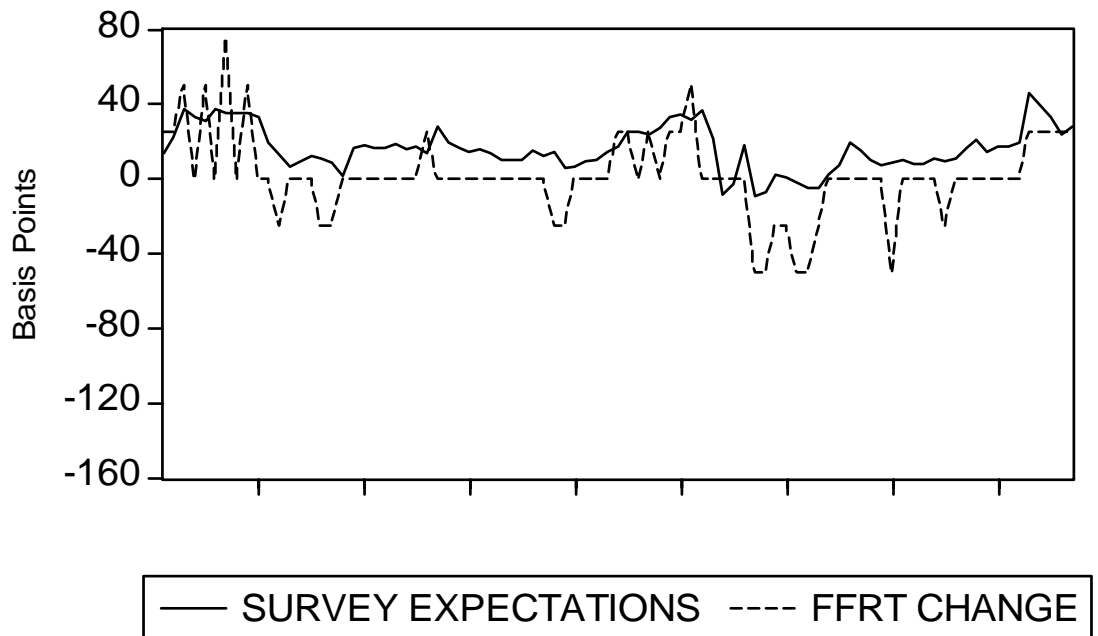
**Figure 2**

**Expected Changes**

**a) Estimates of Futures Method 1994-2004**

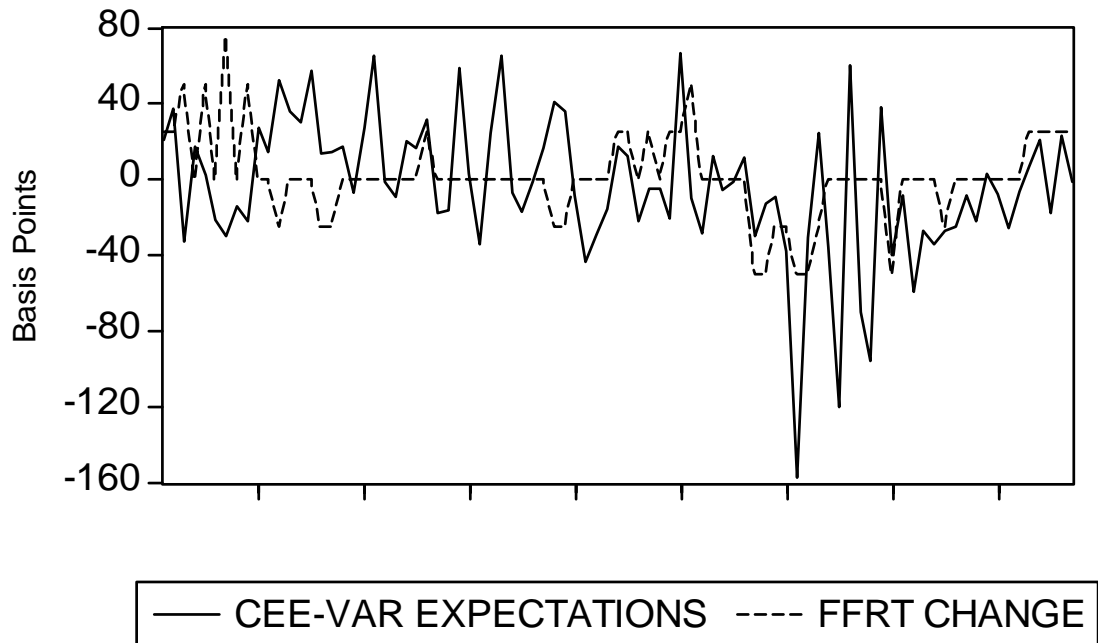


**b) Estimates of Survey Method 1994-2004**

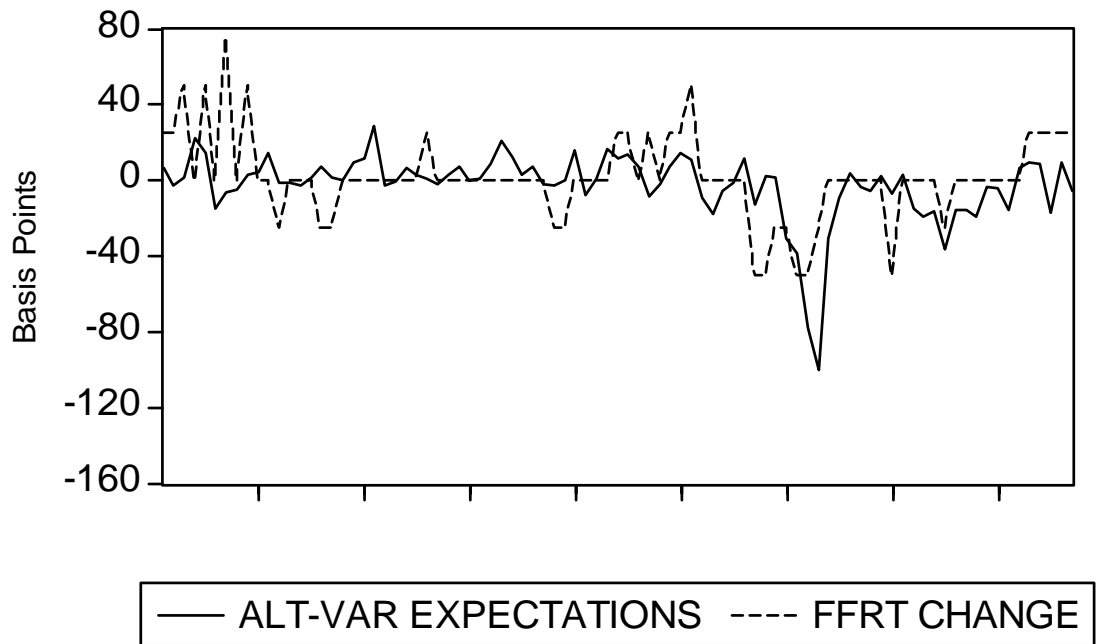


The sample contains scheduled FOMC meetings from January 1994 to December 2004. FFRT CHANGE is the realized change of the Federal funds rate target. Each graph shows the expected changes in the FFRT for the scheduled FOMC meetings as estimated by a particular expectations measure. The numbers are in basis points. Gaps in the graphs are due to excluded observations.

**c) Estimates of CEE-VAR Forecast Method 1994-2004**



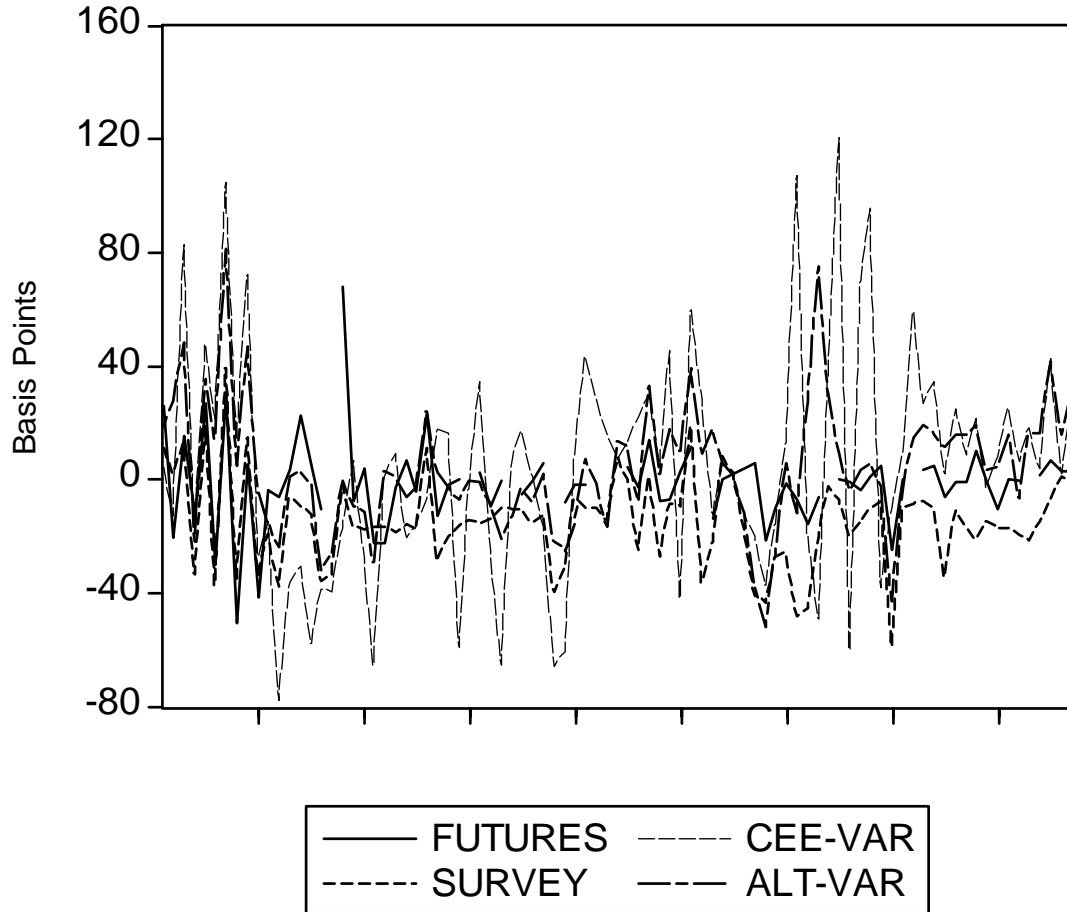
**d) Estimates of ALT-VAR Forecast Method 1994-2004**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. FFRT CHANGE is the realized change of the Federal funds rate target. Each graph shows the expected changes in the FFRT for the scheduled FOMC meetings as estimated by a particular expectations measure. The numbers are in basis points. Gaps in the graphs are due to excluded observations.

**Figure 3**

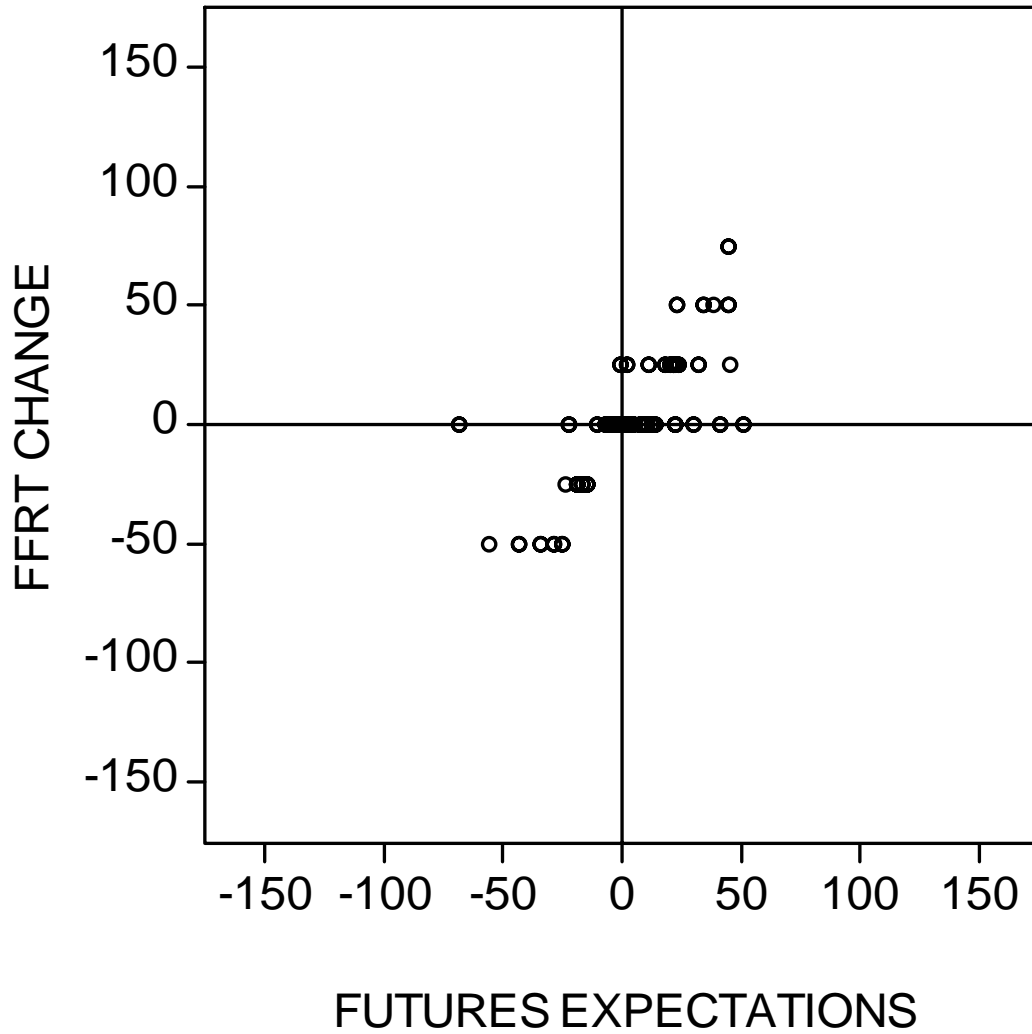
**Unexpected Changes 1994-2004**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. The graph shows the unexpected change in the FFRT for the FOMC meetings as estimated by the four different expectations measures. The numbers are in basis points. Gaps in the graph are due to excluded observations.

**Figure 4**

**FFRT Change vs. Futures Measure Expected Change**

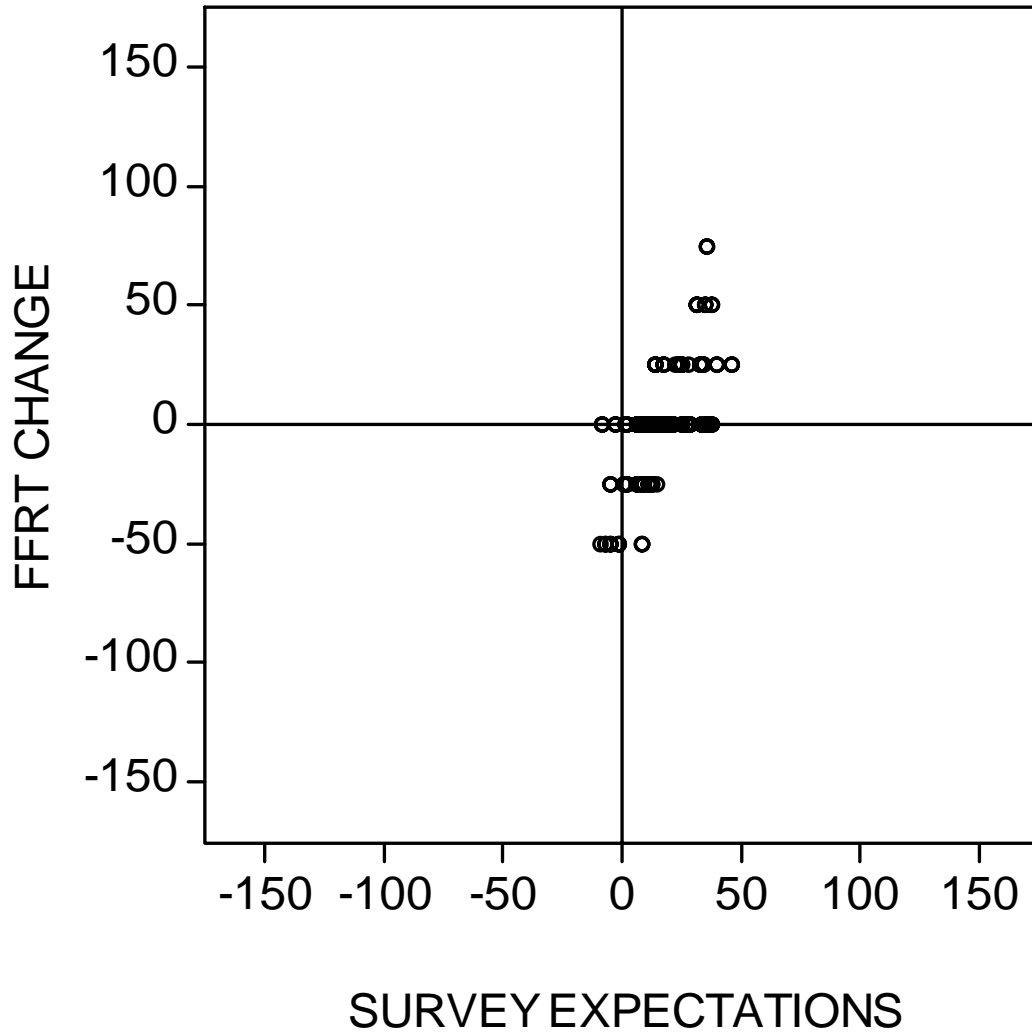


The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FFRT CHANGE is the realized change of the Federal funds rate target. FUTURES EXPECTATIONS are the expected changes in the FFRT as estimated by the futures method. The numbers are in basis points.



**Figure 5**

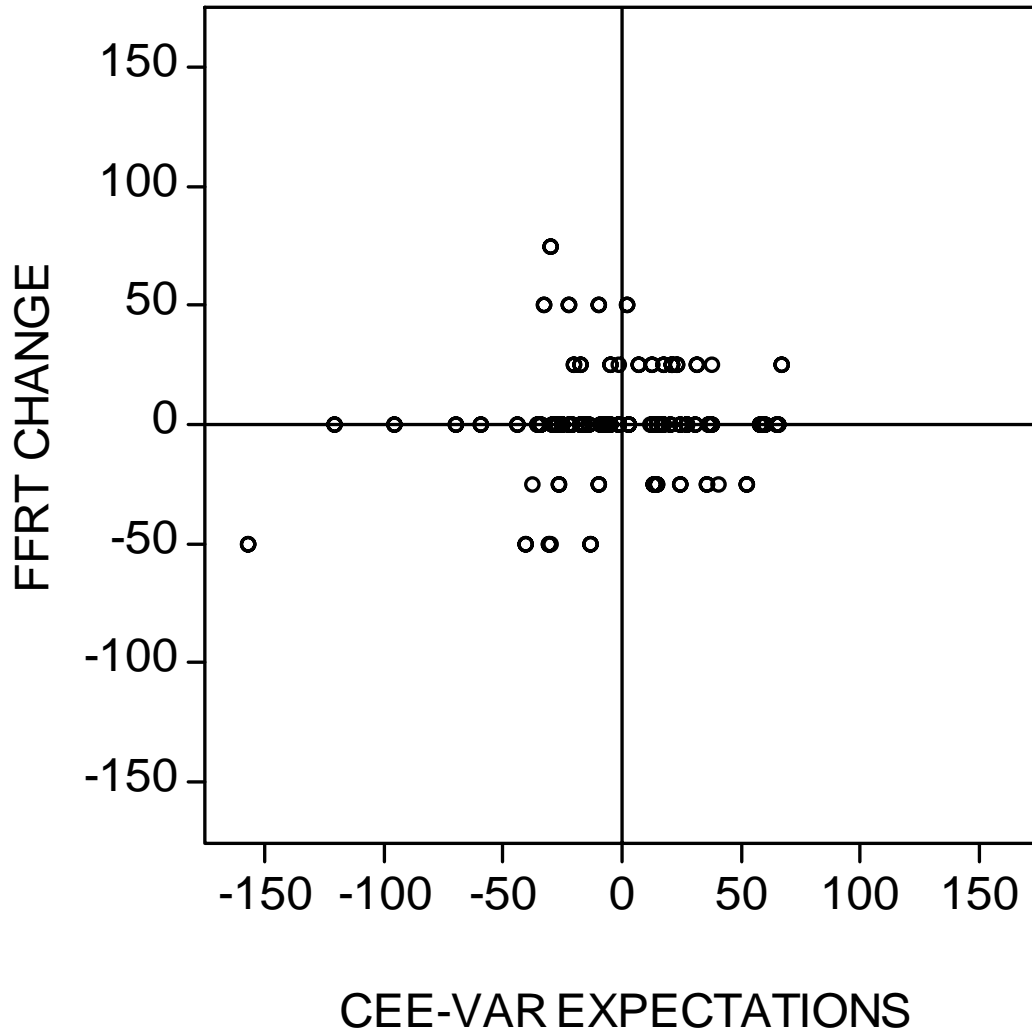
**FFRT Change vs. Survey Measure Expected Change**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FFRT CHANGE is the realized change of the Federal funds rate target. SURVEY EXPECTATIONS are the expected changes in the FFRT as estimated by the survey method. The numbers are in basis points.

**Figure 6**

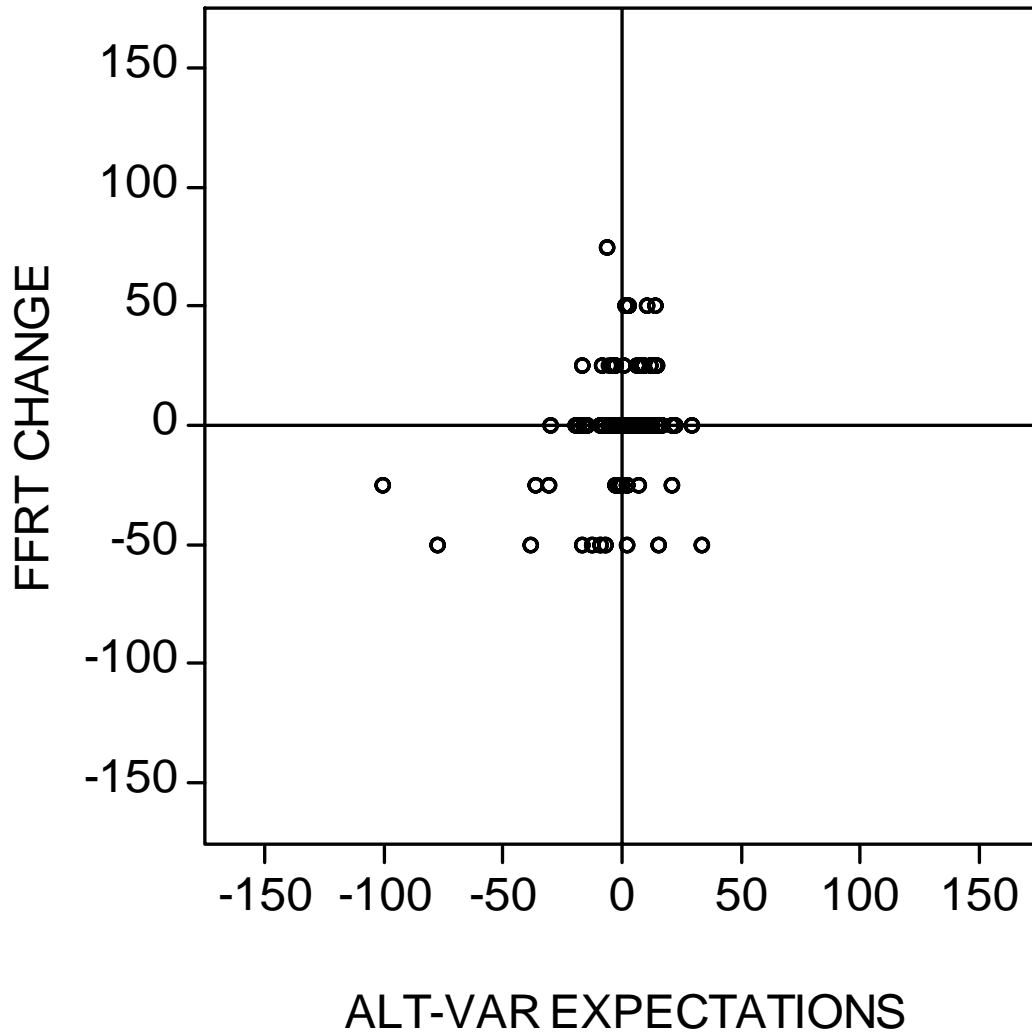
**FFRT Change vs. CEE-VAR Measure Expected Change**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FFRT CHANGE is the realized change of the Federal funds rate target. CEE-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with the Christiano, Eichenbaum and Evans (1996) VAR specification. The numbers are in basis points.

Figure 7

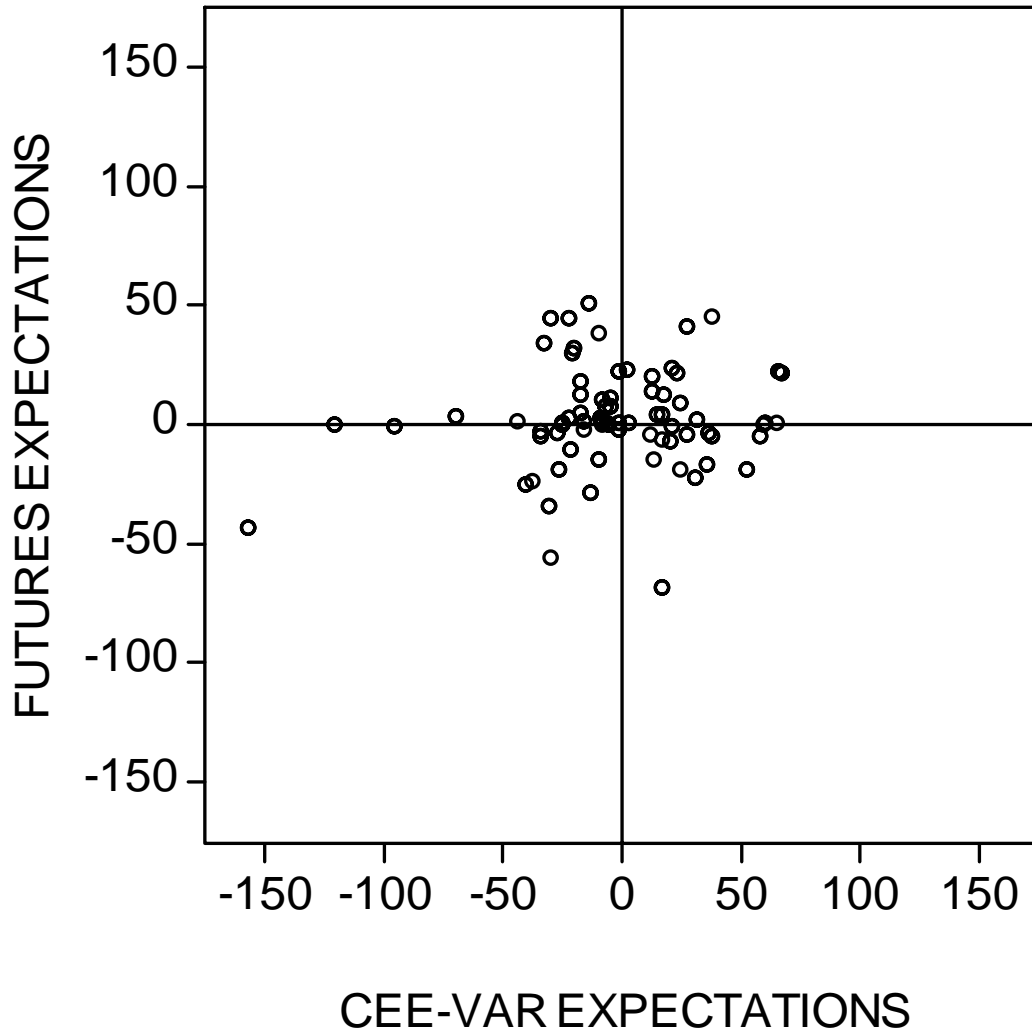
FFRT Change vs. ALT-VAR Measure Expected Change



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FFRT CHANGE is the realized change of the Federal funds rate target. ALT-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with a three-lag, seven-variable VAR specification in first differences. The numbers are in basis points.

**Figure 8**

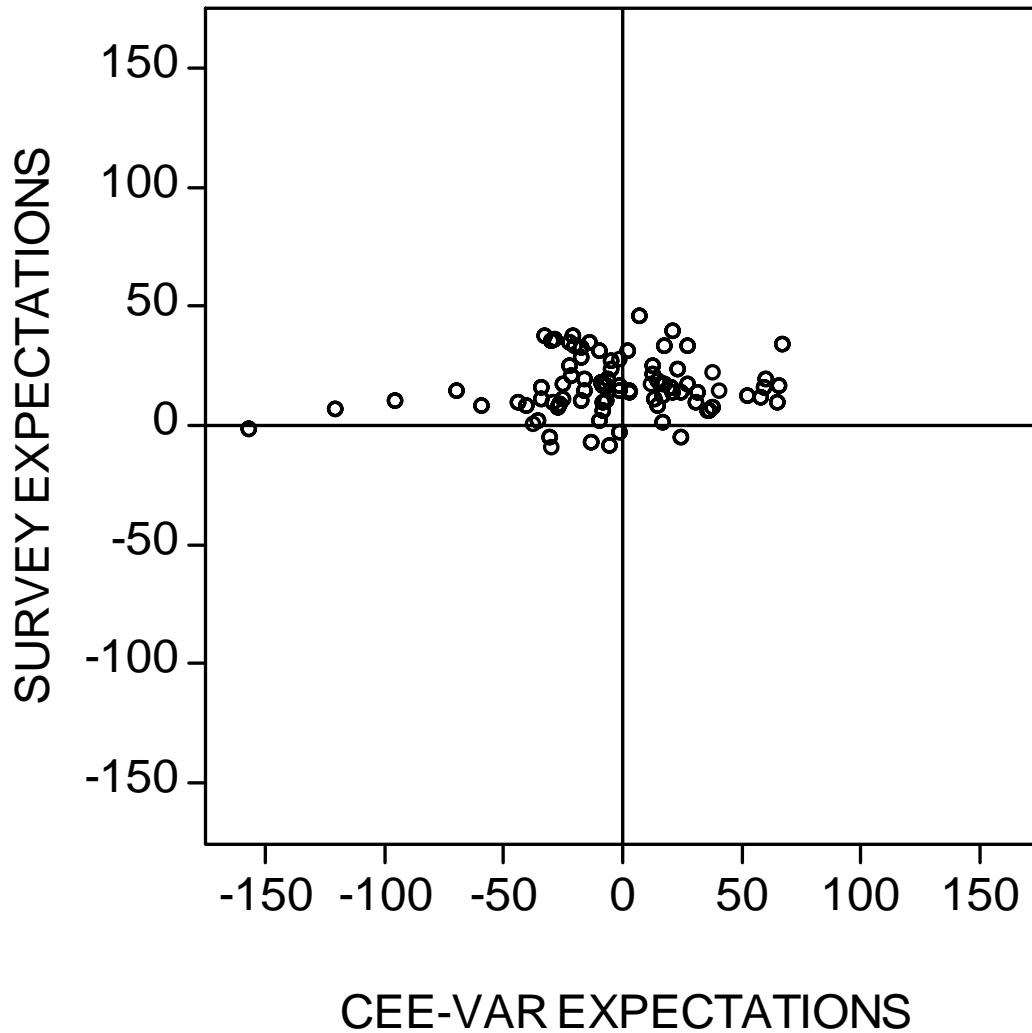
**Futures Expectations vs. CEE-VAR Expectations**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FUTURES EXPECTATIONS are the expected changes in the FFRT as estimated by the futures method. CEE-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with the Christiano, Eichenbaum and Evans (1996) VAR specification. The numbers are in basis points.

**Figure 9**

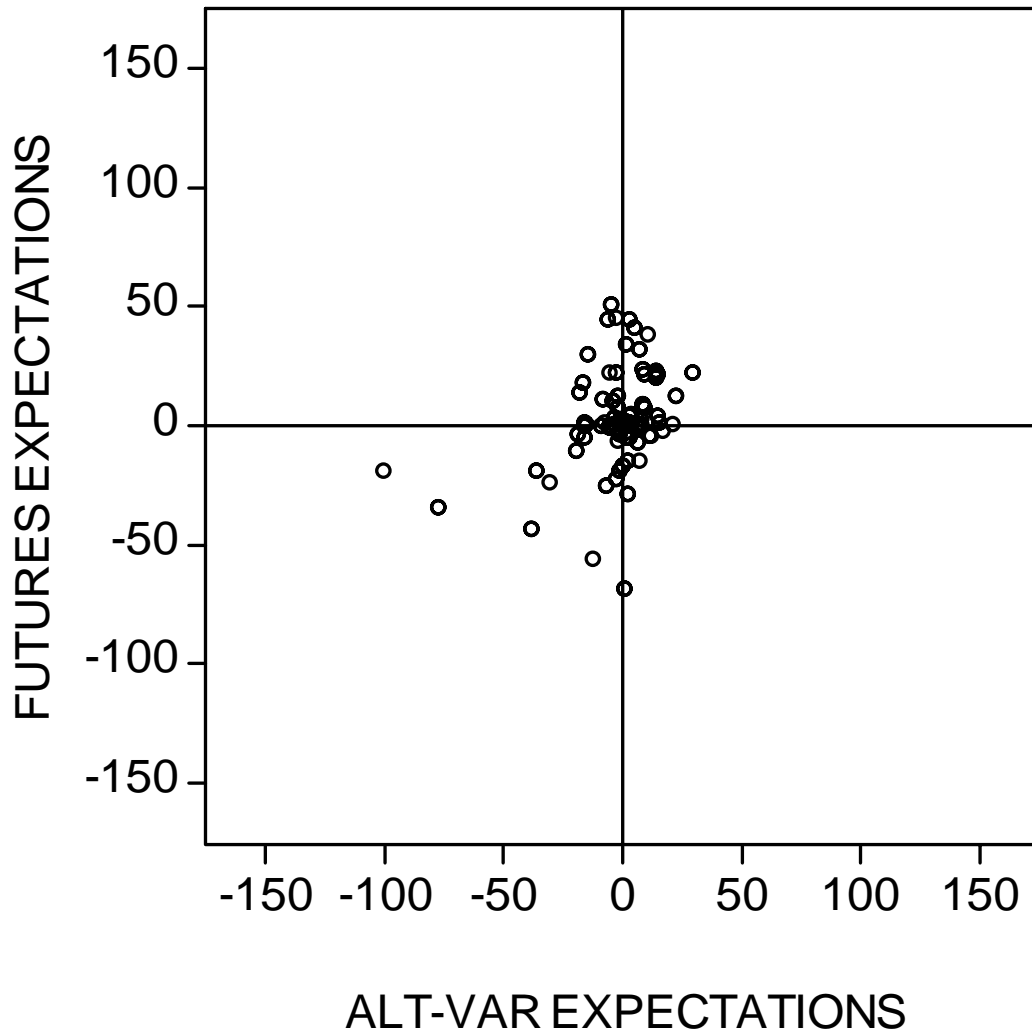
**Survey Expectations vs. CEE-VAR Expectations**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. SURVEY EXPECTATIONS are the expected changes in the FFRT as estimated by the survey method. CEE-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with the Christiano, Eichenbaum and Evans (1996) VAR specification. The numbers are in basis points.

**Figure 10**

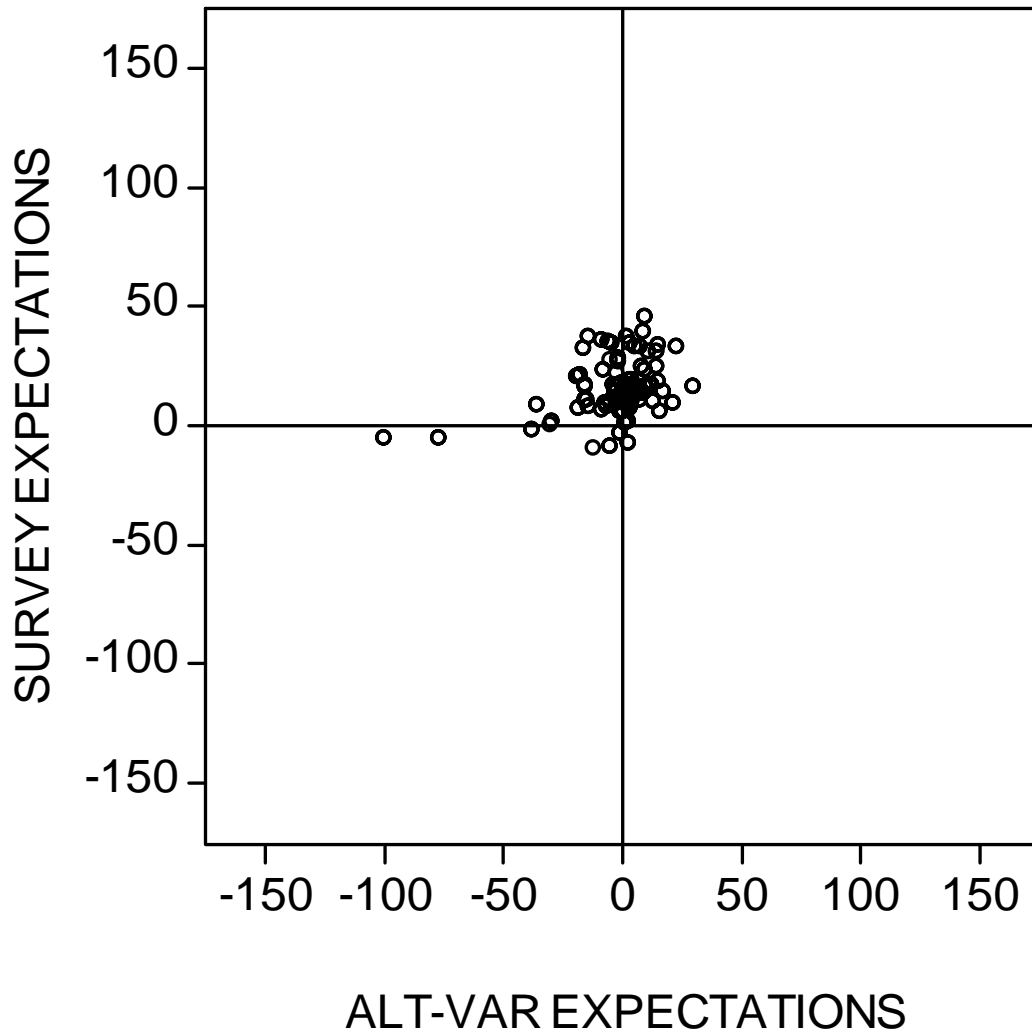
**Futures Expectations vs. ALT-VAR Expectations**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FUTURE EXPECTATIONS are the expected changes in the FFRT as estimated by the futures method. ALT-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with a three-lag, seven-variable VAR specification in first differences. The numbers are in basis points.

**Figure 11**

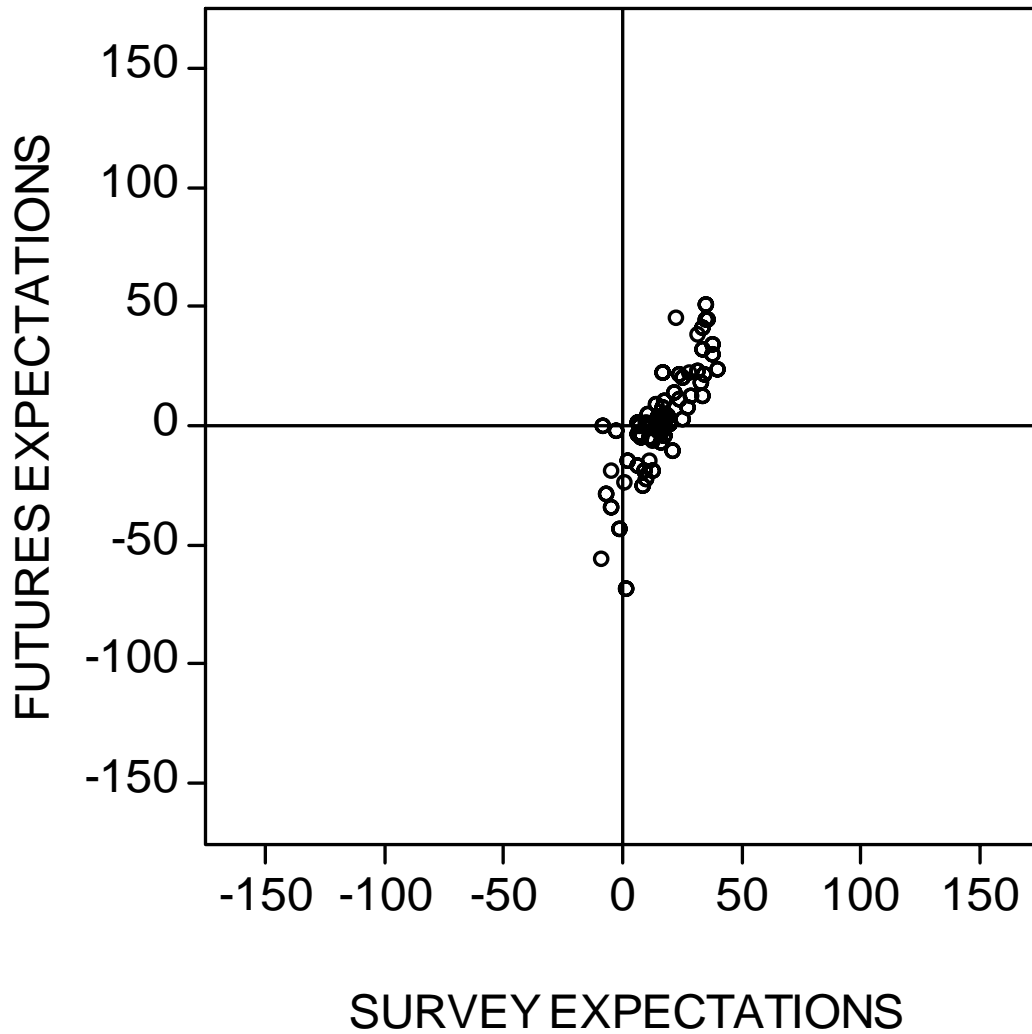
**Survey Expectations vs. ALT-VAR Expectations**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. SURVEY EXPECTATIONS are the expected changes in the FFRT as estimated by the survey method. ALT-VAR EXPECTATIONS are the expected changes in the FFRT as estimated by the VAR forecast method, with a three-lag, seven-variable VAR specification in first differences. The numbers are in basis points.

**Figure 12**

**Futures Expectations vs. Survey Expectations**

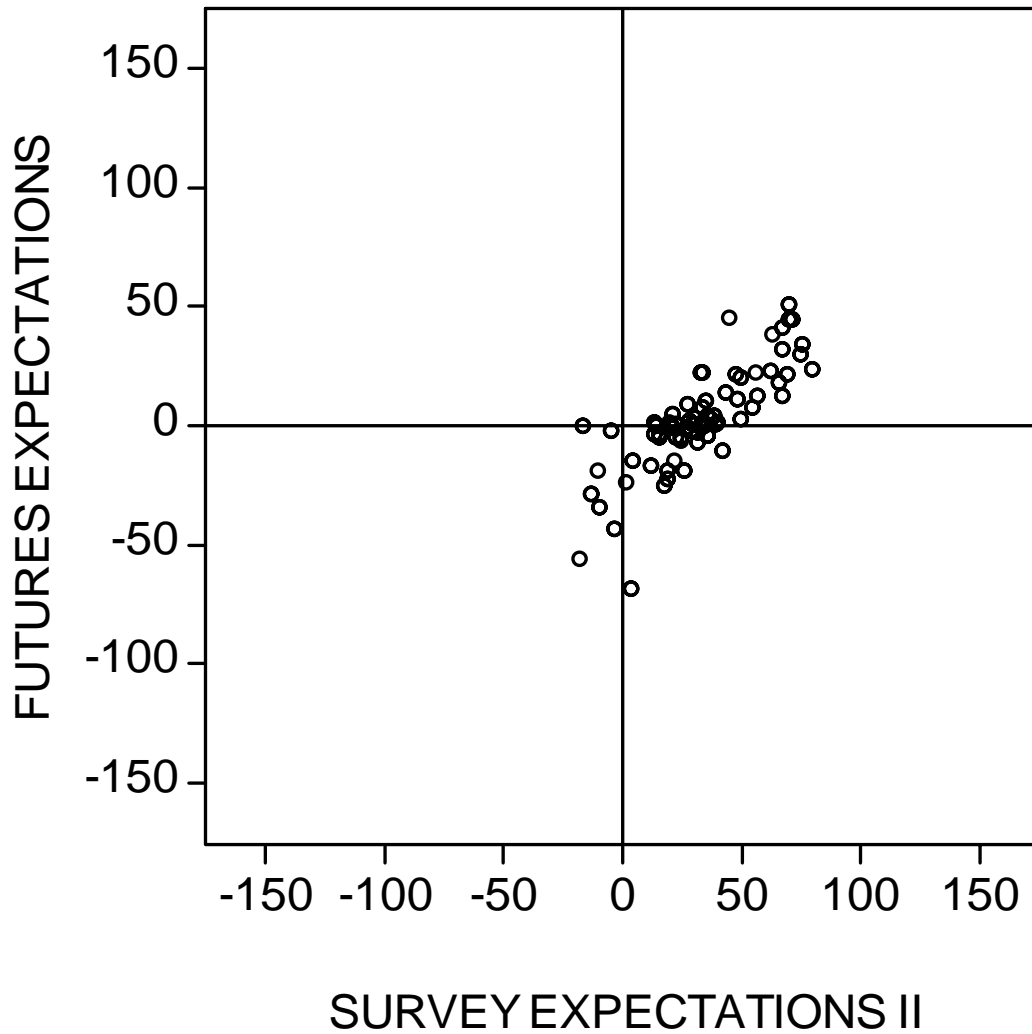


The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FUTURES EXPECTATIONS are the expected changes in the FFRT as estimated by the futures method. SURVEY EXPECTATIONS are the expected changes in the FFRT as estimated by the survey method. The numbers are in basis points.



**Figure 13**

**Futures Expectations vs. Survey Expectations II**



The sample contains scheduled FOMC meetings from January 1994 to December 2004. Each ring in the plot represents one of the FOMC meetings. FUTURES EXPECTATIONS are the expected changes in the FFRT as estimated by the futures method. SURVEY EXPECTATIONS II are the expected changes in the FFRT as estimated by the survey method, but with a more front-loaded adjustment of the original twelve-month expectation than the estimate from Table 12 (one fourth instead of one eighth). The numbers are in basis points.

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