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Risk-Adjusted Futures and Intermeeting Moves

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Abstract

Piazzesi and Swanson (2006) argues that the monthly excess returns on federal funds futures contracts are significantly positive on average; predictable using business cycle and financial market indicators; and that futures rates need significant adjustment for these excess returns. This paper shows that intermeeting moves of the federal funds rate by the FOMC can explain much of the variation in the excess returns. After accounting for these intermeeting moves, business cycle variables, corporate credit and Treasury spreads, and federal funds rate momentum have little marginal predictive power and have smaller and generally less significant coefficient estimates. Both in-sample and out-of-sample results suggest that, after removing influential outliers, futures rates are a useful measure of monetary policy expectations and only require a small adjustment of about 1 basis point per month for excess returns.

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1 Introduction

Since February 4, 1994, the Federal Open Market Committee (FOMC) has announced any changes to the federal funds rate target immediately after each meeting. Almost all of these changes occur at one of the regular, pre-announced FOMC meetings. This paper studies the effect of the unscheduled and surprise federal funds rate decisions that do not occur at a pre-scheduled meeting. These intermeeting moves drastically affect the financial markets by suddenly and unexpectedly changing both the effective federal funds rate and expectations for the upcoming FOMC meetings. The intermeeting federal funds rate movements occur on April 18, 1994 (+25 bp); October 15, 1998 (-25 bp); January 3, 2001 (-50 bp); April 18, 2001 (-50 bp); September 17, 2001 (-50 bp); and January 22, 2008 (-75 bp).

This paper examines the effect of these intermeeting moves on the monthly excess returns on federal funds futures contracts. Academic researchers, private sector forecasters, as well as the news media use these contracts to derive the expected path of the federal funds rate over the coming months. Federal funds futures trade on the Chicago Board of Trade and their payout is based on the difference between the contract rate and average effective federal funds rate over the contract expiration month.[1] Any difference between the futures rate and the average federal funds rate over the contract expiration month reflects returns in excess of the risk-free rate.

Recent work by Piazzesi and Swanson (2006) documents that these monthly excess returns are significantly positive on average and have an inverse relationship with the business cycle. Using a variety of models, they show that excess returns correlate with various business cycle and financial market indicators. Using both in-sample and pseudo out-of-sample results, Piazzesi and Swanson (2006) argues that the rates implied by the federal funds futures contracts need to be adjusted for excess returns and that adjusted futures rates make smaller and less correlated forecast errors.

This paper shows that the intermeeting moves by the FOMC can explain much of the variation in the monthly excess returns. Since the FOMC began announcing federal funds rate target changes, intermeeting moves can explain over 60% of the variation in the monthly excess returns on the 2-month ahead and longer contracts. After accounting for the effects of the intermeeting moves, the estimates of the average excess return are much smaller and average 1 basis point per month. Using several excess return models from the previous literature, I show that business-cycle variables, corporate credit and Treasury spreads, and a measure of federal funds rate momentum have little marginal predictive power after accounting for these intermeeting moves. In addition, the coefficient estimates of these excess return models are smaller and generally less significant after controlling for the intermeeting interest rate decisions.

[1] See Piazzesi and Swanson (2006), Krueger and Kuttner (1996), or Hamilton (2007) for a detailed description of the federal funds futures market.

Using an out-of-sample forecasting method similar to Piazzesi and Swanson (2006), this paper also shows that intermeeting moves are large outliers which bias the out-of-sample forecasting results as well. After removing contracts which are affected by the intermeeting moves, futures rates that are adjusted using any of the Piazzesi and Swanson (2006) excess return models make large positive mean forecast errors and have larger root-mean-squared forecast errors. In addition, the out-of-sample results indicate that the futures rates only require a small adjustment of about 1 basis point per month after removing the effect of the intermeeting moves. Both in-sample and out-of-sample results suggest that, after removing influential outliers, futures rates are a useful measure of monetary policy expectations and only require a very small adjustment for excess returns.

Previous work other than Piazzesi and Swanson (2006) generally finds evidence of some type of excess returns in federal funds futures contracts. Durham (2003) and Sack (2004) use slightly different time periods of data and find positive average excess returns which increase across longer maturity contracts. While previous work does find evidence of average excess returns, studies differ on their conclusions about time-varying excess returns. Using the term-structure of the implied federal funds rates, Durham (2003) finds highly volatile time-varying excess returns on short term contracts. Under the assumption that policy expectations level out over time, Sack (2004) determines that excess returns increase with contract length and vary over time. Durham (2003) also finds conflicting evidence about time-varying excess returns using two different asset-pricing approaches. Using the absolute value of the monthly excess returns, Swanson (2006) shows that recent movements in the federal funds rate correlate with larger forecast errors in the federal funds futures market.

2 Data and Monthly Excess Return Models

This paper uses language and notation consistent with Piazzesi and Swanson (2006) and defines the monthly excess returns on federal funds futures contracts as:

$$rx_{t+n}^{(n)} = f_t^{(n)} - r_{t+n}, \tag{1}$$

where r_{t+n} is the ex post realized average effective federal funds rate over month $t+n$ and $f_t^{(n)}$ is the futures rate of an n-month ahead contract at time t. I sample the futures rates across contracts ranging from 1 to 6 months ahead on the last day of each month t. Figure 1 plots the time series of the monthly excess returns for each n-month ahead contract length. Since the focus of this paper is on the effect of intermeeting moves after the FOMC began announcing federal funds rate target changes, this paper uses data from February 1994 - January 2008.[2]

[2]Prior to February 1994, financial market participants used the size and type of the open market operation conducted by the New York Federal Reserve's Open Market Desk the morning following an FOMC meeting to infer the change in the federal funds rate.

In order to study the effect of intermeeting moves, I define an intermeeting effect variable, D_t. D_t takes the value of the intermeeting federal funds rate change in basis points if an intermeeting move occurs between the sample of the futures rate at time t and the expiration of the contract at time $t+n$ and a value of 0 otherwise. The shaded areas of areas of Figure 1 indicate contracts affected by intermeeting moves by the FOMC. For example, D_t takes the value of -25 for the 2-month ahead contract sample at the end of September 1998 since a 25 basis point intermeeting rate cut occurs on October 15, 1998. I also allow the effect of the intermeeting moves to be cumulative if two intermeeting moves occur during the sample to expiration interval. For example, I assign D_t the value of -100 for 6-month ahead contract at the end of December 2000 since two intermeeting rate cuts of 50 basis points each occur between t and $t+n$. Finally, for contracts which expire in the same month as an intermeeting move occurs, I multiply the intermeeting effect variable by the number of days left in the month after the intermeeting move occurs divided by the total number of days in the month. This correction accounts for the fact that the payout on federal funds futures is based on the average effective federal funds rate over the expiration month.[3]

This paper estimates the following excess return models from the previous literature both with and without the intermeeting effect variable in order to study the effect of intermeeting moves.

Average Excess Return Model

$$rx_{t+n}^{(n)} = \alpha^{(n)} + \varepsilon_{t+n}^{(n)} \tag{2}$$

Employment Growth Model:

$$rx_{t+n}^{(n)} = \alpha^{(n)} + \beta_1^{(n)} f_t^{(n)} + \beta_2^{(n)} \Delta NFP_{t-1} + \varepsilon_{t+n}^{(n)} \tag{3}$$

Corporate Credit Spread Model:

$$rx_{t+n}^{(n)} = \alpha^{(n)} + \beta_1^{(n)} f_t^{(n)} + \beta_2^{(n)} (\text{Baa Spread}) + \varepsilon_{t+n}^{(n)} \tag{4}$$

Treasury Spreads Model:

$$rx_{t+n}^{(n)} = \alpha^{(n)} + \beta_1^{(n)}(\text{1yr-6mo}) + \beta_2^{(n)}(\text{2yr-1yr}) + \beta_3^{(n)}(\text{5yr-2yr}) + \beta_4^{(n)}(\text{10yr-5yr}) + \varepsilon_{t+n}^{(n)} \tag{5}$$

Federal Funds Rate Momentum Model:

$$rx_{t+n}^{(n)} = \alpha^{(n)} + \beta_1^{(n)}(r_t - r_{t-3}) + \varepsilon_{t+n}^{(n)}, \tag{6}$$

Models (2) - (5) appear in Piazzesi and Swanson (2006) and model (6) is an adaptation of a model from Swanson (2006). I estimate each of the above models using ordinary least squares for each contract length n. Model (2) regresses the monthly excess returns on a constant ($\alpha^{(n)}$).

[3]The results in this paper are robust to the removal of this correction. In addition, the results are robust to the specification of D_t as a simple {-1, 0, 1} dummy variable for intermeeting moves. Using the reported version of D_t as opposed to the simple dummy variable provides more easily interpreted coefficient estimates in the results.

Model (3) regresses the monthly excess returns on a constant, the current futures rate ($f_t^{(n)}$), and the year-over-year percentage change from time $t-13$ to $t-1$ in the logarithm of nonfarm payroll employment (ΔNFP_{t-1}). The series for employment growth contains the real-time data known at time t using the real-time data archive from the Federal Reserve Bank of Philadelphia. Model (4) uses the Baa corporate bond spread over the 10-year nominal Treasury at time t in place of the change in nonfarm payrolls in Model (3).[4] Model (5) uses four different Treasury yield spreads at time t to model the excess returns. Model (6) is similar to the federal funds rate momentum model of Swanson (2006) where $r_t - r_{t-3}$ is the change in the federal funds rate from 3 months ago.

Hansen and Hodrick (1980) and Hakkio (1981) discuss that an n-month ahead forward rate like (1) will suffer from $n-1$ lags of autocorrelation due to contract overlap. Thus, equations (2)-(6) use Newey-West (1987) standard errors with $2(n-1)$ lags to allow for the autocorrelation under equation (1).

3 Monthly Excess Returns Results

3.1 Average Excess Returns Model

The estimation results of model (2) without the intermeeting effect variable appear in the top panel of Table 1. The average monthly excess return varies from over 2 basis points on a 1-month ahead contract to over 22 basis points on a 6-month ahead contract. The average excess return is significant across all contract lengths with all of the t-statistics above two. These estimates are similar to the findings of Piazzesi and Swanson (2006) who finds that the average excess returns vary from 3 basis points on a 1-month ahead contract to 30 basis points on a 6-month ahead contract. Durham (2003) and Sack (2004) use slightly different time periods of data and also find significant positive average excess returns which increase across longer maturity contracts.

The autocorrelation of the excess returns is also an important statistic to examine. Ideally, the n-th autocorrelation of the regression residuals (ρ_n) should be zero in an n-month ahead contract. Piazzesi and Swanson (2006) discusses that the federal funds futures rates tend to make autocorrelated errors especially in longer term contracts. The last row in the top panel of Table 1 shows the n-th autocorrelation of the regression residuals and shows that futures rates make significantly correlated excess returns in contracts longer than 2-months ahead.

The bottom panel of Table 1 shows the estimation results of model (2) with the intermeeting effect variable. The intermeeting effect variable explains 32% of the variation in the 1-month ahead contract and over 60% of the variation in the 2-month ahead and longer contracts. The coefficient

[4] Piazzesi and Swanson (2006) use the BBB-spread rather than the Baa-spread. Unfortunately, the BBB-spread is not publicly available.

estimate of the intermeeting effect variable is statistically significant at a high level and increases with contract length. A 50 basis point intermeeting rate cut correlates with 60 basis points of excess returns on a 2-month ahead contract and 108 basis points on a 6-month ahead contract. The larger than one-to-one coefficient on the intermeeting effect variable shows that an intermeeting move also correlates with additional future unexpected policy changes before the contract expiration.

The estimates of the average excess returns and the n-th autocorrelations are also very different from the estimates without the intermeeting effect variable. The average excess return now varies from 1 to 7 basis points as opposed to the much larger previous estimates. In addition, the null hypothesis of a zero average excess return cannot be rejected for contracts longer than 3-months ahead. After accounting for the intermeeting moves, the estimates of the average excess return are very close to the rule-of-thumb adjustment of 1 basis point per month Piazzesi and Swanson (2006) discusses. Controlling for the intermeeting moves also lowers the point estimates of the n-th autocorrelations and highly reduces their statistical significance.

Piazzesi and Swanson (2006) and Durham (2003) run many similar bivariate regression models with a variety of different right hand side variables. Using only the 1-month ahead contracts, Durham (2003) finds a positive average excess return of 3 to 7 basis points after controlling for various factors. The average excess return is significant in all but one of his models. His regressions, however, cannot explain much of the variation of the excess returns and he finds little significance of any business cycle or other variables. In addition to models (2) - (5) I use in this paper, Piazzesi and Swanson (2006) also uses a simple 0-1 recession dummy variable to show that excess returns are higher during recessions. Although the recession dummy is significant across most contract lengths, the $\bar{R}^2$ values of those regressions range from only 0.04 to 0.16 over the sample of data I use in this paper.

The results of the average excess return model with the intermeeting effect variable are consistent with the results of Hamilton (2007). Using both daily and monthly data, he finds significant outliers in the daily first differences of the futures rates and the monthly excess returns. Using a set of monetary policy announcements (which contains all the intermeeting moves with the exception of the recent January 22, 2008 observation), Hamilton (2007) shows that these announcements increase the conditional variance of the daily first differences. In addition, he demonstrates that down-weighting outliers using a t-distribution significantly alters the mean of the distribution of both the daily first differences and the monthly excess returns. The results of this section are consistent with his findings and show that intermeeting moves are significant outliers which highly correlate with the monthly excess returns and can explain much of their variation. The results in Table 1 show that directly modelling and controlling for intermeeting moves also significantly alters the estimates of the average excess return.

3.2 Employment Growth Model

Using a regression on a constant, the current futures rate, and the real-time change in nonfarm payrolls, Piazzesi and Swanson (2006) finds that excess returns on futures contracts move in the opposite direction of employment growth. Model (3) without the intermeeting effect variable replicates their result over the February 1994 - January 2008 data sample I use in this paper. The results of the baseline employment growth model appear in Table 2 and agree with the findings of Piazzesi and Swanson (2006). Nonfarm payrolls and the current futures rate correlate with excess returns. The $\bar{R}^2$ values for these regressions range from 0.02 on a 1-month ahead contract to 0.17 on the 6-month ahead contract. Excess returns have a negative relationship with the change in nonfarm payrolls with a coefficient that varies from -0.01 to -0.42 across contract length. A 1% drop in employment growth correlates with a 20 basis point excess return on a 4-month ahead contract. The coefficient on the current futures rate of the n-month ahead contract ranges from 0.01 on a 1-month ahead contract to 0.27 on a 6-month ahead contract. While the $\bar{R}^2$ values are slightly lower than those reported by Piazzesi and Swanson (2006), the coefficient estimates and significance are in line with previous estimates.

The results of the employment growth model with the intermeeting effect variable appear in the bottom panel of Table 2. After controlling for the effect of intermeeting moves, ΔNFP_{t-1} and $f_t^{(n)}$ do not explain much of the variation in the excess returns. Adding ΔNFP_{t-1} and $f_t^{(n)}$ only increases the $\bar{R}^2$ by less than 0.02 in the 1 to 4-month ahead contracts when compared to the average excess return model with the intermeeting effect variable. Adding the business cycle variables only adds 0.04 and 0.07 to the $\bar{R}^2$ values for the 5 and 6-month ahead contracts which is much smaller than the 0.14 and 0.17 values of the top panel. In addition to the small increase in $\bar{R}^2$, the coefficient estimates of $\alpha^{(n)}, \beta_1^{(n)}$, and $\beta_2^{(n)}$ are all roughly half as large as the previous estimates. While most of the coefficients remain statistically significant, this change in shows that not accounting for intermeeting moves biases the coefficient estimates away from zero. The coefficients on the intermeeting effect variable remain highly statistically significant and are similar to the estimates from the bottom panel of Table 1.

3.3 Corporate Credit Spread Model

Piazzesi and Swanson (2006) also use corporate credit spreads to show that financial market indicators can also help predict monthly excess returns. Model (4) uses the Baa corporate bond yield spread over the 10-year Treasury yield in place of the real-time nonfarm payroll series in model (3). The top panel of Table 3 shows the results of the corporate credit spread model without the intermeeting effect variable. The findings agree with the results of Piazzesi and Swanson (2006) and show that wider corporate credit spreads significantly correlate with larger excess returns with coefficients on the Baa-spread ranging from 0.04 to 0.49. The $\bar{R}^2$ values for these regressions range from 0.06 on a 1-month ahead contract to 0.15 on the 6-month ahead contract.

Adding D_t to the corporate credit spread model produces results similar to adding D_t to the employment growth model. Adding the Baa-Spread and $f_t^{(n)}$ variables adds very little marginal predictive power and only increases the $\bar{R}^2$ by 0.01 or less across all contract lengths. In addition, the coefficient estimates on the Baa Spread are all not significantly different than zero and much smaller than previous estimates. For example, the coefficient on the Baa Spread in the 6-month ahead contract drops from 0.49 to 0.14 with the t-statistic dropping from 2.39 to 1.08 with the inclusion of the intermeeting effect variable. Similar to the employment growth model, the coefficients on the intermeeting effect variable remain highly significant and close to the results of the bottom panel of Table 1.

3.4 Treasury Spreads Model

Using a variety of different nominal Treasury spreads, Piazzesi and Swanson (2006) demonstrate that Treasury spreads can help predict the monthly excess returns in federal funds futures. The estimates of model (5) without the intermeeting effect variable appear in the top panel of Table 4 and agree with previous estimates from the literature. Treasury spreads can explain up to 12% of the variation in the monthly excess returns with most of the coefficients being significant.

The results in the bottom panel of Table 4 show the Treasury spread model with the intermeeting effect variable. While many of the coefficient estimates on the spread variables remain significant, their point estimates are much smaller. In addition, the Treasury spreads add less than 0.04 to the marginal $\bar{R}^2$ in the 4-month ahead and shorter contracts when compared to model (2) using the intermeeting effect variable. While the Treasury spreads do help explain some of the variation in the longer contracts, the marginal predictive power is much lower than the top panel.

3.5 Federal Funds Rate Momentum Model

Previous research suggests that more general movements in the federal funds rate can explain the excess returns since a moving funds rate may be more difficult to forecast. Swanson (2006) uses a measure of federal funds momentum, or the absolute value of the difference between the federal funds rate at time t and three months ago at time $t-3$, to show that a moving funds rate correlates with larger absolute excess returns. Model (6) estimates the effect of the signed version of this momentum variable on the monthly excess returns. The results appear in Table 5 both with and without the intermeeting effect variable. The top panel of Table 5 shows that recent movements in the funds rate significantly explain movements in the excess returns in contracts longer than 1-month ahead. For example, a recent cut of 50 basis points in the federal funds rate correlates with an 12 additional basis points of excess returns in the 4-month ahead contract.

Adding the intermeeting effect variable to the federal funds rate momentum model starkly changes these results. The coefficient estimates of the momentum variable are all at least five times smaller than their previous estimates and are all very close to zero. All of the momentum estimates are not significantly different from zero and the momentum variable has no marginal predictive power in predicting monthly excess returns at any contract length. Accounting for how the federal funds rate is moving (intermeeting versus all movements in the funds rate) appears to be more important than accounting for if the funds is moving when explaining the variation in the monthly excess returns.

In unreported regression results, I consider the exact federal funds rate momentum model of Swanson (2006) using the absolute value of the excess returns as the dependent variable and the absolute value of the federal funds rate momentum as the predictor variable. The conclusions of this model with and without the absolute value of the intermeeting effect variable are identical to the results of Table 5. After accounting for intermeeting moves, federal funds rate momentum has a smaller and insignificant effect on the absolute value of the excess returns and can not explain any of their variation.

4 Out-Of-Sample Federal Funds Rate Forecasts

The results of Section 3 show that intermeeting movements in the federal funds rate can help explain much of the variation in the monthly excess returns. By definition, however, intermeeting moves are not predictable due to their surprise and idiosyncratic nature. Thus, the intermeeting effect variable is not available for use in real-time forecasting. Using a slightly earlier data sample, Piazzesi and Swanson (2006) shows that pseudo out-of-sample forecasts using futures rates that are adjusted using the employment growth model produce smaller mean errors, smaller root-mean-squared errors, and have smaller n-th autocorrelations. Given that unpredictable intermeeting moves explain much of the variation in the excess returns since the FOMC began announcing federal funds rate changes, it is important to analyze how various adjustment mechanisms perform in real-time forecasting.

To evaluate the effectiveness of the excess return models, I perform out-of-sample forecasts using the unadjusted futures rates, rule-of-thumb adjusted futures using a 1 basis point per month adjustment, and the Piazzesi and Swanson (2006) employment growth model. I use the period from February 1994 - December 1995 to estimate initial parameters for the employment growth model and conduct rolling out-of-sample forecasts for the January 1996 - January 2008 sample.

From Piazzesi and Swanson (2006), the forecast errors of the federal funds futures contracts are as follows:

$$-rx_{t+n}^{(n)} = r_{t+n} - E_t[r_{t+n}], \tag{7}$$

where $-rx_{t+n}^{(n)}$ is the negative excess return of the n-month ahead contract at time t. Under the expectations hypothesis, the unadjusted futures prices imply:

$$E_t[r_{t+n}] = f_t^{(n)}. \tag{8}$$

Piazzesi and Swanson (2006) rejects the expectations hypothesis in favor of a time-varying excess return and adjusts futures rates for business-cycle risk using the employment growth model:

$$E_t[r_{t+n}] = f_t^{(n)} - (\alpha^{(n)} + \beta_1^{(n)} \Delta NFP_{t-1} + \beta_2^{(n)} f_t^{(n)}). \tag{9}$$

An alternative adjustment Piazzesi and Swanson (2006) discusses is a simple rule-of-thumb adjustment of one basis point per month as follows:

$$E_t[r_{t+n}] = f_t^{(n)} - n. \tag{10}$$

Out-of-sample forecasting using any excess return model presents challenges to the forecasting model due to the lag in the realization of the excess returns. Forecasts are made at the end of month t about the average federal funds rate over month $t+n$, where n denotes the contract length. The difference between these two values represents the excess return of time t. This lag between the forecast and the realization of the excess returns means that the models can only use parameter estimates from models estimated using data before time $t-n$. The forecast can include information up through time t, but the parameter estimates can only be estimated using data from before time $t-n$ due to the timing lag in the creation of the excess returns in equation (1). For example, if I want to use the employment growth model to adjust a 2-month ahead futures rate at the end of June, I can only estimate the parameters for my regression using excess return data through April since I have not observed the 2-month ahead excess return from the end of May.

The top panel of Table 6 presents the summary statistics of the out-of-sample federal funds rate forecasts. Similar to the in-sample results of Table 1, the unadjusted futures rates make large mean errors which increase with contract length. Using the unadjusted futures rates as a benchmark, the one basis point per month rule-of-thumb adjustment lowers the mean error by the amount of the adjustment and raises the out-of-sample R^2 statistic by about 0.07 across all contract lengths. The risk-adjusted futures computed using the employment growth model have mean errors which are approximately three times smaller than the benchmark unadjusted futures and about twice as small as the rule-of-thumb adjusted futures. The risk-adjusted futures do have somewhat larger root-mean-squared errors and thus negative out-of-sample R^2 statistics. Contrary to the results of Piazzesi and Swanson (2006), the n-th autocorrelations of all of the forecasting methods are similar and increase with contract length over the January 1996 - January 2008 forecasting period.

These results suggest that the risk-adjusted futures may be a less biased but less precise forecast than the unadjusted futures rates. Closer examination of the results, however, shows that such a trade-off does not exist. Figure 2 plots the out-of-sample forecast errors for the 2, 4, and 6-month ahead contracts using all three forecasting methods. The forecast errors for the three different methods converge during certain periods and diverge during other periods. As expected from the results of Section 3, all three forecasting methods make very similar large negative forecast errors when an intermeeting rate cut occurs between the sample of the futures rates and their expiration (Contracts affected by the intermeeting moves are shaded in gray). The forecast errors, however, differ during the late 2001-2002 period and the late 2005 - early 2007 period. During these periods, the risk-adjusted futures make persistent positive forecast errors that are greater than the unadjusted or rule-of-thumb adjusted futures rates. Thus, the smaller mean error of the risk-adjusted futures in the top panel of Table 6 could simply be a byproduct of these persistent positive errors averaging with the large negative errors associated with the intermeeting moves.

To test this hypothesis and show that a bias precision trade-off does not exist, I remove the contracts affected by the intermeeting moves (where all three methods perform equally poorly), and recompute the mean and root-mean-squared errors for the three forecasting methods. These results appear in the bottom panel of Table 6 and show that the positive and persistent forecast errors of the risk-adjusted futures bias the estimates of the mean forecast error. After removing the influence of the intermeeting moves, the risk-adjusted futures make large positive forecast errors on average and have a much larger root-mean-squared error than the benchmark unadjusted futures. The larger squared forecast error results in large and negative out-of-sample R^2 statistics of approximately -0.50 in the 3-month ahead and longer contracts. Contrary to the results in the top panel, the unadjusted and rule-of-thumb adjusted futures make mean forecast errors less than 4 basis points across all contracts. The rule-of-thumb adjusted futures do improve on the unadjusted futures with smaller mean errors (less than one in contracts up to 4-months ahead) and positive out-of-sample R^2 statistics.

I also repeat the forecasting exercise in Table 6 with both the corporate credit spread model and the Treasury spreads model in order to test the robustness of these findings (full results not reported). These alternative adjustment models also produce the same pattern of large and persistent positive forecast errors as the employment growth model. After removing the contracts affected by the intermeeting moves (where again all forecasting methods have similar and large negative forecast errors), the unadjusted and rule-of-thumb adjusted futures vastly outperform both the corporate credit and Treasury models. The poor forecasting performance of the various models based on business cycle and financial market indicators can most likely be traced back to the unexpected nature of intermeeting moves. The various in-sample regression results in the top panels of Tables 1-5 show that not accounting for intermeeting moves biases the coefficient estimates away from zero. This omitted variable bias most likely contributes to the poor performance of the risk-adjustment mechanisms.

I also repeat the forecasting exercise of Section 4 using the January 1992 - January 1994 sample to estimate the initial parameter estimates and out-of-sample forecast the February 1994 - January 2008 sample and find similar conclusions (full results not reported). The estimates of the mean error for the rule-of-thumb adjusted futures are less than one basis point across all contract lengths after removing the contracts affected by the intermeeting moves using this alternative sample. In addition, the rule-of-thumb adjusted futures outperform the unadjusted and risk-adjusted futures with respect to the root-mean-squared error with out-of-sample R^2 statistics of approximately 0.04 without the intermeeting affected contracts and 0.06 with the intermeeting affected contracts.

The out-of-sample forecasting results suggest that, after removing the influential outliers of intermeeting moves, only a small rule-of-thumb adjustment of about about 1 basis point per month is necessary. This result is consistent with the in-sample results of the average excess return model with the intermeeting effect variable in Table 1. Both the in-sample and out-of-sample results suggest that, after removing influential outliers, futures rates are a useful measure of monetary policy expectations and only require a very small adjustment.

5 Conclusions

This paper shows that intermeeting moves are large and influential outliers which explain much of the variation in the monthly excess returns on federal funds futures. Using data since the FOMC began announcing federal funds target rate changes, accounting for these intermeeting moves changes many of the previous results from the literature. In particular, the estimates of the average excess return and the predictive power of business cycle and financial market indicators are much smaller after controlling for the effect of the intermeeting moves. Both in-sample and out-of-sample results show that futures rates are a useful measure of monetary policy expectations that require only a very small adjustment of approximately 1 basis point per month.

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Table 1: Piazzesi and Swanson (2006) Average Excess Return Model

Constant

n	1	2	3	4	5	6
$\alpha^{(n)}$	2.13	5.37	8.87	13.44	18.60	22.04
(t-statistic)	(3.32)	(3.49)	(2.82)	(2.51)	(2.31)	(2.10)
ρ_n	-0.08	0.10	0.19	0.27	0.33	0.30
(t-statistic)	(-0.75)	(1.55)	(2.50)	(3.31)	(2.98)	(2.34)

Constant and Intermeeting

n	1	2	3	4	5	6
$\alpha^{(n)}$	1.45	2.95	3.83	4.92	6.10	7.10
(t-statistic)	(2.75)	(3.36)	(2.44)	(1.89)	(1.53)	(1.19)
D_t	-1.03	-1.21	-1.48	-1.74	-1.93	-2.16
(t-statistic)	(-7.91)	(-11.98)	(-12.47)	(-11.77)	(-11.96)	(-12.86)
$\bar{R}^2$	0.32	0.61	0.66	0.65	0.64	0.60
ρ_n	-0.14	0.03	0.02	-0.03	-0.02	0.03
(t-statistic)	(-0.94)	(0.40)	(0.21)	(-0.28)	(-0.26)	(0.31)

Note: The model is (2) estimated with and without the intermeeting move variable for each n-month ahead contract length. Coefficients appear in basis points with t-statistics in parenthesis. The t-statistics for the coefficient estimates are computed using Newey-West standard errors with $2(n-1)$ lags. ρ_n is the n-th autocorrelation of the regression residuals.

Table 2: Piazzesi and Swanson (2006) Employment Growth Excess Return Model

Constant, Futures Rate, and Employment Growth

n	1	2	3	4	5	6
$\alpha^{(n)}$	-1.57	-3.42	-7.17	-12.90	-24.01	-33.64
(t-statistic)	(-1.15)	(-3.46)	(-1.44)	(-1.70)	(-2.40)	(-3.00)
$f_t^{(n)}$	0.01	0.04	0.07	0.13	0.20	0.27
(t-statistic)	(1.84)	(2.94)	(3.06)	(3.15)	(3.40)	(3.73)
ΔNFP_{t-1}	-0.01	-0.04	-0.11	-0.20	-0.32	-0.42
(t-statistic)	(-0.91)	(-2.01)	(-2.42)	(-2.76)	(-3.11)	(-3.46)
$\bar{R}^2$	0.02	0.04	0.06	0.09	0.14	0.17

Constant, Futures Rate, Employment Growth, and Intermeeting

n	1	2	3	4	5	6
$\alpha^{(n)}$	-0.45	-1.24	-3.74	-7.85	-16.94	-26.76
(t-statistic)	(-0.46)	(-0.61)	(-1.18)	(-1.80)	(-3.16)	(-3.52)
$f_t^{(n)}$	0.00	0.01	0.03	0.06	0.12	0.17
(t-statistic)	(1.04)	(1.88)	(2.50)	(3.17)	(4.28)	(4.68)
ΔNFP_{t-1}	-0.00	-0.01	-0.04	-0.10	-0.19	-0.29
(t-statistic)	(-0.06)	(-0.80)	(-1.83)	(-2.61)	(-3.47)	(-4.00)
D_t	-1.02	1.19	-1.44	-1.67	-1.82	-2.01
(t-statistic)	(-7.57)	(-11.02)	(-11.23)	(-10.19)	(-9.74)	(-10.51)
Marginal $\bar{R}^2$	0.00	0.01	0.01	0.02	0.04	0.07

Note: The model is (3) estimated with and without the intermeeting move variable for each n-month ahead contract length. Coefficients appear in basis points with t-statistics in parenthesis. The t-statistics for the coefficient estimates are computed using Newey-West standard errors with $2(n-1)$ lags. The marginal $\bar{R}^2$ is the increase in the adjusted R^2 by adding the ΔNFP_{t-1} and $f_t^{(n)}$ variables to model (2) with the intermeeting move effect variable of Table 1.

Table 3: Piazzesi and Swanson (2006) Corporate Credit Spread Excess Return Model

Constant, Futures Rate, and Baa Spread

n	1	2	3	4	5	6
$\alpha^{(n)}$	-11.55	-32.97	-58.77	-83.73	-116.54	-144.03
(t-statistic)	(-2.13)	(-3.46)	(-3.47)	(-3.05)	(-2.74)	(-2.46)
$f_t^{(n)}$	0.01	0.04	0.06	0.09	0.12	0.15
(t-statistic)	(2.87)	(3.88)	(3.67)	(3.18)	(2.94)	(2.69)
Baa Spread	0.04	0.11	0.20	0.29	0.40	0.49
(t-statistic)	(1.97)	(3.21)	(3.19)	(2.90)	(2.67)	(2.42)
$\bar{R}^2$	0.06	0.12	0.15	0.14	0.15	0.15

Constant, Futures Rate, Baa Spread and Intermeeting

n	1	2	3	4	5	6
$\alpha^{(n)}$	-2.79	-6.13	-9.87	-11.05	-16.78	-29.17
(t-statistic)	(-0.79)	(-1.11)	(-1.18)	(-0.77)	(-0.73)	(-0.82)
$f_t^{(n)}$	0.01	0.01	0.02	0.02	0.03	0.04
(t-statistic)	(2.46)	(2.61)	(2.21)	(1.37)	(1.22)	(1.11)
Baa Spread	0.01	0.02	0.03	0.04	0.05	0.09
(t-statistic)	(0.59)	(0.88)	(0.97)	(0.69)	(0.62)	(0.73)
D_t	-0.99	-1.17	-1.43	-1.69	-1.87	-2.06
(t-statistic)	(-7.09)	(-10.69)	(-11.98)	(-10.83)	(-9.78)	(-9.73)
Marginal $\bar{R}^2$	0.00	0.01	0.00	0.00	0.00	0.00

Note: The model is (4) estimated with and without the intermeeting move variable for each n-month ahead contract length. Coefficients appear in basis points with t-statistics in parenthesis. The t-statistics for the coefficient estimates are computed using Newey-West standard errors with $2(n-1)$ lags. The marginal $\bar{R}^2$ is the increase in the adjusted R^2 by adding the Baa Spread and $f_t^{(n)}$ variables to model (2) with the intermeeting move effect variable of Table 1.

Table 4: Piazzesi and Swanson (2006) Treasury Spreads Excess Return Model

Constant and Treasury Spreads

n	1	2	3	4	5	6
$\alpha^{(n)}$	3.94	10.88	19.41	28.42	38.75	44.14
(t-statistic)	(2.88)	(3.22)	(3.13)	(2.99)	(2.95)	(2.84)
1 Year - 6 Month	0.05	0.08	0.02	-0.09	-0.38	-0.72
(t-statistic)	(0.64)	(0.52)	(0.07)	(-0.20)	(-0.56)	(-0.81)
2 Year - 1 Year	-0.11	-0.35	-0.61	-0.78	-0.82	-0.65
(t-statistic)	(-1.54)	(-2.11)	(-2.32)	(-1.96)	(-1.47)	(-1.00)
5 Year - 2 Year	0.09	0.27	0.60	0.93	1.36	1.72
(t-statistic)	(1.06)	(1.37)	(2.18)	(2.99)	(4.05)	(4.01)
10 Year - 5 Year	-0.10	-0.26	-0.60	-0.97	-1.52	-2.03
(t-statistic)	(-1.12)	(-1.22)	(-1.96)	(-2.68)	(-3.86)	(-4.04)
$\bar{R}^2$	0.00	0.07	0.11	0.10	0.11	0.12

Constant, Treasury Spreads, and Intermeeting

n	1	2	3	4	5	6
$\alpha^{(n)}$	2.16	4.36	6.08	7.50	8.54	6.48
(t-statistic)	(2.50)	(2.58)	(2.06)	(1.81)	(1.46)	(0.81)
1 Year - 6 Month	0.11	0.16	0.22	0.36	0.35	0.48
(t-statistic)	(1.56)	(1.49)	(1.32)	(1.41)	(1.04)	(1.25)
2 Year - 1 Year	-0.08	-0.14	-0.22	-0.34	-0.33	-0.32
(t-statistic)	(-1.48)	(-1.53)	(-1.48)	(-1.65)	(-1.13)	(-0.89)
5 Year - 2 Year	0.05	0.09	0.24	0.44	0.71	0.88
(t-statistic)	(0.96)	(0.86)	(1.54)	(2.73)	(3.77)	(3.57)
10 Year - 5 Year	-0.07	-0.12	-0.28	-0.53	-0.88	-1.10
(t-statistic)	(-1.14)	(-0.98)	(-1.64)	(-2.70)	(-4.03)	(-3.74)
D_t	-1.07	-1.23	-1.51	-1.83	-2.07	-2.37
(t-statistic)	(-8.76)	(-12.48)	(-13.14)	(-13.52)	(-12.73)	(-14.48)
Marginal $\bar{R}^2$	0.02	0.01	0.02	0.04	0.06	0.08

Note: The model is (5) estimated with and without the intermeeting move variable for each n-month ahead contract length. Coefficients appear in basis points with t-statistics in parenthesis. The t-statistics for the coefficient estimates are computed using Newey-West standard errors with $2(n-1)$ lags. The marginal $\bar{R}^2$ is the increase in the adjusted R^2 by adding the four Treasury spread variables to model (2) with the intermeeting move effect variable of Table 1.

Table 5: Swanson (2006) Federal Funds Rate Momentum Excess Return Model

Constant, and Federal Funds Rate Momentum

n	1	2	3	4	5	6
$\alpha^{(n)}$	2.15	5.49	9.13	13.86	19.46	23.40
(t-statistic)	(3.37)	(3.86)	(3.39)	(3.18)	(2.95)	(2.81)
Momentum	-0.01	-0.07	-0.16	-0.25	-0.37	-0.47
(t-statistic)	(-1.06)	(-2.29)	(-2.65)	(-2.62)	(-2.52)	(2.61)
$\bar{R}^2$	0.00	0.04	0.09	0.11	0.13	0.16

Constant, Federal Funds Rate Momentum, and Intermeeting

n	1	2	3	4	5	6
$\alpha^{(n)}$	1.44	2.97	3.89	5.02	6.32	7.85
(t-statistic)	(2.78)	(3.40)	(2.51)	(1.99)	(1.66)	(1.45)
Momentum	0.00	-0.01	-0.01	-0.01	-0.02	-0.08
(t-statistic)	(0.17)	(-0.23)	(-0.27)	(-0.22)	(-0.26)	(-0.68)
D_t	-1.03	-1.20	-1.47	-1.73	-1.91	-2.08
(t-statistic)	(-8.14)	(-12.45)	(-13.51)	(-11.99)	(-11.86)	(-13.18)
Marginal $\bar{R}^2$	0.00	0.00	0.00	0.00	0.00	0.00

Note: The model is (6) estimated with and without the intermeeting move variable for each n-month ahead contract length. Coefficients appear in basis points with t-statistics in parenthesis. The t-statistics for the coefficient estimates are computed using Newey-West standard errors with $2(n-1)$ lags. The marginal $\bar{R}^2$ is the increase in the adjusted R^2 by adding the federal funds rate momentum variable to model (2) with the intermeeting move variable of Table 1.

Table 6: Out-Of-Sample Federal Funds Rate Forecasts 1996-2008

Full Sample

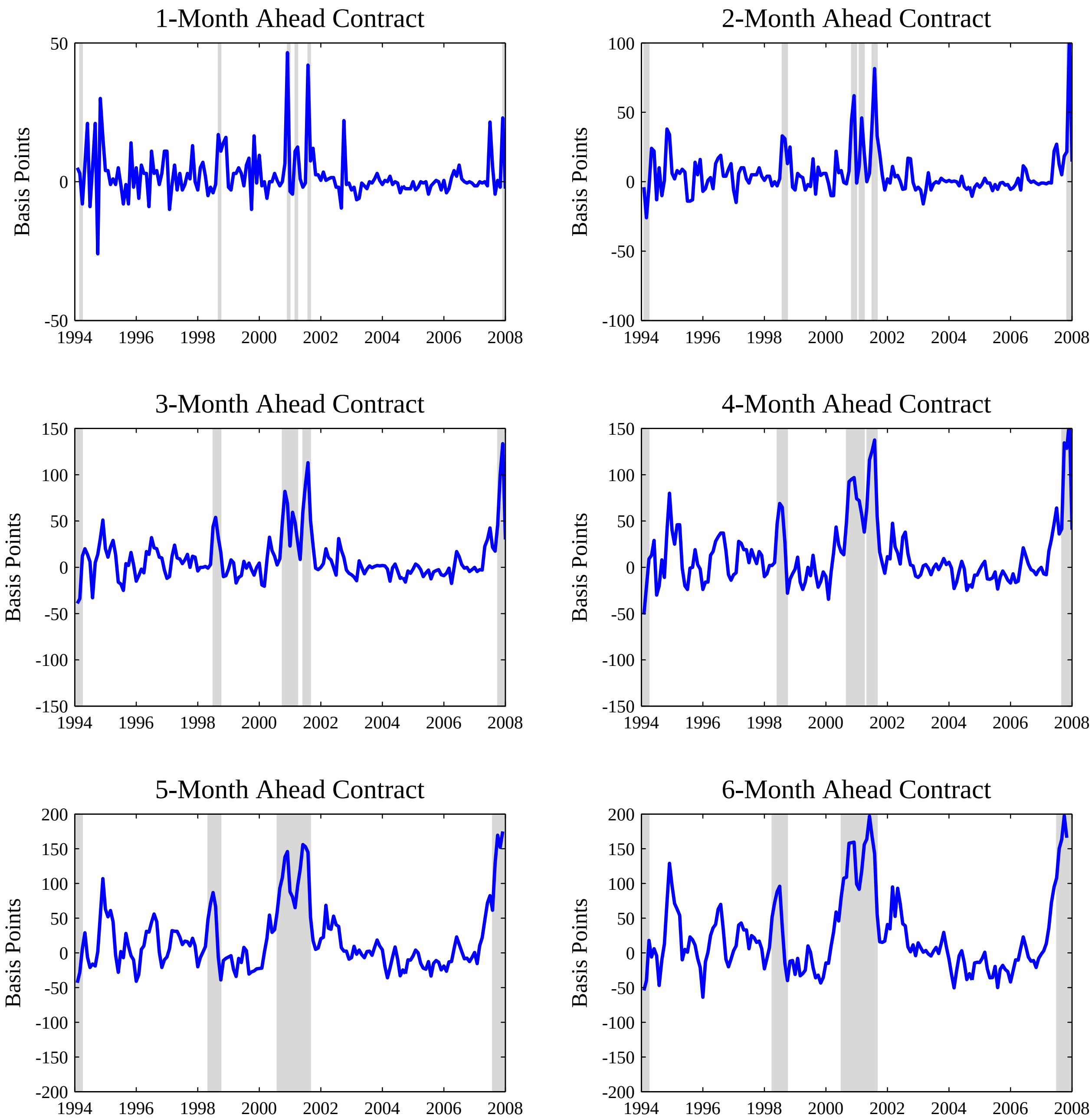
	Unadjusted Futures			Rule-Of-Thumb Adjusted Futures				Risk-Adjusted Futures			
n	ME	RMSE	ρ_n	ME	RMSE	ρ_n	R^2	ME	RMSE	ρ_n	R^2
1	-1.99	7.90	0.03	-0.99	7.70	0.03	0.05	0.53	7.82	0.00	0.02
2	-5.50	16.61	0.15	-3.50	16.06	0.15	0.07	-0.65	16.58	0.17	0.00
3	-9.52	26.57	0.24	-6.52	25.64	0.24	0.07	-3.12	27.89	0.31	-0.10
4	-14.36	38.42	0.31	-10.36	37.11	0.31	0.07	-4.75	41.19	0.36	-0.15
5	-19.64	51.01	0.38	-14.64	49.30	0.38	0.07	-6.99	55.45	0.35	-0.18
6	-22.92	60.76	0.35	-16.92	58.76	0.35	0.06	-7.59	68.86	0.28	-0.28

Without Intermeeting Moves

	Unadjusted Futures		Rule-Of-Thumb Adjusted Futures			Risk-Adjusted Futures		
n	ME	RMSE	ME	RMSE	R^2	ME	RMSE	R^2
1	-1.06	5.47	-0.06	5.37	0.04	1.48	5.51	-0.05
2	-2.39	8.69	-0.39	8.37	0.07	2.62	9.68	-0.24
3	-2.92	13.00	0.08	12.67	0.05	4.14	16.26	-0.56
4	-3.43	18.95	0.57	18.64	0.03	7.79	23.83	-0.58
5	-3.38	24.91	1.62	24.74	0.01	12.42	30.50	-0.49
6	-3.29	31.79	2.71	31.73	0.00	17.06	37.81	-0.41

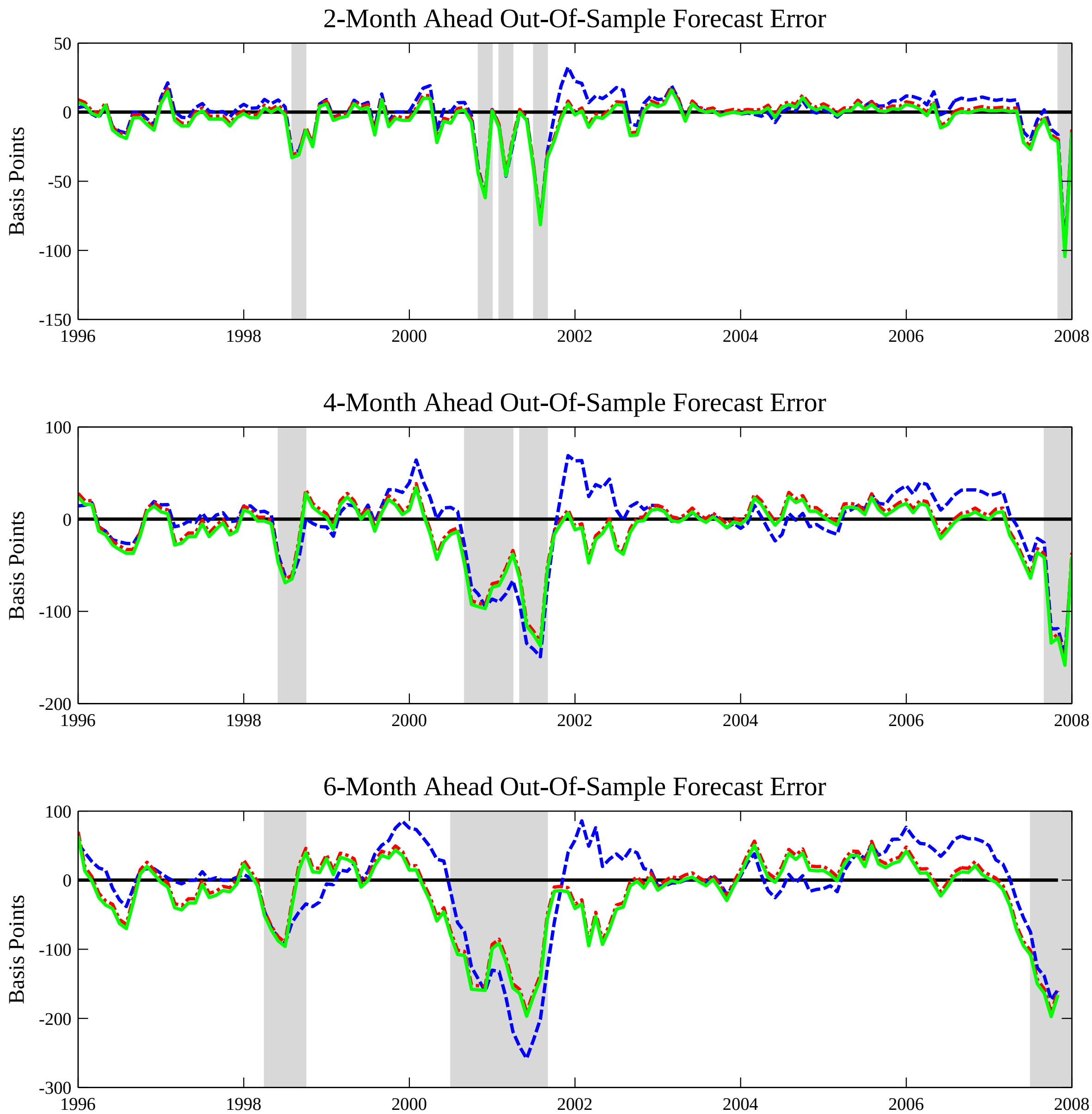
Note: ME denotes mean forecast error, RMSE is the square root of the mean squared forecast error, ρ_n is the n-th autocorrelation of the forecast error, and R^2 denotes the out-of-sample R^2 statistic. The out-of-sample R^2 statistic is equal to one minus the ratio of the mean squared error from the adjusted forecasting model over the mean squared error from the benchmark unadjusted futures. ME and RMSE appear in basis points.

Figure 1: Time Series Plots of Monthly Excess Returns



Note: Shaded areas indicate contracts affected by intermeeting moves of the federal funds rate target by the FOMC.

Figure 2: Time Series Plots of Out-Of-Sample Forecast Errors



Note: This figure plots the forecast errors from the out-of-sample federal funds rate forecasts from January 1996 - January 2008. The green solid line denotes the forecast errors from the unadjusted futures rates, the red dashed and dotted line denotes the forecast errors from the rule-of-thumb adjusted futures rates, and the blue dashed line denotes the forecast errors from the risk-adjusted futures using the Piazzesi and Swanson (2006) employment growth model. Shaded areas indicate contracts affected by intermeeting moves of the federal funds rate target by the FOMC.