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## Article

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## FINANCIAL ECONOMICS | RESEARCH ARTICLE

# Long-term interest rate predictability: Exploring the usefulness of survey forecasts of growth and inflation

Hamid Baghestani<sup>1\*</sup>

**Abstract:** This study focuses on the consensus forecasts from the Survey of Professional Forecasters (SPF) for 1993–2017. These include the SPF forecasts of US 10-year Treasury rate (TBR), Moody's Aaa corporate bond rate (Aaa), CPI inflation, and real GDP growth. We show that both SPF and random walk forecasts of TBR and Aaa generally fail to be orthogonal to changes in SPF inflation (but not growth) forecasts. Such findings point to the potential usefulness of SPF inflation forecasts in improving the accuracy of SPF and random walk forecasts of TBR and Aaa. Further results indicate that changes in SPF inflation forecasts accurately predict directional change in both TBR and Aaa at longer forecast horizons for 2008–2017 (but not for 1993–2007). These latter results raise the question of whether long-term interest rates have become easier to predict, which deserves subsequent research.

**Subjects:** Monetary Economics; Economic Forecasting; Investment & Securities

### ABOUT THE AUTHOR

Hamid Baghestani has a 1982 Ph.D. in Economics from the University of Colorado, Boulder. He is currently Professor of Economics at the American University of Sharjah, UAE. His research interests include time-series analysis, macro-econometric modeling and forecasting, energy economics, monetary economics, and financial markets. He has published widely on these topics in internationally respected peer-reviewed journals such as *Applied Economics*, *Energy Economics*, *Energy Policy*, *Journal of Business*, *Journal of Forecasting*, *Journal of Industrial Economics*, *Journal of Macroeconomics*, and *Oxford Bulletin of Economics and Statistics*.

### PUBLIC INTEREST STATEMENT

Long-term interest rates are among financial indicators that are inherently difficult to accurately predict. Theory and empirical evidence both suggest that the best forecast of the future rate is today's rate, and researchers warn market participants and policymakers against using the publicly available survey forecasts of long-term interest rates for decision-making. To improve the accuracy of survey forecasts of long-term interest rates, we propose the idea that one should explore the usefulness of the predictive information contained in the survey forecasts of other theoretically relevant variables such as inflation and output growth. Focusing on the consensus forecasts from a panel of professional forecasters, our investigation points to the potential usefulness of survey forecasts of inflation (but not output growth) for improving the accuracy of both survey and naïve forecasts of long-term interest rates for 2008–2017. Equally important, our findings further indicate that changes in the survey forecasts of inflation accurately predict directional change in long-term interest rates at longer forecast horizons.

**Keywords:** long-term interest rates; Fisher effect; inflationary expectations; orthogonality; directional accuracy; Survey of Professional Forecasters  
**JEL classification:** E43; E44; E47; G12

## 1. Introduction

It is inherently difficult to accurately predict long-term interest rates due to their approximate random walk behavior (Pesando, 1979, 1980; Reichenstein, 2006). Studies investigating the accuracy of survey forecasts of long-term interest rates have shown that such forecasts fail to beat the random walk benchmark (Baghestani, 2009b; Baghestani, 2018; Brooks & Gray, 2004; Mitchell & Pearce, 2007; Stark, 2010). As such, the literature warns market participants and policymakers against using the publicly available survey forecasts of long-term interest rates for making economic, financial, and policy decisions. One source of inaccuracy commonly cited is the failure of survey participants in incorporating useful and relevant information available at the time of the forecast, implying that there is room for improving the survey forecasts of interest rates (Baghestani, 2006a; Chun, 2012; Friedman, 1980; Froot, 1989; Jongen & Verschoor, 2008; MacDonald & Macmillan, 1994; Miah, Khalifa, & Hammoudeh, 2016).

There are a good number of studies in the literature which have investigated the predictive information content of various economic and financial indicators for interest rates. Baghestani (2005), for instance, makes use of the predictive information contained in the survey forecasts of inflation and real output growth to improve the accuracy of survey forecasts of the 3-month Treasury bill rate. The inflation forecasts are relevant due to the Fisher (1930) equation, which maintains that the expected nominal interest rate is the sum of the expected real interest rate and the expected inflation rate. The output growth forecasts are also relevant since changes in growth expectations can signal future changes in demand and supply of loanable funds and, thus, alter expectations about real interest rates.

This study adds to the literature by focusing on the forecasts from the Survey of Professional Forecasters (SPF). Among other indicators, the survey asks participants to provide their forecasts of the 10-year Treasury rate (TBR), Moody's Aaa corporate bond rate (Aaa), CPI inflation, and real GDP growth. Utilizing the consensus (median) forecasts, we set out to examine whether the SPF and random walk forecast errors of TBR and Aaa are orthogonal to changes in SPF growth and inflation forecasts, and whether changes in SPF inflation forecasts accurately predict directional change in both TBR and Aaa. Our findings for 1993–2017 indicate that the SPF and random walk forecast errors of TBR and Aaa fail to be orthogonal to changes in SPF inflation (but not growth) forecasts. In addition, changes in SPF inflation forecasts do not accurately predict directional change in either TBR or Aaa for 1993–2007. In contrast, for 2008–2017 when monetary policy kept the federal funds rate unusually low, changes in SPF inflation forecasts accurately predict directional change in both TBR and Aaa at longer forecast horizons. Put together, our findings point to the potential usefulness of SPF inflation forecasts for improving the accuracy of both SPF and random walk forecasts of TBR and Aaa. We proceed by briefly reviewing the related literature. Section 3 describes the SPF and random walk forecasts. Section 4 presents the forecast evaluation test results. Section 5 concludes.

## 2. Literature review

The study by Pesando (1979) demonstrates the notion that, under the pure expectations model with time-invariant term premium, long-term interest rates approximately follow a random walk. To keep it simple, we focus on the relationship between the long-term interest rate on an  $m$ -period bond at time  $t$  ( $R_t^m$ ) and a one-period short-term interest rate at time  $t$  ( $r_t$ ), derived by Reichenstein (2006, p. 117),

$$E_t[R_{t+1}^m] - R_t^m = (1/m) \cdot [r_{t+m} - r_t]$$

where  $E_t[R_{t+1}^m]$  is the long-term interest rate in  $t + 1$  expected at time  $t$ , and  $r_{t+m}$  is the short-term interest rate in  $t + m$  expected at time  $t$ . With  $m = 40$  quarters for the 10-year Treasury rate, the

right-hand side term is close to zero, which means that the future 10-year Treasury rate is expected to be approximately today's rate. It follows that, under the efficient market hypothesis, today's long-term rate rapidly and fully reflects all relevant information so that future rate changes deviate from zero only in response to unexpected shocks. As for short-term interest rates, Pesando (1979) notes that market efficiency does not necessarily imply that such rates follow a random walk behavior. Brooks and Gray (2004), Mitchell and Pearce (2007), Baghestani (2009b), Baghestani (2018), Stark (2010), among others, have found that the survey forecasts of long-term interest rates are inferior to the random walk forecasts. Consistent with the theory, empirical findings are mixed for the survey forecasts of short-term interest rates. For instance, Baghestani, Arzaghi, and Kaya (2015) examine the accuracy of the Blue Chip survey forecasts of 3-month Euro currency rates and 10-year government bond rates for the Eurozone, Australia, Canada, Japan, Switzerland, the UK, and the US for 1999–2008. They find that nearly half of the short-term interest rate forecasts are superior to the random walk. However, consistent with the efficient market hypothesis, the forecasts of long-term interest rates all fail to beat the random walk benchmark.

Despite the implications of the efficient market hypothesis, the literature contains studies that have proposed ways for producing accurate forecasts of interest rates. Baghestani (2008b, 2010a, 2017) shows that the predictive information content of both survey-based and model-based measures of expected inflation can help produce more accurate forecasts of the 10-year Treasury and the 30-year mortgage rate than the random walk benchmark. Guidolin and Timmermann (2009) propose a flexible forecast combination approach to generate accurate forecasts of the US short-term interest rates. They note, “it is important both to combine information embedded in different forecasts and to allow for nonlinear (regime) dynamics in spot and forward rates” (p. 298). Ghysels and Wright (2009) propose a method to predict the upcoming SPF quarterly forecasts of output growth, inflation and short-term interest rates. Utilizing daily observed changes in interest rates, they estimate what the SPF participants would predict if they were asked to make a forecast each day. Closely related to our goal, however, is the study by Baghestani (2005) which makes use of the predictive information contained in the survey forecasts of inflation and real output growth to improve the accuracy of survey forecasts of short-term interest rates. We add to the literature by investigating the potential usefulness of the predictive information embedded in the SPF forecasts of real output growth and inflation for improving the SPF and random walk forecasts of long-term interest rates. This is important because the theory suggests that long-term interest rates approximately follow a random walk (Pesando, 1979, 1980; Reichenstein, 2006).

Before proceeding further, we briefly discuss the literature findings on the accuracy of survey forecasts of inflation and real output growth. Ang, Bekaert, and Wei (2007) compare the accuracy of US inflation forecasts from four alternative models. These include the univariate ARIMA, Philips curve type, term structure, and survey-based models (including the Livingston, Michigan, and SPF). They show that the consensus inflation forecasts from both the Livingston and SPF surveys whose participants are professional forecasters are superior to the forecasts from the other three non-survey models. Ang et al. (2007, p. 1165) further note that “even participants in the Michigan survey who are consumers, not professionals, produce accurate out-of-sample forecasts, which are only slightly worse than those of the professionals in the Livingston and SPF surveys.”<sup>1</sup> Clements (2006) proposes a number of tools for evaluating probability event forecasts. Using these tools, he shows that the SPF forecasts of inflation are conditionally efficient against the no-change forecasts. There are many other studies (including Keane & Runkle, 1990; Romer & Romer, 2000; Thomas, 1999), which directly or indirectly examine the accuracy of SPF inflation forecasts. For instance, Romer and Romer (2000) show that the Federal Reserve forecasts of inflation are more informative than the (private) Blue Chip and SPF forecasts. However, for the 1979–1983 period when the inflation rate was very volatile, Baghestani and Soliman (2009) show that the Michigan survey forecasts of inflation are more informative than the Federal Reserve forecasts. As for real GDP (output) growth, Romer and

Romer (2000) find weak evidence in support of the notion that the Federal Reserve forecasts are more informative than the Blue Chip and SPF growth forecasts. Consistent with these results, Baghestani (2014b) finds that the SPF forecasts closely replicate the Federal Reserve growth forecasts. Aretz and Peel (2010) show that the SPF growth forecasts efficiently embody the information in the term structure spread, when allowing for the forecasters' loss functions to become more negatively skewed with the forecast horizon. Focusing on the 1969–2003 period, Campbell (2007, p. 199) maintains, “The SPF forecasts reveal that the period of the great moderation represents a moderation in volatility, uncertainty and, more importantly, predictability. Before 1984, professional forecasters were considerably more adept than a simple autoregressive model at forecasting future growth. After 1984, the two sets of forecasts are roughly comparable.” There are also studies that investigate the accuracy of the SPF forecasts of the components of real GDP. See, among others, Baghestani (1994, 2006b, 2011, 2012) which focus on real net exports and growth in real business and residential investment forecasts.

### 3. SPF and random walk forecasts

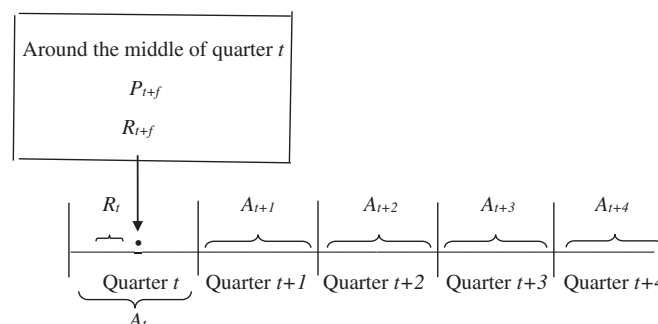
In 1968, the American Statistical Association and the National Bureau of Economic Research (ASA-NBER) initiated the Survey of Professional Forecasters (SPF) to collect quarterly forecasts of several US macroeconomic and financial indicators. The survey, currently conducted by the research department of the Federal Reserve Bank of Philadelphia, added TBR to the list of indicators starting with the first quarter of 1992. As such, in this study, we utilize the SPF forecasts made in 1992 onward.

Around the middle of every quarter, the survey asks leading forecasting firms for their forecasts for the current (survey) quarter, and for the upcoming four quarters. Utilizing the individual responses, the survey then calculates the consensus (both mean and median) forecasts and releases them sometime before the end of the second month of the survey quarter. In line with other studies, we utilize the SPF consensus forecasts calculated as the *median* response of the individual forecasts. See Croushore (1993) for detailed information on the SPF.

Figure 1 presents the timeline of the forecasts. As noted,  $A_t$ ,  $A_{t+1}$ ,  $A_{t+2}$ ,  $A_{t+3}$ , and  $A_{t+4}$  are the actual interest rates (TBR or Aaa) for the respective quarters. With the forecast horizon  $f = 0, 1, 2, 3$ , and 4,  $P_{t+f}$  is the SPF forecast of  $A_{t+f}$  made around the middle of quarter  $t$ . In addition, we let  $R_t$  denote the most recent actual rate known at the time of the forecast, calculated as the average of the rates belonging to the first 10 days of the second month of the survey quarter. Then,  $R_{t+f} (=R_t)$  represents the comparable random walk forecast of  $A_{t+f}$  made around the middle of quarter  $t$ . Furthermore, we calculate the SPF (random walk) forecast of default spread as the SPF (random walk) forecast of Aaa minus the SPF (random walk) forecast of TBR.<sup>2</sup>

**Figure 1. The timeline of SPF and random walk forecasts.**

Notes:  $A_t$ ,  $A_{t+1}$ ,  $A_{t+2}$ ,  $A_{t+3}$ , and  $A_{t+4}$  represent the actual interest rate (TBR or Aaa) for the respective quarters. With the forecast horizon  $f = 0, 1, 2, 3$ , and 4,  $P_{t+f}$  and  $R_{t+f} (=R_t)$  are, respectively, the SPF and random walk forecasts of  $A_{t+f}$  made around the middle of quarter  $t$ .  $R_t$  is the average of daily interest rates (TBR or Aaa) for the first 10 business days of the second month of quarter  $t$ .



We focus on the SPF and random walk forecasts of TBR and Aaa that are made in the first quarter of 1992 through the fourth quarter of 2017 (1992Q1-2017Q4). As such, the sample periods for the current-quarter, one-, two-, three-, and four-quarter-ahead forecasts are, respectively, 1992Q1-2017Q4, 1992Q2-2018Q1, 1992Q3-2018Q2, 1992Q4-2018Q3, and 1993Q1-2018Q4. For simplicity, however, we use a single period (1993Q1-2017Q4) for evaluating the forecasts of TBR, Aaa, and default spread at all horizons.

#### 4. Forecast evaluation test results

In this section, we focus on answering the following five questions:

- (1) Are SPF forecasts of TBR, Aaa, and default spread free of systematic bias?
- (2) Do SPF forecasts of TBR, Aaa, and default spread beat the random walk benchmark?
- (3) Are SPF forecasts of TBR, Aaa, and default spread directionally accurate?
- (4) Are TBR and Aaa forecast errors orthogonal to SPF growth and inflation forecasts?
- (5) Do SPF inflation forecasts have directional predictive power for TBR and Aaa?

We answer the first four questions for the 1993Q1-2017Q4 period and the last question for the two sub-periods of 1993Q1-2007Q4 and 2008Q1-2017Q4. During the latter period (which includes the 2008 global financial crisis), monetary policy kept the federal funds rate unusually low. Both Swanson and Williams (2014) and Gilchrist, López-Salido, and Zakrajšek (2015) explore the changing behavior of long-term interest rates when the target federal funds rate hits the zero lower bound. Jarrow and Li (2014) further show that the Federal Reserve's quantitative easing reduced both the short- and long-term (<12 years) forward rates.

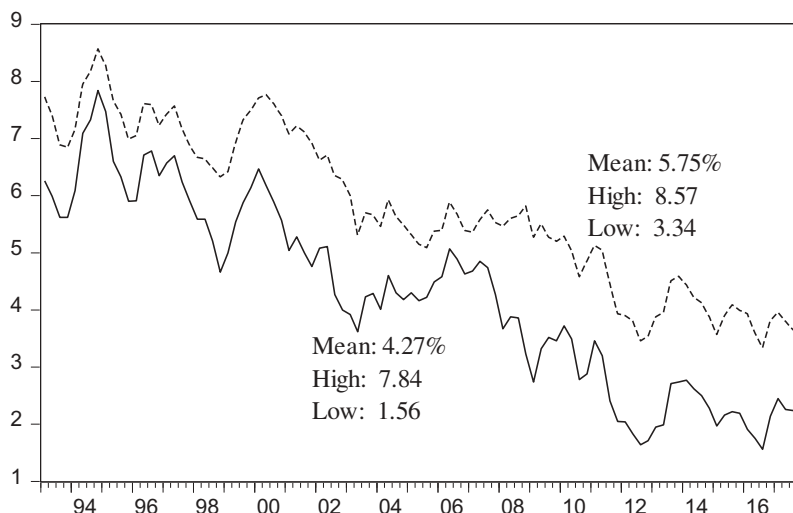
Figure 2 plots the actual TBR and Aaa for 1993Q1-2017Q4. As indicated, TBR has a mean rate of 4.27% with a high (low) rate of 7.84 (1.56), and Aaa has a mean rate of 5.75% with a high (low) rate of 8.57 (3.34). Additionally, Figure 3 plots the actual default spread (Aaa—TBR) for 1993Q1-2017Q4. As indicated, the spread has a mean rate of 1.48% with a high (low) rate of 2.59 (0.68).

##### 4.1. Are SPF forecasts of TBR, Aaa, and default spread free of systematic bias?

In answering, we estimate the following test equation,

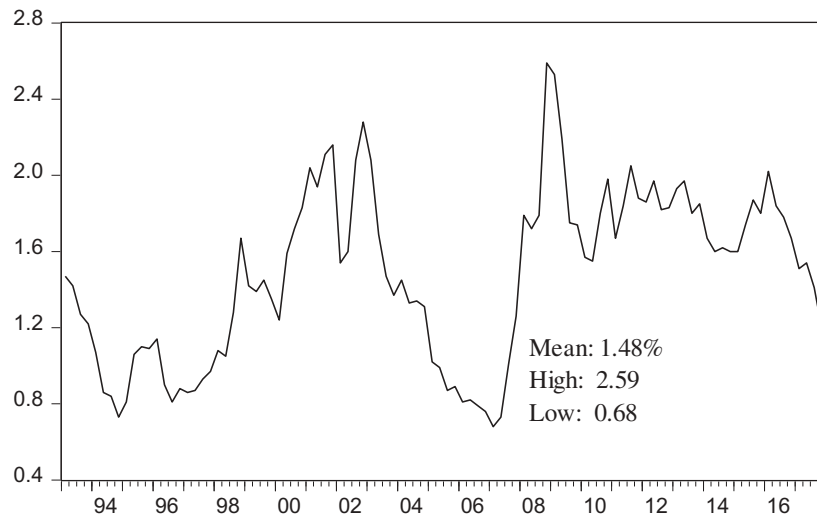
$$(A_{t+f} - P_{t+f}) = \alpha + u_{t+f} \quad (1)$$

**Figure 2. Time plots of TBR (solid line) and Aaa (dotted line): 1993Q1-2017Q4.**





**Figure 3. Time plot of default spread: 1993Q1-2017Q4.**



where  $(A_{t+f} - P_{t+f})$  is the SPF forecast error, and  $\alpha$  is the population mean forecast error (ME). The forecast  $(P_{t+f})$  is free of systematic bias if we cannot reject the null hypothesis that  $\alpha = 0$ . Since the forecasts are made in the middle of quarter  $t$ , the error term  $(u_{t+f})$  may follow an  $f^{\text{th}}$ -order moving average process under the null hypothesis of rationality.<sup>3</sup> In addition, the forecast errors are generally heteroscedastic due to unforeseen shocks. Accordingly, we estimate Equation (1) for  $f = 0$  using the White (1980) procedure, which accounts for the heteroscedasticity in the error term and, thus, yields the correct standard error. In estimating Equation (1) for  $f = 1, 2, 3$ , and 4, however, we obtain the correct standard errors by using the Newey-West (1987) procedure, which accounts for both the heteroscedasticity and the inherent  $f^{\text{th}}$ -order serial correlation in the error term.

Column 1 (rows 1–10) of Table 1 reports the OLS estimates of Equation (1) along with the absolute t-values (calculated using the correct standard errors) for TBR and Aaa. As shown by superscript **a**, we reject the null hypothesis that the population mean forecast error ( $\alpha = \text{ME}$ ) equals zero, meaning that the SPF forecasts of TBR and Aaa fail to be free of systematic bias. Consistent with these results, the absolute ME for each forecast, ranging from 0.054 to 0.617, is large compared to the mean absolute forecast error (MAE) in column 2, which ranges from 0.129 to 0.867. Column 1 (rows 11–15) further reports the OLS estimates of Equation (1) along with the correct absolute t-values for the SPF forecasts of the default spread (Aaa—TBR). The SPF spread forecasts for  $f = 0, 1$ , and 2 are free of systematic bias, but, as shown by superscript **a**, the ones for  $f = 3$  and 4 tend to significantly under-predict the actual spread.

#### 4.2. Do SPF forecasts of TBR, Aaa, and default spread beat the random walk benchmark?

In answering, we calculate Theil's  $U$  coefficient defined as the mean squared error (MSE) of the SPF forecast divided by the MSE of the random walk forecast. Column 3 (rows 1–10) of Table 1 reports the  $U$  coefficient estimates for both TBR and Aaa. As can be seen, these estimates, ranging from 1.44 to 2.12, are all above one. We use the Diebold-Mariano (1995) test to examine the null hypothesis that the MSE of SPF forecast equals the MSE of the random walk forecast. As shown by superscript **b**, we reject the null hypothesis of equal forecast accuracy, meaning that the SPF forecasts of TBR and Aaa are all significantly less accurate than the random walk forecasts. With the  $U$  coefficient estimate of 1.63 in row 11, the same is true for the current-quarter forecast of the spread. However, for the one- through four-quarter-ahead SPF forecasts of the spread in rows 12–15, the  $U$  coefficient estimates range from 1.08 to 1.12, and we cannot reject the null hypothesis of equal forecast accuracy. Put together, we conclude that the SPF forecasts of TBR, Aaa, and default spread all fail to beat the random walk benchmark in terms of the MSE.



**Table 1. SPF forecast accuracy test results: 1993Q1-2017Q4**

$(A_{t+f} - P_{t+f}) = \alpha + u_{t+f}$					
		$\alpha$ (=ME)	MAE	$U$	$\pi$
Row no.	$f$	(1)	(2)	(3)	(4)
10-year Treasury rate					
1	0	-0.061 <sup>a</sup> (3.64)	0.140	1.58 <sup>b</sup>	0.52
2	1	-0.202 <sup>a</sup> (4.03)	0.445	1.47 <sup>b</sup>	0.33
3	2	-0.338 <sup>a</sup> (4.06)	0.613	1.44 <sup>b</sup>	0.42
4	3	-0.478 <sup>a</sup> (4.32)	0.749	1.49 <sup>b</sup>	0.44
5	4	-0.617 <sup>a</sup> (4.75)	0.867	1.49 <sup>b</sup>	0.44
Moody's Aaa corporate bond rate					
6	0	-0.054 <sup>a</sup> (3.50)	0.129	2.12 <sup>b</sup>	0.55
7	1	-0.172 <sup>a</sup> (4.30)	0.362	1.58 <sup>b</sup>	0.36
8	2	-0.284 <sup>a</sup> (4.13)	0.512	1.53 <sup>b</sup>	0.43
9	3	-0.384 <sup>a</sup> (4.15)	0.611	1.53 <sup>b</sup>	0.44
10	4	-0.491 <sup>a</sup> (4.45)	0.705	1.56 <sup>b</sup>	0.43
Default spread					
11	0	0.007 (0.70)	0.070	1.63 <sup>b</sup>	0.60 <sup>c</sup>
12	1	0.030 (1.18)	0.188	1.12	0.55
13	2	0.054 (1.28)	0.259	1.06	0.55
14	3	0.094 <sup>a</sup> (1.65)	0.308	1.07	0.51
15	4	0.126 <sup>a</sup> (1.82)	0.332	1.08	0.54

$A_{t+f}$  is the actual rate in quarter  $t + f$  and  $P_{t+f}$  is the SPF forecast of  $A_{t+f}$ . Numbers in parentheses are the absolute  $t$ -values (calculated using the correct standard errors). Superscript <sup>a</sup> indicates significance at the 10% or lower level. ME is the mean forecast error, and MAE is the mean absolute forecast error. Theil's  $U$  coefficient is calculated as the MSE of the SPF forecast divided by the MSE of the random walk forecast. Superscript <sup>b</sup> indicates that the  $p$ -value of the Diebold and Mariano (1995) test, which examines the null hypothesis that the MSE of SPF forecast equals the MSE of random walk forecast, is below 0.10.  $\pi$  is the directional accuracy rate, where the actual change in interest rates is  $(A_{t+f} - R_t)$  and the SPF predicted change is  $(P_{t+f} - R_t)$ . Superscript <sup>c</sup> indicates that the  $p$ -value is below 0.10, for testing the null hypothesis that  $\pi = 0.50$  against the alternative that  $\pi > 0.50$ .

#### 4.3. Are SPF forecasts of TBR, Aaa, and default spread directionally accurate?

In answering this question, we define the actual change as  $(A_{t+f} - R_t)$  and the SPF predicted change as  $(P_{t+f} - R_t)$ . Column 4 of Table 1 reports the accuracy rate ( $\pi$ ), which is calculated as the number of quarters in which  $(A_{t+f} - R_t)$  and  $(P_{t+f} - R_t)$  have the same sign divided by the sample size. In line with Greer (1999), we use the proportion test to see whether the accuracy rate of SPF forecasts is significantly greater than the 50% benchmark that one expects from tossing a fair coin to predict directional change. As can be seen,  $\pi$  is above 0.50 only for the forecasts in rows 1, 6, and 11–15. Among these forecasts, as shown by superscript <sup>c</sup>, we reject the null hypothesis of  $\pi = 0.50$  in favor of the alternative that  $\pi > 0.50$  only for the current-quarter forecast of the spread in row 11. The remaining forecasts fail to accurately predict directional change.

#### 4.4. Are TBR and Aaa forecast errors orthogonal to SPF growth and inflation forecasts?

Orthogonality means that the forecast error is uncorrelated with the relevant information available at the time of the forecast. This occurs when the forecasters *efficiently* utilize all available relevant information. In answering, we thus estimate the following test equation,

$$(A_{t+f} - P_{t+f}) = \alpha + \beta (Y_{t+f-t-1} Y_{t+f}) + \gamma (I_{t+f-t-1} I_{t+f}) + u_{t+f} \quad (2)$$

where  $(A_{t+f} - P_{t+f})$  represents the SPF forecast error of TBR and Aaa,  $Y_{t+f-t-1} Y_{t+f}$  is the SPF forecast of output growth made in the middle of quarter  $t$  (quarter  $t-1$ ), and  $I_{t+f-t-1} I_{t+f}$  is the SPF inflation

**Table 2. Orthogonality test results: 1993Q1-2017Q4**

Row no.	$f$	$\alpha$	$\beta$	$\gamma$	$R^2$
Panel A: SPF forecasts errors: $(A_{t+f} - P_{t+f}) = \alpha + \beta (Y_{t+f-t-1}Y_{t+f}) + \gamma (I_{t+f-t-1}I_{t+f}) + u_{t+f}$					
10-year Treasury rate					
1	0	-0.062 <sup>a</sup> (3.99)	-0.007 (0.63)	0.036 <sup>a</sup> (3.65)	0.14
2	1	-0.206 <sup>a</sup> (4.17)	-0.009 (0.27)	0.080 <sup>a</sup> (4.12)	0.09
3	2	-0.348 <sup>a</sup> (4.13)	-0.001 (0.03)	0.102 <sup>a</sup> (3.16)	0.09
4	3	-0.494 <sup>a</sup> (4.32)	-0.003 (0.06)	0.100 <sup>a</sup> (2.48)	0.06
5	4	-0.625 <sup>a</sup> (4.68)	-0.022 (0.46)	0.081 <sup>a</sup> (1.88)	0.03
Moody's Aaa corporate bond rate					
6	0	-0.056 <sup>a</sup> (3.79)	-0.016 (1.58)	0.028 <sup>a</sup> (3.73)	0.11
7	1	-0.171 <sup>a</sup> (4.36)	-0.037 (1.54)	0.059 <sup>a</sup> (3.89)	0.08
8	2	-0.282 <sup>a</sup> (4.08)	-0.042 (1.17)	0.078 <sup>a</sup> (2.78)	0.08
9	3	-0.386 <sup>a</sup> (4.03)	-0.036 (0.83)	0.081 <sup>a</sup> (2.32)	0.06
10	4	-0.487 <sup>a</sup> (4.25)	-0.048 (1.14)	0.073 <sup>a</sup> (1.94)	0.05
Panel B: Random walk forecasts errors: $(A_{t+f} - R_{t+f}) = \alpha + \beta (Y_{t+f-t-1}Y_{t+f}) + \gamma (I_{t+f-t-1}I_{t+f}) + u_{t+f}$					
10-year Treasury rate					
11	0	-0.027 <sup>a</sup> (2.02)	-0.008 (0.85)	0.019 (1.25)	0.06
12	1	-0.077 <sup>a</sup> (1.75)	0.007 (0.25)	0.062 <sup>a</sup> (3.33)	0.08
13	2	-0.130 <sup>a</sup> (1.79)	0.059 (1.47)	0.067 <sup>a</sup> (2.21)	0.10
14	3	-0.189 <sup>a</sup> (1.90)	0.066 (1.41)	0.065 <sup>a</sup> (1.65)	0.07
15	4	-0.234 <sup>a</sup> (1.94)	0.068 (1.39)	0.044 (1.16)	0.05
Moody's Aaa corporate bond rate					
16	0	-0.011 (1.00)	-0.003 (0.42)	0.018 (1.44)	0.08
17	1	-0.057 <sup>a</sup> (1.68)	-0.019 (0.86)	0.050 <sup>a</sup> (2.85)	0.08
18	2	-0.104 <sup>a</sup> (1.74)	-0.013 (0.41)	0.060 <sup>a</sup> (2.29)	0.05
19	3	-0.152 <sup>a</sup> (1.86)	-0.016 (0.43)	0.064 <sup>a</sup> (1.99)	0.04
20	4	-0.195 <sup>a</sup> (1.99)	-0.026 (0.67)	0.058 <sup>a</sup> (1.95)	0.03

See the notes in Table 1.  $(A_{t+f} - P_{t+f})$  is the SPF forecast error and  $(A_{t+f} - R_{t+f})$  is the random walk forecast error.  $(Y_{t+f-t-1}Y_{t+f})$  is the change in SPF forecast of output (real GDP) growth and  $(I_{t+f-t-1}I_{t+f})$  is the change in SPF forecast of CPI inflation.

forecast made in the middle of quarter  $t$  (quarter  $t-1$ ). Failure to reject the null hypothesis that  $\beta = 0$  ( $\gamma = 0$ ) means that the SPF forecast error  $(A_{t+f} - P_{t+f})$  is not orthogonal to the change in SPF output growth (inflation) forecasts known at the time of the forecast.

Rows 1–10 of Table 2 report the OLS estimates of Equation (2) along with the correct absolute  $t$ -values for both TBR and Aaa for 1993Q1-2017Q4. As can be seen for all forecasts in rows 1–10, we reject the null hypothesis that  $\gamma = 0$ , but we cannot reject the null hypothesis that  $\beta = 0$ . This means that the SPF forecast errors of TBR and Aaa are all orthogonal to the change in SPF output growth forecasts, but fail to be orthogonal to the change in SPF inflation forecasts. Such evidence suggests that the change in SPF inflation forecasts contains useful information for improving the accuracy of the SPF forecasts of TBR and Aaa.

To augment these results, we further investigate whether the random walk forecast errors of TBR and Aaa are orthogonal to changes in SPF growth and inflation forecasts by estimating the following test equation,

$$(A_{t+f} - R_{t+f}) = \alpha + \beta (Y_{t+f-t-1}Y_{t+f}) + \gamma (I_{t+f-t-1}I_{t+f}) + u_{t+f} \quad (3)$$

where  $(A_{t+f} - R_{t+f})$  represents the random walk forecast error of TBR and Aaa. Rows 11–20 of Table 2 report the OLS estimates of Equation (3) along with the correct absolute t-values for both TBR and Aaa for 1993Q1–2017Q4. As can be seen for these forecasts, we cannot reject the null hypothesis that  $\beta = 0$ . This means that the random walk forecast errors of TBR and Aaa are all orthogonal to the change in SPF output growth forecasts. However, for the forecasts in rows 12–14 and 17–20, we reject the null hypothesis that  $\gamma = 0$ . Such findings point to the potential usefulness of SPF inflation forecasts in improving the accuracy of both the one- through three-quarter-ahead random walk forecasts of TBR and the one- through four-quarter-ahead random walk forecasts of Aaa.

#### 4.5. Do SPF inflation forecasts have directional predictive power for TBR and Aaa?

Following the orthogonality test results in rows 11–20 of Table 2, we now want to see whether the change in SPF inflation forecasts accurately predicts the direction of change in TBR and Aaa. We define the actual change in TBR and Aaa as  $(A_{t+f} - R_t)$  and the change in SPF inflation forecast as  $(I_{t+f} - {}_{t-1}I_{t+f})$ . We calculate the directional accuracy rate as the number of quarters in which  $(A_{t+f} - R_t)$  and  $(I_{t+f} - {}_{t-1}I_{t+f})$  have the same sign divided by the sample size. Table 3 reports the results for TBR (Aaa) in column 1 (column 3) for 1993Q1–2007Q4, and in column 2 (column 4) for 2008Q1–2017Q4. Again, we use the proportion test to see whether the accuracy rate is significantly greater than the 50% benchmark that one expects from tossing a fair coin to predict the direction of change (Greer, 1999). As can be seen in columns 1 and 3 for 1993Q1–2007Q4,  $\pi$  (ranging from 0.47 to 0.57) is not significantly differently from 0.50. As shown in columns 2 and 4, the same is true for the current-quarter and one-quarter-ahead forecasts of TBR and Aaa for 2008Q1–2017Q4. For the two-, three-, and four-quarter-ahead forecasts of TBR and Aaa in rows 3–5 (columns 2 and 4), however,  $\pi$  ranges from 0.61 to 0.68. For these forecasts, as shown by superscript c, we reject the null hypothesis of  $\pi = 0.50$  in favor of the alternative that  $\pi > 0.50$ . As such, we conclude that changes in SPF inflation forecasts accurately predict directional change in both TBR and Aaa at longer forecast horizons only for 2008–2017.

#### 5. Conclusions

Diebold and Lopez (1996) point out that, for many economic and financial indicators, a random walk forecast is not necessarily a naïve forecast. This is especially true for long-term interest rates and exchange rates (Rossi, 2013).<sup>4</sup> With this in mind, our findings for 1993–2017 indicate that the SPF forecasts of the 10-year Treasury rate (TBR) and Moody's Aaa corporate bond rate (Aaa) are biased and fail to beat the random walk benchmark. These forecasts are also directionally inaccurate and, thus, are not of value to a user (Leitch & Tanner, 1991; Stekler, 1994). Such evidence is consistent with Kolb and Stekler (1996), Greer (1999), Greer (2003), and Cho (1996) who find little or no evidence indicating that survey forecasts of long-term interest rates are directionally accurate. Further examination indicates that the SPF default spread (Aaa—TBR) forecasts fail to beat the random walk benchmark and

**Table 3. Directional accuracy test results of SPF inflation forecasts for TBR and Aaa**

		10-year Treasury rate		Moody's Aaa corporate bond rate	
		1993Q1-2007Q4	2008Q1-2017Q4	1993Q1-2007Q4	2008Q1-2017Q4
Row no.	<i>f</i>	(1)	(2)	(3)	(4)
1	0	0.52	0.53	0.47	0.55
2	1	0.57	0.58	0.57	0.53
3	2	0.52	0.68 <sup>c</sup>	0.50	0.63 <sup>c</sup>
4	3	0.49	0.65 <sup>c</sup>	0.49	0.65 <sup>c</sup>
5	4	0.53	0.61 <sup>c</sup>	0.48	0.63 <sup>c</sup>

Numbers are directional accuracy rates, where the actual change in TBR or Aaa is  $(A_{t+f} - R_t)$  and the change in SPF inflation forecast is  $(I_{t+f} - {}_{t-1}I_{t+f})$ . Superscript c indicates that the *p*-value is below 0.10, for testing the null hypothesis that  $\pi = 0.50$  against the alternative that  $\pi > 0.50$ .

are directionally inaccurate. Such findings are consistent with Baghestani (2009b) who examines the Blue Chip forecasts of the default spread.<sup>5</sup>

One source of inaccuracy commonly cited in the literature is the failure of survey participants to incorporate useful and relevant information available at the time of the forecast. This implies that there is room for improving the survey forecasts of interest rates. Baghestani (2005) shows that the predictive information contained in the survey forecasts of inflation and output growth can help improve the accuracy of survey forecasts of the 3-month Treasury rates. Motivated by such evidence, we examine whether the TBR and Aaa forecast errors are orthogonal to changes in SPF inflation and output growth forecasts. Our findings for 1993–2017 indicate that the SPF forecast errors of TBR and Aaa fail to be orthogonal to changes in SPF inflation (but not growth) forecasts. Further examination also indicates that the random walk forecast errors of TBR and Aaa generally fail to be orthogonal to changes in SPF inflation (but not growth) forecasts.

Given the latter orthogonality test results, we further examine whether changes in SPF inflation forecasts accurately predict the direction of change in TBR and Aaa for the two sub-periods of 1993–2007 and 2008–2017. Our findings for 1993–2007 indicate that changes in SPF inflation forecasts do not accurately predict directional change in either TBR or Aaa. However, for 2008–2017 when monetary policy kept the federal funds rate unusually low, changes in SPF inflation forecasts accurately predicted directional change in both TBR and Aaa at longer forecast horizons. Put together, our findings point to the potential usefulness of SPF inflation forecasts for improving the accuracy of both SPF and random walk forecasts of TBR and Aaa. Equally important, our results indicate that changes in SPF inflation forecasts accurately predict directional change in both TBR and Aaa at longer forecast horizons for 2008–2017 (but not for 1993–2007). These latter findings raise the question of whether long-term interest rates have become easier to predict, which deserves subsequent research.

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#### Notes

1. The inflation forecasts from the Michigan survey of consumers have been shown to contain useful predictive information for energy prices (See, among others, Baghestani, 2014a, 2015).
2. The actual quarterly data on both TBR and Aaa are averages of daily rates from the Federal Reserve Bank of St. Louis database (<https://fred.stlouisfed.org>). The SPF forecasts of TBR, Aaa, CPI inflation, and output (real GDP) growth come from the Federal Reserve Bank of Philadelphia database (<https://www.philadelphiafed.org>).

3. When making the four-quarter-ahead forecast, for instance,  $u_{t+3}$ ,  $u_{t+2}$ ,  $u_{t+1}$ , and  $u_t$  are not yet known at the time of the forecast and, as such, we cannot rule out the possibility that  $u_{t+4}$  is correlated with  $u_{t+3}$ ,  $u_{t+2}$ ,  $u_{t+1}$ , and  $u_t$  under the null hypothesis of rationality.
4. For instance, in line with Reichenstein (2006), Baghestani (2008a) shows that the random walk forecasts of the US 30-year mortgage rate for 1987–2006 are rational. Baghestani (2009a) reaches a similar conclusion for the random walk forecasts of the dollar/euro for 1999–2007 and the dollar/pound for 1971–2007.
5. The literature generally reports favorable results for the survey forecasts of term spreads (defined as the difference between long-term and short-term interest rates), interbank loan spreads (defined as the 3-month London interbank offered rate and the federal funds rate), and mortgage spreads (defined as the difference between the 30-year mortgage and 10-year Treasury rates). See, among others, Baghestani (2009c, 2010b, 2018).

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