Another Look at Short-Term Interest Rate as a Predictor of Inflation

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Abstract

Studies show the implementation of Trade Reporting And Compliance Engine (TRACE) led to a more efficient bond market (see for example, Bessembinder, Maxwell, and Venkataraman (2006) and Edwards, Harris, and Piwowar (2007)). In view of this finding, our paper uses data following the launch of TRACE and reexamines the Fisher effect in the form of Fama's (1975) joint hypotheses: in the long-run, the real rate of interest is approximately constant, with changes in the Treasury bill rate reflecting changes in expected inflation rate one-for-one, and that the market for U.S. Treasury bills is efficient. We find a significant positive relation between the nominal rate and inflation rate. However, the relationship is not one-for-one as proposed by Fisher. Thus our result is inconsistent with that of Fama, but consistent with the findings of McMinn and Kim (1985), and Boyd, Jalal, and Pokorny (2015). Further, this finding is contrary to our expectation since the implementation of TRACE supposedly improved bond market efficiency. Therefore, we believe the Treasury bill rate, which is our proxy for short-term interest rate, is not a good predictor of expected inflation.

JEL Classification: E43, G14
Key words: Fisher-Effect, TRACE, nominal interest rate, inflation, and real rate.

1. Introduction

Fisher (1930) postulates that in the long run, the real rate of interest (r*) is approximately constant, and is determined largely by the marginal product of capital and the time preference of economic agents, with changes in the nominal interest rate reflecting changes in the rate of inflation one-for-one. This hypothesis is the so-called Fisher Effect. Since its inception, several economists have tested its validity with conflicting results.

A possible explanation for the inconsistency in results could be due to lack of internal efficiency in the bond market at the time. In July 2002, the National Association of Securities Dealers (NASD) implemented a reporting system known as Trade Reporting And Compliance Engine or TRACE. Following its implementation, a number of studies report declines in execution costs on bond transactions. For example, Bessembinder, Maxwell, and Venkataraman

(2006) analyzes the cost of execution of a sample of institutional trades in corporate bonds before and after the implementation of the TRACE reporting system. The study finds a decline of approximately 50% in execution costs following the initiation of TRACE. In a similar study, Edwards, Harris, and Piwowar (2007) estimates the average transaction cost as a function of trade size for bonds that traded between January 2003 and January 2005, and reports lower transaction costs for bonds after the TRACE system disseminated prices publicly. As these studies show, greater transparency in reporting transaction data in bond markets leads to lower transaction costs, which by definition, improves market efficiency[1].

The implementation of the TRACE reporting system presumably improves market efficiency. Therefore, we believe reexamining the Fisher effect using data following the launch of the TRACE reporting system will contribute to the literature, and possibly help resolve the conflict. The rest of the paper proceeds as follows: Section 2 reviews previous studies on this subject; Section 3 discusses the data and methodology; section 4 reports the results; and section 5 concludes.

2. The Fisher Effect and Its Testing

To ascertain its validity or otherwise, several academic researchers have tested the Fisher effect with mixed results. Jaffe and Mandelker (1976) reports a negative relationship between stock returns and inflation over a short sample period, but a positive relationship in a much longer period (1875 – 1970). This latter positive relationship between stock returns and inflation is consistent with Boudoukh and Richardson (1993), who finds evidence suggesting long run nominal stock returns are positively related to long term inflation rates. Geske and Roll (1983) applies the Fisher effect to common stocks and finds a negative relation between stock returns and inflation. This result is contrary to the Fisher hypothesis.

Anari and Kolari (2001) analyzes stocks and goods prices from 1953 through 1998 in six industrial countries. The paper reports long-run Fisher elasticities of stock prices with respect to goods prices of greater than one, adding support to the Fisher effect. Wong and Wu (2003) uses data from G7 and eight Asian countries to study the Fisher effect. The study finds support for the Fisher effect, and at the same time documents a positive relation between long run stocks returns and expected inflation, but not contemporaneous inflation.

Using Israeli inflation rates, and prices of index and nominal bonds from September 1984 through March 1992, Kandel, Ofer, and Sarig (1996) documents a negative relation between ex-ante real interest rate and expected inflation. This finding contradicts the Fisher hypothesis. In addition, the paper reports that nominal interest rates include a risk premium on inflation.
In another study, Fuei (2007) uses the Singaporean 3-month interbank interest as a proxy for the nominal interest rate and employs Johansen's cointegration analysis to determine the existence of a long-run Fisher effect in the Singaporean economy covering the period 1976 through 2006. The paper finds evidence of a positive relation between nominal interest rate and inflation rate. Employing quarterly data form 2001 to the second quarter of 2012, Ray (2012) documents evidence supporting a partial Fisher effect in the U. S. in a sense that the regression coefficient is

[1] Reilly and Brown (2012, pp. 97) notes that a number of microeconomic textbooks define an efficient market as one with minimal transaction cost – internal efficiency.

significantly different from the theoretical value of unity. However, the paper does not find support for the Fisher effect in selected Asian countries within the same time frame.

Using data on Treasury bill rates and consumer price index from 1953 through 1971, Fama (1975) finds evidence supporting the Fisher effect in a form of a joint hypothesis stating: the real rate of interest (r*) is constant and that the market for U. S. Treasury bills is efficient. Like Fisher's work, Fama's (1975) test on the Fisher hypothesis was not without criticism. In a commentary to Fama's (1975) publication, Carlson (1977) rejects Fama's joint hypotheses, and concludes that short-term interest rate variations are not capable of predicting variations in inflation rates. Furthermore, using data from 1953 through 1983, McMinn and Kim (1985) re-estimates Fama's (1975) model and documents inconsistent results from that of Fama.
In a general equilibrium setting, Boyd, Jalal, and Pokorny (2015) shows that the Fisher effect does not hold for corporate debt. The paper reports that although interest rate on corporate debt and inflation are directly related, it is less than the one-for-one relationship hypothesized by Fisher.

Utilizing monthly data on inflation rates and one- to twelve-month U. S. Treasury bills from 1964 through 1986, Mishkin (1992) reexamines the relationship between inflation and interest rates, and finds no support for a short run Fisher effect, but documents evidence supporting the existence of a long run Fisher effect.

Westerlund (2008) applies cointegration techniques to a panel data on twenty countries from the Organization of Economic Cooperation and Development (OECD). The analysis uses each country's short-term nominal interest rate and consumer price index for a period covering 1980 through 2004, and reports evidence indicating the Fisher hypothesis cannot be rejected. Using either the Treasury bill rate or the lending rate, and the consumer price index for each of a sample of twenty-six countries, Berument and Jelassi (2002) tests the Fisher effect. For more than half the countries studied, the paper finds support for a one-to-one relationship between the interest rate and inflation.

In a structural vector autoregression framework, Rapach (2003) analyzes the effects that a permanent change in inflation could have on the long-run real rate of interest in 14 industrialized countries. The study notes that the long-run nominal interest rate adjusts less than one-for-one to a permanent increase in inflation, thereby lowering the long-run real interest rate.
By applying the King and Watson (1997) methodology[2] to post-war quarterly data on 11 countries, Koustas and Serletis (1999) examines the relationship between short-term interest rates and inflation, and reports evidence rejecting the long-run Fisher effect.

Fisher and Seater (1993) purports that tests of the Fisher effect are possible if inflation and interest rate series are integrated of order one, and do not cointegrate. However, in a study of the long-run Fisher effect in 17 industrialized countries, Jensen (2009) argues that inflation is not integrated of order one or larger. The paper concludes that the inability of inflation to follow a nonstationary unit-root is the reason past research on the long-run Fisher effect failed to support

[2] This methodology pays particular attention to the integration and cointegration properties of the variable under consideration.

the hypothesis.

The brief review of related studies on the long-run Fisher effect shows the evidence is clearly mixed. Though Jensen (2009) offers a reason why past research do not support the long-run Fisher effect, the study uses data in the pre-TRACE period. Considering the significance of the Fisher effect in financial economic theories, and its implications for financial policy regarding interest rates, we believe a further examination of this important subject will make a positive contribution to the body of literature in this area.

3. Hypotheses

It is clear from the foregoing section that most studies on the Fisher effect use either common stock returns or T-bill (or corporate bond) rate as a proxy for the nominal rate of return. For example, whereas Boudoukh and Richardson (1993), Anari and Kolari (2001), Wong and Wu (2003) report a positive relationship between nominal stock returns and inflation rate, and thus indirectly supporting the Fisher hypothesis, Geske and Roll (1983), Jaffe and Mandelker (1976), Kandel, Ofer, and Sarig (1996) document a negative relationship between stock returns and inflation. Using Treasury bill rate (or corporate bond rate) as a proxy for the nominal interest rate, papers supporting the Fisher hypothesis include Fama (1975), Berument and Jelassi (2002), and Westerlund (2008), while studies not supporting the hypotheses include Carlson (1977), McMinn and Kim (1985), Mishkin (1992), Rapach (2003), Koustas and Serletis (1999), and Boyd et al. (2015).

Of particular interest to this study is that of Fama (1975), who finds evidence supporting the Fisher effect in the form of a joint hypotheses that states:
In the long run, the real rate of interest (r) is constant, with movements in the nominal interest rate reflecting movements in the rate of inflation one-for-one, and that the market for U. S. Treasury bills is efficient*.

Like Fisher's work, Fama's (1975) test on the Fisher hypothesis was not without criticism. In a commentary to Fama's (1975) publication, Carlson (1977) rejects Fama's joint hypotheses, and concludes that short-term interest rate variations are not capable of predicting variations in inflation rates. Furthermore, using data from 1953 through 1983, McMinn and Kim (1985) re-estimates Fama's (1975) model and documents inconsistent results from that of Fama. Thus the present study extends this line of research and tests Fama's joint hypotheses with more recent data than the previous studies.

4. Data and Methodology

4.1 Data

Our data, obtained from two sources, covers the period 06/01/1987 through 09/01/2017, and comprises of 364 observations. Monthly returns data on 3-month Treasury bills is obtained from the Federal Reserve System (www.federalreserve.gov), and becomes our proxy for the nominal interest rate, r_t. Next, we obtain monthly Consumer Price Index (CPI) data from the Bureau of Labor Statistics (www.bls.gov). For the purpose of the least square regression analysis, we convert the CPI data into monthly inflation rates. Since TRACE was officially launched in July of 2002, we divide our sample into two subsamples: the period before the launch, 06/01/87 – 07/01/02, and the period after the launch, 08/01/02 – 09/01/17, resulting in 182 observations for each sub-period.

Table 1 reports descriptive statistics on our data. Panel A depicts key statistics on the independent variable, the monthly return on 3-month Treasury bills, while panel B reports statistics on the dependent variable, the monthly inflation rate. A paired t-test was performed for the two subsample periods (06/01/87 – 07/01/02 and 08/01/02 – 09/01/17) on each of the two variables. In each case, the null hypothesis of no significant difference between means (for the two sub-periods) was rejected at the 5% significance level in favor of the alternative.

4.2 Methodology

In his 1975 paper, Fama tested the joint hypotheses of the real rate of interest (r^*) being constant and the efficiency of the U. S. Treasury bills market. Our methodology follows that of McMinn and Kim (1985), who closely followed Fama's work.
Like McMinn and Kim (1985), we will test the Fisher effect by examining the relationship between the nominal interest rate (r), which is the rate of return on a 3-month Treasury bill, and inflation rate (I). Following the analysis in McMinn and Kim (1985), we let r_t be the nominal return (set at time $t-1$) on a T-bill that matures at time t. Next, let r^*_t be the real return and $\hat{r}_t^*|\varphi_{t-1}$ be its expected value given the information set φ_{t-1} available at time $t-1$. Finally, let $\hat{I}_t|\varphi_{t-1}$ be the expected value of the inflation rate, I_t, which is observable on the basis of the information set φ_{t-1}. Note that the nominal return on the bill, $r_t = (p_t - p_{t-1})/p_{t-1}$, is known at time $t-1$ since both the purchase price (p_{t-1}) and the face value of the bill (p_t) are known at time $t-1$. However, the real rate of return, r^*_t, which is approximately $(r_t - I_t)$, is a random variable at time $t-1$ since I_t, the inflation rate at time t, is uncertain at time $t-1$.

> As noted by both Fama (1975) and McMinn and Kim (1985), if the expected value of the real rate of interest is constant over time, and assuming the market for Treasury bills is efficient to the extent that the market correctly incorporates all available information in assessing the expected inflation rate, then the nominal return, r_t on the bill is the sum of the constant expected real rate of interest, $\hat{r}_t^*$ and the expected inflation rate, $\hat{I}_t|\varphi_{t-1}$,

$$r_t = \hat{r}_t^* + \hat{I}_t|\varphi_{t-1} \qquad (1)$$

Expressing expected inflation explicitly from equation 1 gives

$$\hat{I}_t|\varphi_{t-1} = -\hat{r}_t^* + r_t \qquad (2)$$

From the above, as long as the expected real rate of interest, $\hat{r}_t^*$, is constant for all t, all variations over time in the nominal rate, r_t, directly reflects all variations in the expected inflation rate.

Furthermore, under the assumption that the market is efficient, the information contained in φ_{t-1} is fully utilized in setting the value of the nominal return, r_t. In view of this, Fama (1975) notes "the nominal rate r_t observed at t-1 is the best possible predictor of the rate of inflation from t-1 to t." For the purpose of testing these hypotheses, equation 2 is expressed as a regression model,

$$I_t = \alpha_0 + \alpha_1 r_t + \varepsilon_t \qquad (3)$$

where ε_t is a random error term.

If our data is to support the joint hypotheses of the real rate of interest being constant, and that the market for T-bills is efficient, then the following has to be true:
the coefficient of r_t, α_1, should not be significantly different from unity, and
the intercept term, α_0, should be negative and significantly different from zero.

5. Results

We re-examined Fama's (1975) joint hypotheses by estimating equation 3 using data following the implementation of the TRACE reporting system. The reasoning is that the TRACE reporting system enhances market efficiency. Just like Fama, we derive inflation rate from Consumer Price Index (CPI), and use the 3-month T-bill rate as the nominal interest rate. Though the main focus of this study is on the post-TRACE period, we include in our analysis, the period before the launch, and also a combination of the two sub-sample periods.

Panels A, B, and C of Figure 1 plot inflation residuals on predicted inflation for the period before and after the implementation of TRACE, and the whole sample period. Clearly, the model appears to be adequate since the residuals are randomly scattered (without any discernable pattern) around a reference line at zero in all three panels. Plots of residuals against time (not reported here) reveal no pattern, indicating the residuals are not autocorrelated. Similarly, a histogram of the standardized residuals appears to have the 'normal' shape.

Table 3 reports the ordinary least square regression results. For the post-TRACE period, the coefficient (α_1) of the nominal return is significantly different from unity (less than 1.0 by more than two standard errors). In addition, the intercept term, α_0, though statistically significant at the 1 percent level, does not have the correct sign. The pre-TRACE period has similar result except the coefficient on the intercept term is not statistically significant. The result for the whole sample period mimics that of the post-TRACE period. Overall, our result is consistent with that of McMinn and Kim (1985), Boyd et al. (2015), and Carlson (1977), but inconsistent with Fama (1975).

Table 2 depicts the correlation matrix for Federal funds, 3-month, and 6-month T-bill rates. Due to the near perfect positive correlation among these variables, we re-estimate equation 3 with the Federal funds rate, and the 6-month T-bill rates as independent variables. The results, not reported here, are indistinguishable from that reported on Table 3.

Though our findings reveal a significant positive relation between inflation rate and nominal interest rate, it is less than the one-for-one relationship proposed by Fisher (1930). Certainly, this is contrary to our expectation since TRACE reporting system enhances market efficiency with its concomitant reduction in transaction costs. With more rapid dissemination of information and reduction in transaction costs, one would have expected a one-for-one relationship between inflation and nominal interest rate during the post-TRACE period.

6. Conclusion

Using data following the implementation of the TRACE reporting system, this study reexamines the long-run Fisher effect in the form of Fama's (1975) joint hypotheses: in the long-run, the real rate of interest is approximately constant, with changes in the Treasury bill rate reflecting changes in expected inflation rate one-for-one, and that the market for U.S. Treasury bills is efficient. We find a significant positive relation between the nominal interest rate and the inflation rate. However, the relationship is less than the one-for-one relationship proposed by Fisher. Thus our result is inconsistent with that of Fama, but consistent with the findings of McMinn and Kim (1985) and Boyd et al. (2015). Since the implementation of TRACE supposedly improved bond market efficiency, this finding is contrary to our expectation. As a result, we believe the Treasury bill rate, which is our proxy for short-term interest rate, is not a good predictor of expected inflation.

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Appendix

Table 1: Descriptive Statistics

Panel A: 3-Month Treasury Bill Returns

Sample Period	**06/01/87 – 07/01/02**	**08/01/02 – 09/01/17**	**06/01/87 – 09/01/17**
Mean	5.22478022	1.219066	3.221923
Mode	5.14	0.02	0.02
Minimum	1.68	0.01	0.01
Maximum	9.14	5.16	9.14
N	182	182	364

Panel B: Inflation Rates

Sample Period	**06/01/87 – 07/01/02**	**08/01/02 – 09/01/17**	**06/01/87 – 09/01/17**
Mean	0.256289893	0.173117	0.214703
Mode	0	0	0
Minimum	-0.280741157	-1.77055	-1.77055
Maximum	0.950118765	1.376849	1.376849
N	182	182	364

Table 2: Correlation Matrix

	3-month	Fed-Fund	6-month
3-month	1		
Fed-Fund	0.991754	1	
6-month	0.998168	0.990276	1

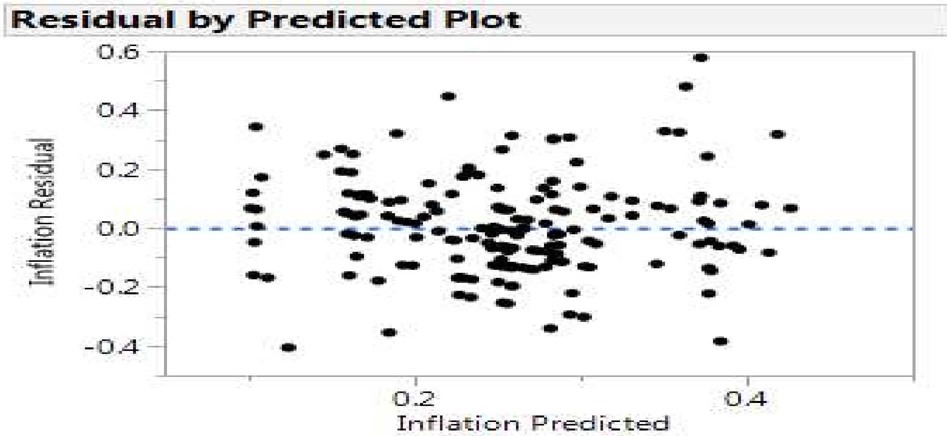
Table 3: Regression of Inflation Rate (I_t) on T-bill rate (r_t).

We regress monthly inflation rates, I_t (computed from consumer price index data) on monthly 3-month Treasury bill returns for the sub-sample periods 06/01/87 – 07/01/02, 08/01/02 – 09/01/17, and the whole sample period. Standard errors of the estimates are in parentheses.

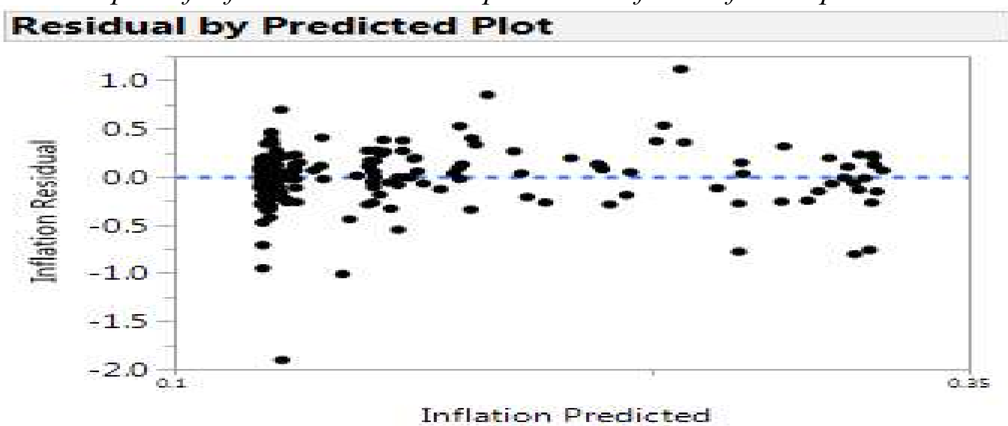
Period	α_0	α_1	F-statistic	R-Square	N
06/01/87 – 07/01/02	0.0290 (0.03902)	0.0435 (0.00711)	37.46	17.23%	182
08/01/02 – 09/01/17	0.1268 (0.02899)	0.0380 (0.01433)	7.03	3.8%	182
06/01/87 – 09/01/17	0.1216 (0.02082)	0.0289 (0.00503)	32.96	8.3%	364

Figure 1: Inflation Residuals vs. Predicted Inflation

Panel A: A plot of inflation residuals on predicted inflation for the period 06/1987 to 07/2002.



Panel B: A plot of inflation residuals on predicted inflation for the period 08/2002 to 09/2017.



Panel C: A plot of inflation residuals on predicted inflation for the period 06/1987 to 09/2017.