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Abstract:

This paper examines the forward premium puzzle based on 1-week forward rates across weekdays. The paper finds that Thursday consistently appears to be a special day on which the puzzle disappears, while it is present on other weekdays. In addition to Thursday, Monday is also found to be a similar special day for the Euro. The paper proposes that this Thursday effect (Monday effect for Euro) is caused by monetary announcements released constantly on Tuesday (Thursday) by the FOMC (the European Central Bank). The empirical tests provide convincing evidence in favor of the proposed explanation.

Keywords: Forward premium puzzle; Day-of-the-week-effect; Central Bank; Monetary announcements

JEL Classification: F31; G14; G15

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1. Introduction

One of the most extensively examined topics in international finance has been the efficiency of forward market for foreign exchange. From early studies such as Fama (1984), to more recent ones such as Meredith and Ma (2002), an enormous number of studies have shown the failure of forward exchange rate to serve as an unbiased predictor of future spot rate. In literature, the robustness of the puzzle has been tested in multiple aspects, including different time periods (e.g. Zhou and Kutan (2005)), different countries (e.g. Bansal and Dahlquist (2000)), different maturities (e.g. Chinn and Meredith (2004)), etc. This paper inspects the puzzle from a new angle—different weekdays. It is noticeable that the studies using forward rates with 1-week maturity usually take the observations on a particular weekday as the representative of that week, but no papers seem to concern if different weekday would generate inconsistent results. This paper adds to the literature by examining the day-of-the-week effect in the relationship between current forward rate and future spot rate.

The paper first tests the forward premium puzzle by using 1-week forward rates across weekdays. The results are interesting yet intriguing: there does exist an inconsistency across weekdays. Specifically, for all currencies, Thursday consistently appears to be a special day on which the puzzle disappears, while it is present on other weekdays. In addition, for Euro, Monday is also found to be a similar special day. These empirical findings, which have not been reported in literature before, can be called the *Thursday effect of forward premium puzzle*[1]. The further robust test shows that the effect is significant only when the span of sample period is long enough.

The paper attributes the effect to the monetary policy announcements made by the Federal Open Market Committee (the similar monetary policy committee in the European Central Bank) constantly on Tuesdays (Thursdays). The paper argues that the market expectation about future spot rate is dominantly affected by such fundamental information so that expectation error can be

[1] The paper will show that Monday effect of Euro is actually the European version of the Thursday Effect.

reduced and the future spot rate follows the relationship implied by the theory in the week when the information is released. Due to the delivery arrangement that the orders will be settled two business days after the transaction date in both the money market and foreign exchange market, when the information is released on Tuesday (Thursday in the European case), the arbitrage transactions conducted by the investors who want to speculate on the information will be completed two business days later, i.e. Thursday (Monday for Euro). Thus the relationship between future spot rate and current forward rate on Thursdays (Monday for Euro) is closer to the scenario described by the theory, and the puzzle seems to disappear on Thursdays (and also Monday for Euro). But since the FOMC does not meet every week (about eight times a year and once one month in the European case), the effect emerges only when the sample period is long enough. The empirical tests provide evidence supporting such an explanation.

The contributions of this paper are twofold. First, it provides new empirical evidence that deepens the forward premium puzzle. This evidence shows that the forward premium puzzle depends on the day of the week. Second, the paper proposes an explanation that has solid intuitive foundation. As summarized in Engle (1996), the explanations for the puzzle basically can be divided into two categories -- time varying risk premium and irrational expectations. And the findings in this paper tend to support the second category. The paper is also related to the literature of exchange rate dynamics. A lot of studies show that there is a lack of connection between spot rate and macroeconomic variables, but as shown in Simpson et. al (2005), the spot rate does respond to fundamental shocks such as the announcements of interest rate. The findings in the paper are consistent with such stylized facts.

The rest of the paper is structured as below: section 2 reports the new empirical evidences about the forward premium puzzle, section 3 proposes an explanation, section 4 tests the tentative explanation and section 5 concludes.

2. Empirical findings

The data employed in this paper were extracted from DataStream and contain dollar rates for several major currencies, including the Canadian Dollar (CAD), Euro (EUR) and Japanese Yen (JPY). Both spot and 1-week forward exchange rates were collected on a daily basis for each of these currencies. The CAD and JPY data cover the period between 10/27/1997 and 11/15/2004, and the EUR data start from 1/4/1999 and end at 11/15/2004. All weekend rates were excluded.

Suppose $s_{t+\tau}$, s_t are the logarithms of the spot rates at time $t+\tau$ and t respectively and $f_{t,\tau}$ is the logarithm of the forward exchange rate with maturity τ at time t. A typical test for the unbiasedness hypothesis of the forward rate is:

$$s_{t+\tau} - s_t = \alpha + \beta(f_{t,\tau} - s_t) + \varepsilon_{t+\tau} \ . \qquad (1)$$

As argued by Breuer (1996), whether or not the settlement date of the forward contract matches the settlement date of future spot trading should be examined for the test. In our case, since we are using forward contracts with 1-week maturity, the question is whether or not the future spot rate in equation (1) should be exactly 7 days ahead of the current spot rate. According to Grabbe (1995), to determine the one week forward settlement date for forward trading that takes place today, first determine the spot settlement date, and then the same day of the next week is the settlement date of the forward contract. For example, for a EUR/ USD 1-week forward contract entered into on Monday, the spot settlement date will be two business days after[2] (i.e. Wednesday), and thus the delivery date of the forward contract should be next Wednesday. To speculate on this contract, a speculator should trade currency in the spot market next Monday, with the delivery date being next Wednesday. Due to this intuitional arrangement, the forward rate on any day of the week is associated with the spot rate exactly one week later. Therefore the future spot rate used in the test should be the spot rate exactly one week after the transaction date.

[2] Spot settlement date is two business days after the transaction date except for Canadian dollar and Mexican Peso against U.S. dollars in North America.

Thus, by construction, 1-week forward rates are regressed with weekly spot returns. Therefore the frequency of the data and maturity of the contracts do not overlap in the estimation, and serial correlation of error items can be ignored here. However, it is well known that spot returns have time-varying volatility in the second conditional moments. To avoid the inefficiency of the estimation caused by heteroscadicity, the Newey-West estimator for the standard errors is applied in the estimation.

Table 1 reports the results. For the CAD, the betas on all weekdays other than Thursday are significantly negative numbers (around -5 in our sample). In contrast, the beta on Thursday is -0.46, and an insignificant t-statistics (-0.78) suggests that the beta is not statistically different than zero. For the EUR, Thursday also generates an insignificant result. In addition, the beta on Monday appears to be statistically insignificant and close to zero as well, while other weekdays have significantly negative betas around -6. For the JPY, although none of the weekdays show a significant result, the inconsistency between Thursday (beta is -0.56) and other weekdays (betas are from -1.18 to -2.02) is still noticeable. Thus, a new pattern never reported before can be found in the table: instead of a significantly negative number like other weekdays, the beta on Thursday is statistically equal to zero across currencies. Additionally, Monday is a similar special day for the Euro. This pattern can be called the *Thursday effect of the forward premium puzzle*[3]

To test the robustness of the finding across various subperiods within the entire data period, a rolling regression was applied for each weekday. In the regressions, a window is chosen that is shorter than the entire data coverage. Beginning at the first instance of this window, equation (1) is used to regress the data within the window and obtain one result. Then, moving the window one position forward and regressing the data in the next window generates another result. This process continues until the bottom of the window reaches the end of the data. Thus, multiple estimates can be obtained for each weekday to determine whether the new finding is consistent

[3] The rest of the paper will argue and show that both the Thursday effect across the currencies and Euro's Monday effect are caused by the similar reasons, and the latter is actually a European version of the Thursday effect.

across subperiods. The results are illustrated in histogram figure (1) through (3). Each sub-figure of the figure illustrates the distribution of the betas associated with various weekdays (row of the figure matrix) and the choice of window periods (column of the matrix).

As we can see from the last column of the figures, in a long window period (6-year for CAD and JPY, 5-year for EUR), the betas on Thursdays fall in a narrow interval between -0.5 to 0.5, while the results on other weekdays are significantly negative (-3 to -5 for CAD, -4 to -6 for EUR, -1 to -2 for JPY). In contrast, in shorter window periods (left two columns of the figure), the betas are mostly distributed around zero and the differences between Thursday's distribution and other weekdays' are not clearly identifiable. In addition to Thursday, Monday also appears to be a special day for Euro. On that day, the majority of betas are clustered around 0 rather than some significant negative numbers in the long window period, and such an inconsistency can not be seen either in shorter window periods. Therefore, two conclusions can be drawn from these figures. First, the Thursday (Monday) effect is robust across subperiods; second, the effect emerges only when the estimation period is long enough.

In summary, the new findings about the puzzle discovered by the paper are: 1) Thursdays generate different results than other weekdays across currencies. 2) Mondays behave similarly for the Euro, 3) the Thursday and Monday effect do not show up until the window period is long enough.

3. Explanations

The proposed explanation in this paper arises from the effort to answer the key question: under what condition can beta be close to zero[4]. I derived the condition based on a simple factor

[4] Initial effort to find an explanation focuses naturally on whether abnormal events or information in the foreign exchange market take place constantly on Thursday, but it did not succeed

model of exchange rate that follows Backus et. al.(2001). In this model, the forward premium, according to CIP [5], equals interest rate differential. i.e.,

$$f_t - s_t = r_t^* - r_t \tag{2}$$

where r_t^*, r_t are the logarithm of foreign and domestic interest rates respectively. Preliminary data examination shows that the two interest rates are highly correlated. Also, Anh (2004) found that common factors can explain over 90% of the variation of the interest rates. So we can assume that both countries' yield rates are affected by some common factors, but the way the rates are affected is different. Suppose $z_{1,t}, z_{2,t}$ are two latent common factors and α_1 , α_2 α_1^*, α_2^* are constant coefficients, thus domestic and foreign interest rates can be written as:

$$r_t = \alpha_1 z_{1,t} + \alpha_2 z_{2,t} \tag{3}$$

$$r_t^* = \alpha_1^* z_{1,t} + \alpha_2^* z_{2,t} \tag{4}$$

Only two common factors are included in this setup because of the following reasons. First, Ding (2007) found that two common factors would account for almost all variation of the interest rate explained by the common factors; Second, intuitively there are two types of information in the market: fundamental and non-fundamental information, which can be represented by the two factors respectively; Third, according to Baillie and Bollerslev (1994), both properties of high persistency and random walk can be found in the forward premium. Usually, fundamental information such as macroeconomic variable is highly persistent and pretty stable, while non-fundamental information is independent across time and much more volatile. So this setup can also accommodate the statistical features of the forward premium.

Without losing generality, I assume that $z_{1,t}$ represents fundamental information and $z_{2,t}$ reflects the non-fundamental information. An interest rate differential can be obtained from equations (3) and (4):

[5] Extensive studies show that CIP generally holds. In fact, dealers quote the forward rates based on the CIP formula.

$$r_t^* - r_t = (\alpha_1^* - \alpha_1)z_{1,t} + (\alpha_2^* - \alpha_2)z_{2,t} \tag{5}$$

Therefore, forward premium can be written as,

$$f_t - s_t = (\alpha_1^* - \alpha_1)z_{1,t} + (\alpha_2^* - \alpha_2)z_{2,t} \tag{6}$$

The future spot exchange rate is structured as forward rate plus risk premium, i.e.:

$$s_{t+1} = f_t + \text{risk premium} + \varepsilon_t$$

where ε_t is an error term with standard normal distribution. The risk premium is certainly affected by the latent factors $z_{1,t}, z_{2,t}$ as well. Assume

$$\text{risk premium} = \lambda_1 z_{1,t} + \lambda_2 z_{2,t}$$

where λ_1, λ_2 are constant coefficients. Therefore, we have:

$$s_{t+1} = f_t + \lambda_1 z_{1,t} + \lambda_2 z_{2,t} + \varepsilon_t \tag{7}$$

Subtracting current spot rate on the both sides of equation (7) results in:

$$s_{t+1} - s_t = f_t - s_t + \lambda_1 z_{1,t} + \lambda_2 z_{2,t} + \varepsilon_t \tag{8}$$

Plugging equation (6) into equation (8) results in:

$$s_{t+1} - s_t = (\alpha_1^* - \alpha_1)z_{1,t} + (\alpha_2^* - \alpha_2)z_{2,t} + \lambda_1 z_{1,t} + \lambda_2 z_{2,t} + \varepsilon_t \tag{9}$$

Thus, based on equation (6) and (9), the OLS estimated slope coefficient of equation (1) can be expressed as:

$$\beta = 1 + \frac{\lambda_1 (\alpha_1^* - \alpha_1)V(z_1) + \lambda_2 (\alpha_2^* - \alpha_2)V(z_2)}{(\alpha_1^* - \alpha_1)^2 V(z_1) + (\alpha_2^* - \alpha_2)^2 V(z_2)}$$

which can be rewritten as:

$$\beta = 1 + \frac{\lambda_1^* (\alpha_1^* - \alpha_1)\frac{V(z_1)}{V(z_2)} + \lambda_2 (\alpha_2^* - \alpha_2)}{(\alpha_1^* - \alpha_1)^2 \frac{V(z_1)}{V(z_2)} + (\alpha_2^* - \alpha_2)^2}$$

Since the non-fundamental variable is believed to be much more volatile than the fundamental one, so the ratio of two variances can be ignored. Then, the slope coefficient can be simplified as:

$$\beta = 1 + \frac{\lambda_2}{\alpha_2^* - \alpha_2}$$

According to the equation above, the zero beta suggests:

$$\lambda_2 \,/(\alpha_2^* - \alpha_2) \approx -1$$

which can be rewritten as:

$$(\alpha_2^* - \alpha_2) + \lambda_2 \approx 0$$

Plugging this relationship into equation (9), the expected future spot exchange rate can be expressed as:

$$Es_{t+1} = s_t + (\alpha_1^* - \alpha_1)z_{1,t} + \lambda_1 z_{1,t}$$

In the equation above, non-fundamental information is canceled out, which suggests that if expected spot exchange rate change depends mainly on fundamental information, then the beta tends to be zero.

Meanwhile, an important institutional factor has to be considered. Equation (1) is derived from CIP and UIP, while both CIP and UIP are based on the no-arbitrage condition. Recall the arbitrage process for the CIP condition by using a 1-week forward contract. First, borrow domestic currency in the money market. Second, buy foreign currency in the spot market. Third, deposit foreign currency to earn interest and fourth sell the foreign currency at the rate specified in the forward contract (sell the foreign currency in the spot market for UIP) one week later. According to Grabbe (1995), the delivery date of short-term money market instruments is two business days after the transaction date. Suppose a speculator observes information and decides to speculate on it on weekday T (T could be any number from 1 through 5). The money will be delivered to his account on weekday T+2 (2 means two business days), and then he can start

trading in the foreign exchange market. Therefore, information released on weekday T of this week should significantly affect the relationship between spot rate on weekday T+2 of the next week and forward rate on weekday T+2 this week.

According to the theoretical model, zero beta on Thursdays means that Thursday's expected spot rate is basically determined by fundamental information. The institutional arrangement previously discussed suggests that the fundamental information that dominantly influences investors' expectation of next Thursday's spot rate should be released this Tuesday. Thus, the cause of the Thursday effect should be the answer to the following question: is there any major fundamental information that is released constantly on Tuesdays and affects the next Thursday's spot rate significantly? After screening a lot of fundamental information, the Federal Open Market Committee (FOMC)'s monetary announcement about the federal fund target rate is found to be the most likely candidate. The FOMC, responsible for open market operations in the U.S., meets regularly to determine the adjustment of the base interest rate. Interestingly, it is almost always on Tuesdays when they meet and announce the adjustment during the coverage period of our data. (See table (4)). When such major fundamental information comes to the market on Tuesday, market participants are likely to form their expectations of the spot rates for next Thursday mainly based on this information. This process explains how fundamental information dominates non-fundamental information in determining the spot rates on these special Thursdays. It is this scenario which I propose as the explanation of the Thursday Effect.

For the Euro, in addition to Thursday, Monday also possesses similar properties as Thursdays. According to our logic, we expect to see that some fundamental information such as monetary policy announcements is released constantly two business days before Monday, i.e. Thursday. The fact is that the monetary policy committee in the European Central Bank does meet and announce the base interest rate mostly on Thursday, as shown in table 5. So our proposed explanation can also explain the Monday effect for the Euro.

This logic can also explain why this effect only shows up in long window periods: not every Thursday has an announcement. The FOMC meets about eight times a year, and about once a month for its counterpart in the European Central Bank. Therefore, the effect is not significant enough to emerge in a relatively short window period, as it contains fewer observations of the announcement weeks.

As for other central banks, the monetary policy committee in the Bank of Canada also meets on Tuesdays with the same frequency as the FOMC. So the effect of their monetary policy announcement should be mixed with that of FOMC and does not cause a different day-of-the-week effect. The meeting date of the similar committee in the Bank of Japan is fairly random and not fixed at one specific weekday. Thus, the Japanese monetary announcement does not cause a different day-of-the-week effect either.

The proposed explanation argues that when monetary policy announcements are made, as opposed to non-fundamental information (usually private information), market participants consider the news as common knowledge and have similar interpretations of the news. Therefore, irrational expectation behavior will be reduced in the foreign exchange market. In this sense, our explanation fits in the literature that attributes the puzzle to irrational expectations or expectation errors.

4. Empirical tests

The proposed explanation has two components: the FOMC's (the European Central Bank) monetary announcement is the direct cause of the Thursday effect (Monday effect for Euro), and the transmission mechanism is that people expect future spot rate mainly based on the fundamental information in the announcement weeks. These two aspects can be used to test the proposed explanation.

A natural way to test the first component is to compare the betas obtained with and without observations in announcement weeks. The logic of the test is simple: if the effect is caused by the

announcements, then the sample without the observations of the announcement weeks should generate a beta consistent with other weekdays. Accordingly, I estimated equation (1) by using three different samples: all Thursday observations, Thursdays excluding announcement weeks and Thursdays of announcement weeks only. The Panel A of table 2 reports the betas of three tests for each currency.

The results are consistent across currencies. In the sample of all Thursdays, the beta for all currencies are pretty close to zero (CAD: -0.4643, EUR: -0.5885 and JPY: -0.5561) and have low corresponding t-statistics (CAD: -0.78, EUR: -0.39, JPY: -0.23). Once the observations of Thursdays in announcement weeks are taken out, the remaining sample generates dramatically different results. The betas become more negative and much further away from zero (CAD:-5.4351 EUR:-6.7543, JPY:-2.21) and their t-statistics are much more significant (CAD:-2.16 EUR:-2.53, JPY:-0.93). The similarity between the Thursdays without the announcements and other weekdays can be seen by comparing the preceding betas with the average betas of other weekdays reported in the last column of the table. Apparently, the forward premium puzzle reappears on Thursday if the observations on announcement weeks are excluded. Moreover, in the test using only announcement week Thursdays, insignificant t-statistics suggest that the zero beta hypothesis cannot be rejected. For EUR and JPY, the beta even tends to move toward the positive side. All these results support the argument that it is announcement week Thursdays that significantly change the beta on Thursdays overall and cause the inconsistency with previous forward premium puzzle findings.

Similar tests are conducted for the Euro's Monday effect and the results are reported in panel B of table 2. In this case, the three samples consist of all Monday observations, all non-announcement Mondays, and only the Mondays with the announcements. The beta based on all the Monday observations is -0.0248 with an insignificant t-statistic (-0.01), while the sample without the observations in announcement weeks generates a negative beta (-6.3175) with a significant t-statistic (-2.17). This latter finding is consistent with other weekdays (weekday

average is -5.9245). All these results support the claim that the monetary announcement made by the European Central Bank consistently on Thursday is the direct cause of the Monday effect for the Euro.

Finally, we test the second component of the explanation. If our proposed mechanism of the Thursday effect is correct, the spot rate should respond significantly to changes in the effective federal fund rate in the announcement weeks, but not in other weeks. A simple way to test this would be to regress spot rate return on the federal fund rate along with a dummy variable indicating the announcement weeks. However, since it is very likely that market participants interpret the information in a nonlinear way, such a linear (or even quadratic test) may not be conclusive. To avoid the complication of specifying the specific relationship between these two variables, I used a sign test proposed by Campbell and Dufour (1995) to detect the response of exchange rates to the monetary announcement.

Let g_t denote any conditioning variable that is a measurable function of information set I_t, and let b_0 denote the median of y_t and define

$$S_g(b_0) = \sum_{t=1}^{n-1} \text{sign}((y_{t+1} - b_0)g_t),$$

where $\text{sign}(u) = 1$ for $u > 0$ and zero otherwise. Under the null hypothesis that y_{t+1} has constant median b_0 and is independent of g_t, Campbell and Dufour (1995, proposition 1) show that $S_g(b_0)$ has an exact binomial finite sample distribution with *n* trials and a probability of success equal to 0.5.

To apply the sign test in our case, let $y_{t+1} = s_{t+1} - s_t$ and $g_t = i_t^* - i_t$, where s_{t+1}, s_t are the logarithm of the spot rates, and i_t, i_t^* are the effective federal fund rate and its foreign counterpart. The sign statistic is given by $S_g(b_0) = \sum_{t=1}^{n-1} \text{sign}((s_{t+1} - s_t - b_0)(i_t^* - i_t))$, where b_0 is the median spot exchange rate change. If the interest rate does not have a significant impact on spot rate return,

then $S_g(b_0)$ should have an exact binomial finite sample distribution with n trials and a probability of success equal to 0.5, which can be verified by a standard proportional t-test. If the interest rate does have a significant impact, then a higher federal fund rate reduces the interest rate differential (foreign minus domestic interest rate), and according to UIP, should cause the domestic currency to depreciate (i.e spot return should be higher). Therefore, if the spot rate responds significantly to the announcements, the ratio should be significantly less than 0.5.

The interest rates used in the test were downloaded from the website of St. Louis Fed and the central banks of the foreign countries. The spot returns came from the DataStream. Table 3 reports the results of this sign test. The ratio in the table is calculated as $S_g(b_0)$ divided by the number of observations in each sample. For the sample without announcements, the ratios are very close to 0.5 (CAD: 0.5, EUR: 0.53, JPY: 0.48). Low t-statistics (CAD: 0, EUR: 1.19, JPY: -0.54) suggest that for each currency, we cannot reject the hypothesis that the ratio equals 0.5. For the sample with the announcement weeks only, the ratios are significantly less than 0.5 (CAD: 0.37, EUR: 0.28, JPY: 0.25) supported by the high t-statistics. These results imply that the federal fund rate does not significantly affect the spot rate in the weeks without the monetary announcements while it does in the announcement weeks. The results obtained from this test are thus supportive of the second components of our proposed explanation.

5. Conclusions.

This article tests the unbiasedness hypothesis of forward rates across weekdays and finds that the puzzle seems to disappear on Thursdays across currencies (Monday for Euro as well). More specifically, instead of being significant negative number, the beta is statistically equal to zero on the special weekdays. Furthermore, the paper finds that this phenomenon only emerges when the window period is long enough. This new empirical finding can be referred to the Thursday Effect of the forward premium puzzle.

The paper proposes an explanation based on a simple factor model of exchange rates. According to the model, the beta being zero suggests that expected future spot rate depends on fundamental information dominantly. Hence the paper argues that when U.S. monetary policy announcements are released regularly on Tuesdays, the speculators would mainly focus on this fundamental information forming their expectations of the future spot rate. Meanwhile, due to the delivery arrangement that the orders will be settled two business days after the transaction date in both the money market and foreign exchange market, the arbitrage transactions conducted by the speculators will be completed two business days later, i.e. Thursday (Monday for Euro). Thus the relationship between future spot rate and current forward rate is closer to the scenario described by the theory on Thursdays (Monday for Euro). Similarly, the Monday effect for Euro can be attributed to European Central Bank's regular release of monetary policy information on Thursdays, which are two working days ahead of Mondays. Empirical test of the paper support the proposed explanation.

The paper identifies a calendar effect in the foreign exchange market. So for future research, whether a trading strategy can be designed based on this market inefficiency should be evaluated. And also, since the paper suggests that the spot rate responds to the fundamental information such as the announcement of interest rates, the ability of these fundamental variables to forecast future spot rate in these special weeks should be examined.

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Table 1: results for the test of the forward premium puzzle across weekdays

Currency	Coefficients	Mon	Tue	Wed	Thu	Fri
CAD/USD	α	-0.0002 (-0.48)	-0.0002 (-0.49)	-0.0001 (-0.41)	-0.0004 (-0.93)	-0.0002 (-0.41)
	β	-4.7374 (-1.92)	-4.8086 (-1.92)	-5.2937 (-2.28)	-0.4643 (-0.78)	-5.5295 (-2.28)
EUR/USD	α	0.0003 (0.37)	0.0004 (0.55)	0.0004 (0.54)	0.0004 (0.44)	0.0005 (0.63)
	β	-0.0248 (-0.01)	-5.9046 (-2.42)	-5.9350 (-2.35)	-0.5885 (-0.39)	-5.9341 (-2.37)
JPY/USD	α	-0.0013 (-1.02)	-0.0015 (-1.02)	-0.0010 (-0.69)	-0.0007 (-0.39)	-0.0013 (-0.77)
	β	-1.6755 (-0.69)	-2.0187 (-0.94)	-1.1814 (-0.56)	-0.5561 (-0.23)	-1.6816 (-0.67)

Notes: the numbers above parenthesis are estimate of alpha and beta in the test equation $s_{t+\tau} - s_t = \alpha + \beta(f_{t,\tau} - s_t) + \varepsilon_{t+\tau}$., number in parenthesis are t-statistics for the zero null hypothesis.

Table 2: Test of samples with and without the announcements

Panel A				
currency	All Thursdays	Thursday without announcements	Thursdays with announcements	Average of other weekdays*
CAD/USD	-0.4643 (-0.78)	-5.4351 (-2.16)	-0.1609 (-0.22)	-5.0923 (-2.1)
EUR/USD	-0.5885 (-0.39)	-6.7543 (-2.53)	2.4859 (1.39)	-5.9245 (-2.38)
JPY/USD	-0.5561 (-0.23)	-2.21 (-0.93)	7.7934 (0.92)	-1.6393 (-0.715)
Panel B				
currency	All Mondays	Mondays without meeting	Mondays with meeting	Average of other weekdays*
EUR/USD	-0.0248 (-0.01)	-6.317576 (-2.17)	4.5680 (1.65)	-5.9245 (-2.38)

Notes: numbers above parentheses reported in this table are the estimate of beta in the test equation $s_{t+\tau} - s_t = \alpha + \beta(f_{t,\tau} - s_t) + \varepsilon_{t+\tau}$. Numbers in the parentheses are t-statistics based on zero hypotheses. The equation is tested by three samples respectively, including the observations on all Thursdays (Monday for Euro as well), the observations on Thursday (Monday for Euro) excluding announcement weeks and observations on Thursdays (Monday for Euro) with the announcement only.

*What reported under the average of other weekdays are the mathematical average of beta estimate and t-statistics on other weekdays. But for Euro, it does not include the estimates on Monday.

Table 3: sign test of samples with and without the announcements

	CAD/USD	EUR/USD	JPY/USD
Ratio for non-announcement weeks	0.5000 (0)	0.5352 (1.19)	0.4852 (-0.54)
Ratio for announcement weeks	0.375 (1.72)	0.28 (2.17)	0.25 (2.82)

Notes: numbers above parentheses reported in this table are the ratio of the sign statistics $S_g(b_0) = \sum_{t=1}^{n-1} \text{sign}((s_{t+1} - s_t - b_0)(i_t^* - i_t))$ over the size of each sample. Numbers in the parentheses are the t-statistics of the ratio test. Null hypothesis is the ratio equal 0.5. The test is conducted by two samples for each currency, including the observations in weeks with and without the announcements respectively.

Table 4: The FOMC meeting dates

Date	Day	Date	Day	Date	Day
11/12/1997	Wednesday	6/27/2000	Tuesday	9/24/2002	Tuesday
12/16/1997	Tuesday	8/22/2000	Tuesday	11/6/2002	Wednesday
2/3/1998	Tuesday	10/3/2000	Tuesday	12/10/2002	Tuesday
3/31/1998	Tuesday	11/15/2000	Wednesday	1/28/2003	Tuesday
5/19/1998	Tuesday	12/19/2000	Tuesday	3/18/2003	Tuesday
6/30/1998	Tuesday	1/3/2001	Wednesday	5/6/2003	Tuesday
8/18/1998	Tuesday	1/30/2001	Tuesday	6/24/2003	Tuesday
9/29/1998	Tuesday	3/20/2001	Tuesday	8/12/2003	Tuesday
11/17/1998	Tuesday	4/18/2001	Wednesday	9/16/2003	Tuesday
12/22/1998	Tuesday	5/15/2001	Tuesday	10/28/2003	Tuesday
2/2/1999	Tuesday	6/26/2001	Tuesday	12/9/2003	Tuesday
3/30/1999	Tuesday	8/21/2001	Tuesday	1/27/2004	Tuesday
5/18/1999	Tuesday	9/17/2001	Monday	3/16/2004	Tuesday
6/29/1999	Tuesday	10/2/2001	Tuesday	5/4/2004	Tuesday
8/24/1999	Tuesday	11/6/2001	Tuesday	6/29/2004	Tuesday
10/5/1999	Tuesday	12/11/2001	Tuesday	8/10/2004	Tuesday
11/16/1999	Tuesday	1/29/2002	Tuesday	9/21/2004	Tuesday
12/21/1999	Tuesday	3/19/2002	Tuesday	11/10/2004	Wednesday
2/1/2000	Tuesday	5/7/2002	Tuesday	12/14/2004	Tuesday
3/21/2000	Tuesday	6/25/2002	Tuesday		
5/16/2000	Tuesday	8/13/2002	Tuesday		

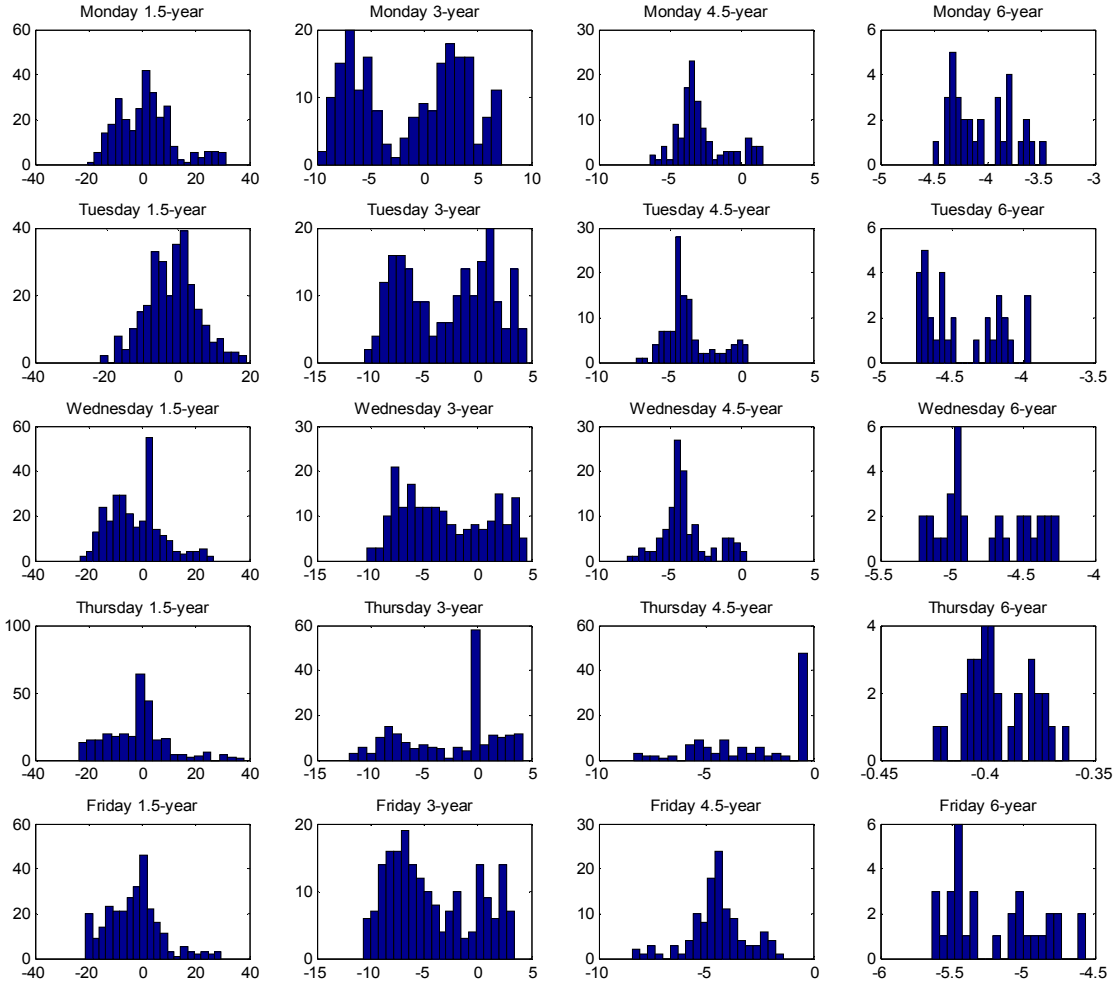
Information resources: website of federal reserve FOMC
(http://www.federalreserve.gov/FOMC/#calendars)

Table 5: The European Central Bank monetary policy committee meeting dates

Date	Day	Date	Day	Date	Day	Date	Day
3/4/1999	Thursday	3/16/2000	Thursday	4/26/2001	Thursday	12/5/2002	Thursday
3/18/1999	Thursday	3/30/2000	Thursday	5/10/2001	Thursday	1/9/2003	Thursday
4/8/1999	Thursday	4/13/2000	Thursday	5/23/2001	Wednesday	2/6/2003	Thursday
4/22/1999	Thursday	4/27/2000	Thursday	6/7/2001	Thursday	3/6/2003	Thursday
5/6/1999	Thursday	5/11/2000	Thursday	6/21/2001	Thursday	4/3/2003	Thursday
5/20/1999	Thursday	5/25/2000	Thursday	7/5/2001	Thursday	5/8/2003	Thursday
6/2/1999	Wednesday	6/8/2000	Thursday	7/19/2001	Thursday	6/5/2003	Thursday
6/17/1999	Thursday	6/21/2000	Wednesday	8/2/2001	Thursday	7/10/2003	Thursday
7/1/1999	Thursday	7/6/2000	Thursday	8/30/2001	Thursday	7/31/2003	Thursday
7/15/1999	Thursday	8/3/2000	Thursday	9/17/2001	Monday	9/4/2003	Thursday
7/29/1999	Thursday	8/31/2000	Thursday	10/11/2001	Thursday	10/2/2003	Thursday
8/26/1999	Thursday	9/14/2000	Thursday	10/25/2001	Thursday	11/6/2003	Thursday
9/9/1999	Thursday	10/5/2000	Thursday	11/8/2001	Thursday	12/4/2003	Thursday
9/23/1999	Thursday	10/19/2000	Thursday	12/6/2001	Thursday	1/8/2004	Thursday
10/7/1999	Thursday	11/2/2000	Thursday	1/3/2002	Thursday	2/5/2004	Thursday
10/21/1999	Thursday	11/16/2000	Thursday	2/7/2002	Thursday	3/4/2004	Thursday
11/4/1999	Thursday	11/30/2000	Thursday	3/7/2002	Thursday	5/6/2004	Thursday
11/18/1999	Thursday	12/14/2000	Thursday	4/4/2002	Thursday	6/3/2004	Thursday
12/2/1999	Thursday	1/18/2001	Thursday	5/2/2002	Thursday	7/1/2004	Thursday
12/15/1999	Wednesday	2/1/2001	Thursday	6/6/2002	Thursday	8/5/2004	Thursday
1/5/2000	Wednesday	2/15/2001	Thursday	7/4/2002	Thursday	9/2/2004	Thursday
1/20/2000	Thursday	3/1/2001	Thursday	8/1/2002	Thursday	10/7/2004	Thursday
2/3/2000	Thursday	3/15/2001	Thursday	9/12/2002	Thursday	11/4/2004	Thursday
2/17/2000	Thursday	3/29/2001	Thursday	10/10/2002	Thursday	12/2/2004	Thursday
3/2/2000	Thursday	4/11/2001	Wednesday	11/7/2002	Thursday	12/5/2004	Thursday

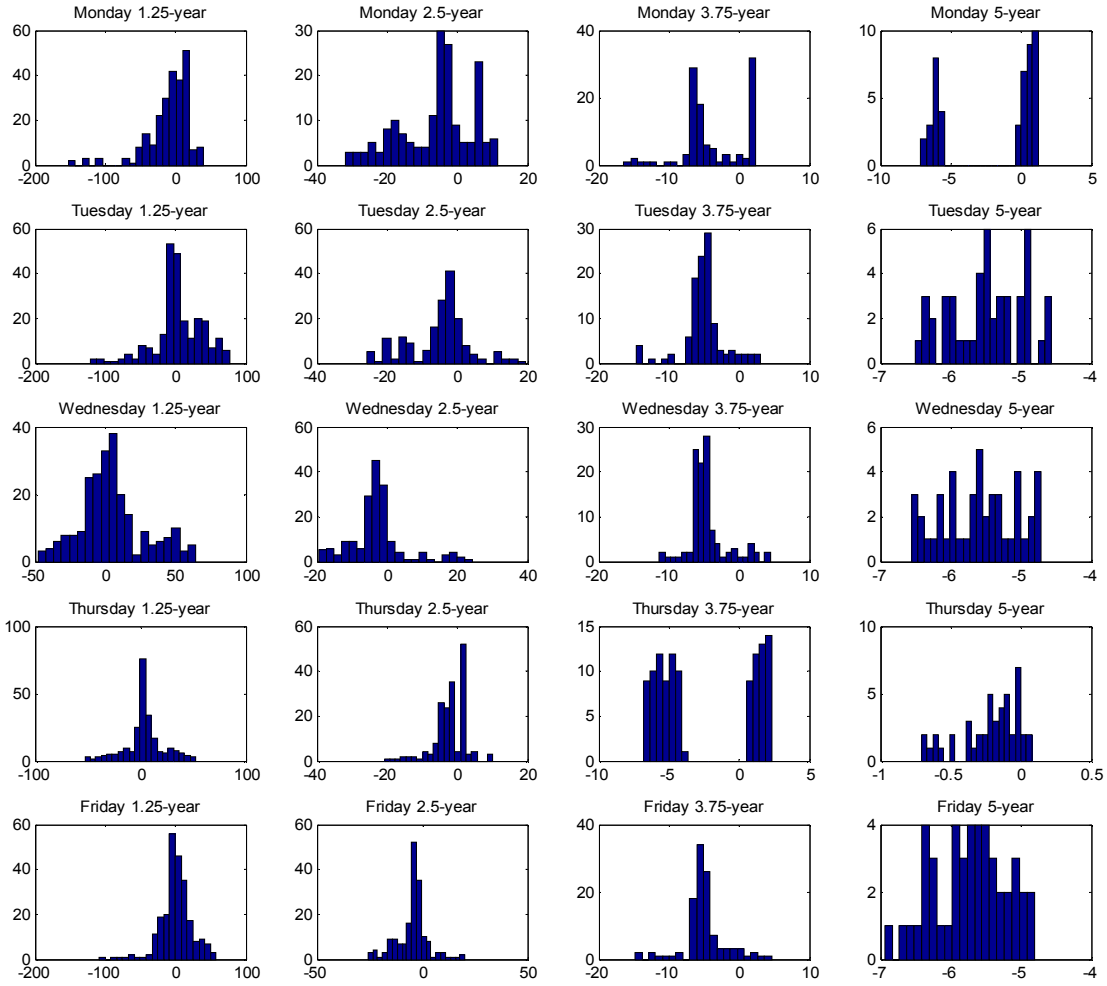
The format of date: month/day/year.
Data resources: website of European Central Bank
(http://www.ecb.int/press/pr/date/previous/html/index.en.html)

Figure 1: Distribution of the slope coefficient for CAD/USD on different weekdays



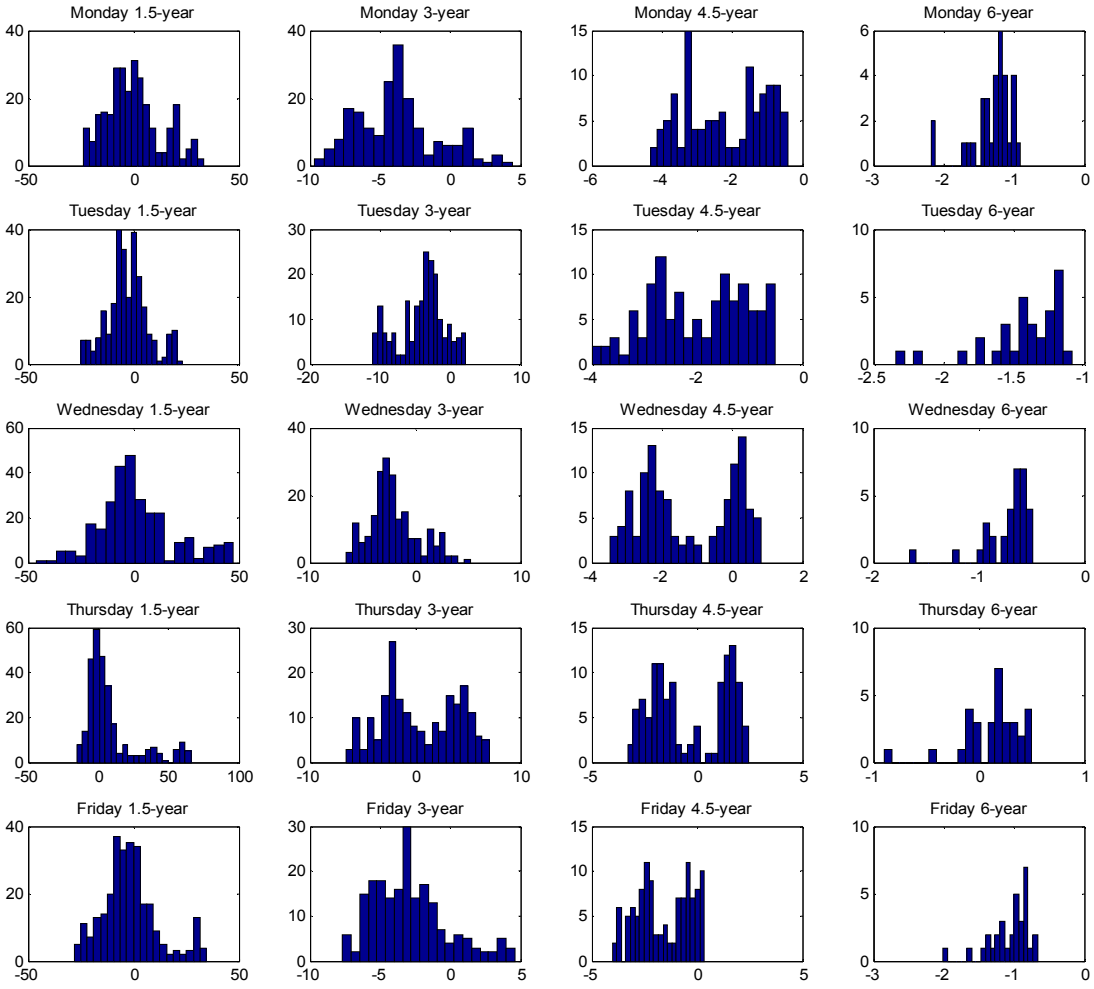
Notes: Each sub-figure of the figure illustrates the distribution of the betas across weekdays (row of the figure matrix) for the choice of window periods (column of the matrix). Window periods used here are 1.5, 3, 4.5 and 6 years.

Figure 2: Distribution of the slope coefficient for EUR/USD on different weekdays



Notes: Each sub-figure of the figure illustrates the distribution of the betas across weekdays (row of the figure matrix) for the choice of window periods (column of the matrix). Window periods used here are 1.25, 2.5, 3.75 and 5 years. These windows are shorter than the windows for CAD and JPY due to the smaller size of EUR sample.

Figure 3: Distribution of the slope coefficient for JPY/USD on different weekdays



Notes: Each sub-figure of the figure illustrates the distribution of the betas across weekdays (row of the figure matrix) for the choice of window periods (column of the matrix). Window periods used here are 1.5, 3, 4.5 and 6 years.