NORTHERN ARIZONA UNIVERSITY
The W. A. Franke College of Business

Macroeconomic Announcements and Foreign Exchange Risk

Working Paper Series—14-05 | October 2014

Ding Du
Northern Arizona University
The W. A. Franke College of Business
PO Box 15066
Flagstaff, AZ 86011.5066, USA
Ding.Du@nau.edu
(928) 523-7274
Fax: (928) 523-7331

Ou Hu
Department of Economics
Youngstown State University
Youngstown, OH 44555
ohu@ysu.edu
(330) 941-2061

Xiaobing Zhao
Northern Arizona University
The W. A. Franke College of Business
PO Box 15066
Flagstaff, AZ 86011
Xiaobing.Zhao@nau.edu
(928) 523-7279
Fax: (928) 523-7331

Macroeconomic Announcements and Foreign Exchange Risk

1. Introduction

With overwhelming evidence to reject purchasing power parity (e.g., Frankel and Rose, 1995), the International Capital Asset Pricing Model of Solnik (1974), Sercu (1980), and Adler and Dumas (1983) suggests that foreign exchange (FX) changes should be a priced factor. However, most studies find that stocks are generally not sensitive to FX changes and there is no significant relationship between FX sensitivity and mean excess returns across stocks (e.g., Jorion, 1990, 1991).[1] This anomaly is called the "exposure puzzle" in the FX risk literature.

In this paper, we examine if FX risk is priced on prescheduled macroeconomic announcement days. Our investigation is motivated by the following two lines of research. First, Savor and Wilson (2013a, 2013b) suggest that the tradeoff between state variable risk and asset returns underlying standard asset-pricing theories should be particularly strong on prescheduled macroeconomic announcement days, because important information about the state of the economy is revealed at such times. Second, a voluminous literature (e.g., Anderson et al., 2007; Faust et al. 2007; Evans and Lyons, 2008) empirically documents the reaction of FX changes to macroeconomic announcements, implying that FX changes, like market returns, contain important information about the state of the economy. Thus, the announcement effects in Savor and Wilson (2013a, 2013b) may extend to FX risk.

Empirically, we follow Savor and Wilson (2013a, 2013b) to test our conjecture and find strong supporting evidence. First, on announcements days, stocks that are sensitive to FX changes have higher excess returns than stocks that are not sensitive to FX changes. The mean return difference between the FX-sensitivity and the FX-insensitivity stocks is 9.21 basis points (bps) per day with a t-statistic of 3.19 on announcement days. In contrast, on non-announcement days, the return difference is only 0.86 bps with a t-statistic of 0.71. Second, the announcement effects associated with FX changes are distinct from those associated with the market risk or size in that on announcement days, within the same beta or size quintile, FX-sensitivity stocks generally have higher excess returns than FX-insensitivity stocks. Third, differences in mean excess returns between announcement and non-announcement days associated with FX risk are not due to differences in FX exposure, but rather FX risk premium. Specifically, the percentage of test assets that have significantly different FX exposure on announcement days is generally less than the size of such tests (i.e., 10%). In contrast, the FX risk premium estimated with the standard Fama and MacBeth (1973) two-pass regression is always statistically higher on announcement days. Our results are robust in sub-samples and to alternative sets of test assets as well as to alternative

[1] See also Allayannis and Ihrig (2001), Bartov and Bodnar (1994), Bartram (2008), Bartram, Brown, and Minton (2010), Bodnar, Dumas, and Marston (2002), Bodnar and Gentry (1993), Chow, Lee, and Solt (1997), Dominguez and Tesar (2001), Francis, Hasan, and Hunter (2008), and Kolari, Moorman, and Sorescu (2008).

specifications to construct the FX factor. Our results are also robust to errors-in-variables and possible misspecification biases

The present paper contributes to the literature in three ways. First, the present paper helps bridge the FX risk literature (e.g., Jorion, 1990, 1991) with the FX announcement effects literature (e.g., Faust et al. 2007) by showing that at times when investors expect to learn important information about the state of the economy (i.e., on announcement days), they do demand higher returns to hold FX-sensitivity assets. Thus, FX risk after all matters. Second, the present paper helps explain the exposure puzzle in the FX risk literature. FX risk is generally not priced, because FX risk primarily matters on macroeconomic announcement days and such days are a small fraction of trading days (about 12% in our sample). Third, the present paper strengthens Savor and Wilson (2013a, 2013b) by showing the significantly different risk-return relationship between announcement and non-announcement days for FX risk. Such a perspective has significant theoretical as well as empirical implications for asset pricing.

The remainder of the paper is organized as follows: Section 2 discusses our data. Section 3 documents the announcement effects associated with FX changes. Section 4 reports asset-pricing test results. Section 5 concludes the paper with a brief summary.

2. Data

Following Savor and Wilson (2013a, 2013b), we use daily data in empirical tests. The daily stock returns data are obtained from the Center for Research in Security Prices (CRSP). The daily return data on 25 size and book-to-market (BM) portfolios, 30 industry portfolios and the Fama-French factors are from Kenneth French's website (the details of the construction of these portfolios are also available at Kenneth French's website).[2]

As for exchange rates, we follow previous studies and use the (daily) Major Currencies Index (MCI) from the Board of Governors of the U.S. Federal Reserve System, which is a weighted average of the foreign exchange values of the U.S. dollar against currencies of major industrial countries. The MCI includes the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden, and is defined such that an increase in the MCI represents an appreciation of the U.S. dollar.

Our sample period begins on January 2nd, 1974, because dollar exchange rates began floating in 1973 (Bartov, Bodnar, and Kaul, 1996), and we require one year of daily data to construct relevant portfolios for empirical tests. Our sample period ends on December 30th, 2011, which is dictated by the availability of daily individual stock returns data from CRSP.

[2] We thank Fama and French for making these data available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

Following Savor and Wilson (2013a, 2013b), we focus on Inflation, unemployment and interest rate announcements. Inflation and unemployment announcement dates are from the Bureau of Labor Statistics. Producer Price Index (PPI) announcements instead of Consumer Price Index (CPI) announcements are used, since PPI is released earlier. The dates for the Federal Open Market Committee (FOMC) scheduled interest rate announcement are from the Federal Reserve from 1978. Unscheduled FOMC meetings are not included in the sample.[3]

3. Announcement effects associated with FX risk

3.1 Empirical methodology

If a risk factor (e.g., FX risk) is priced in the equity market, mean excess returns of assets should vary systematically with the exposure to this factor. Therefore, a standard approach in empirical asset pricing is to construct diversified portfolios based on the exposure to a factor. We take this approach and construct a variety of portfolios to test our conjecture (e.g., FX-sensitivity portfolios).

To estimate the mean (excess) return of an asset (e.g., FX-sensitivity portfolios), we regress time-series (excess) returns on a constant. Savor and Wilson (2013a, 2013b) argue that the risk-return tradeoff underlying standard asset-pricing theories should be particularly strong on prescheduled macroeconomic announcement days, because important information about the state of the economy is revealed at such times. Therefore, it may be more informative to estimate mean (excess) returns separately for announcement days and non-announcement days. We adopt the regression approach of Cooper, Gutierrez and Hameed (2004) to estimate mean (excess) returns of assets separately for announcement days and non-announcement days. Essentially, we regress time-series (excess) returns on an announcement-day dummy and a non-announcement-day dummy, with no intercept. To test whether mean (excess) returns on announcement and non-announcement days are equal, we regress time-series (excess) returns on a constant and an announcement-day dummy. In all cases, the t-statistics are based on Newey-West HAC standard errors with the lag parameter set equal to 5 for our daily data. Cooper, Gutierrez and Hameed (2004) point out: "These (regression) approaches preserve the full time-series of returns and allow us to reliably estimate the standard errors under serial correlation" (p. 1350).

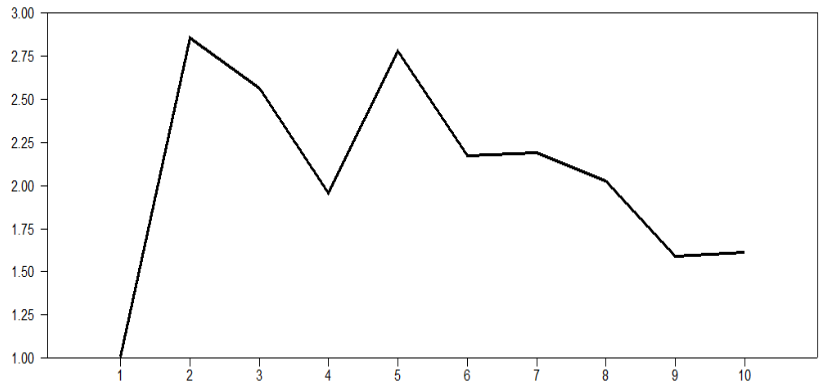
Panels A1 and A2 in Figure 1 summarize the key finding of Savor and Wilson (2013b). To test if the market risk is priced, Savor and Wilson (2013b) construct 10 beta-sorted portfolios. Panel A1 depicts excess returns for these portfolios on all days. Consistent with previous studies, there is no systematic positive relationship between beta and mean excess returns. Panel A2 depicts excess returns for the same beta-sorted portfolios separately for announcement days (A_day) and non-announcement days (N_day). As we can see, mean excess returns of the beta-sorted portfolios on announcement days are different from

---

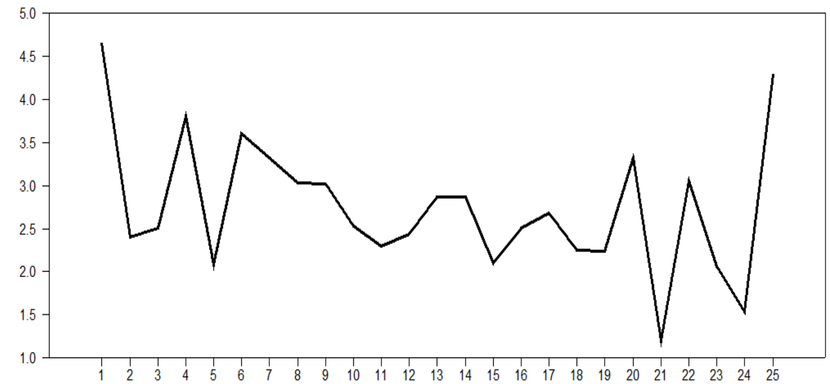
[3] We thank Professor Savor for providing us with the announcement dates and the beta-sorted portfolio returns data.

Figure 1. Mean excess returns for 10 Beta-sorted portfolios and 25 value-weighted FX-sorted portfolios

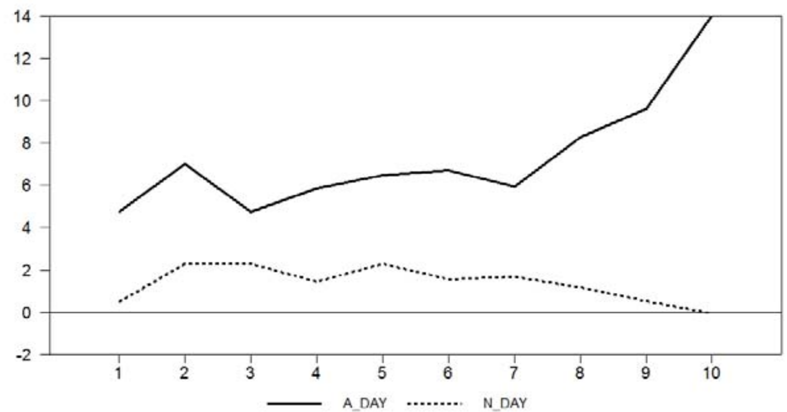
Panel A1: Mean excess returns for 10 Beta-sorted portfolios



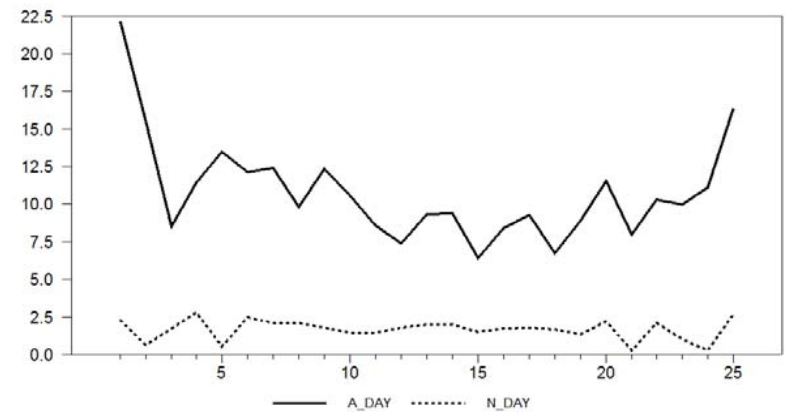
Panel B1: Mean excess returns for 25 value-weighted FX-sorted portfolios



Panel A2: Mean excess returns for 10 Beta-sorted portfolios separately for announcement days and non-announcement days



Panel B1: Mean excess returns for 25 value-weighted FX-sorted portfolios separately for announcement days and non-announcement days



Panel A1 depicts excess returns for 10 beta-sorted portfolios, where Panel A2 shows those separately for announcement days (A_day) and non-announcement days (N_day), Panels B1 and B2 present excess returns for 25 value-weighted FX-sensitivity portfolios in a similar fashion.

those on non-announcement days. First, excess returns of the portfolios are higher on announcement days. Second, on announcement days, the relationship between beta and mean excess returns is positive. In contrast, on non-announcement days, the relationship is slightly negative. Since there is evidence suggesting that FX changes also contain important information about the state of the economy (e.g., Faust et al. 2007), we next test if announcement effects extend to FX risk.

3.2 Macroeconomic announcements and FX risk

In the same spirit of Savor and Wilson (2013b), to focus on the effects of FX risk on excess returns, we construct 25 diversified value-weighted FX-sensitivity portfolios. The FX sensitivity for a stock at the beginning of a month is estimated with the prior one year of daily data. To control for the effects of the market risk emphasized by Savor and Wilson (2013b), we use the following two-factor model.

$$r_{it} = \alpha_i + \beta_{i,MKT} MKT_t + \beta_{i,FX} FXCH_t + \varepsilon_{it} \tag{1}$$

where r_{it} is the excess return on stock *i* on day *t*, MKT_t is the daily excess market return, and $FXCH_t$ is the daily MCI percentage change. The β's are the associated factor loadings, and ε_{it} is the disturbance.

After obtaining individual stocks' FX sensitivity (i.e., $\beta_{i, FX}$), we rank stocks into 25 portfolios based on their FX sensitivity. These portfolios are held for one month and rebalanced monthly as in Savor and Wilson (2013b). Panel A of Table 1 shows the relevant summary statistics for the 25 FX-sensitivity portfolios. As we can see, on average, each FX-sensitivity portfolio has 219 firms over our sample period. Therefore, the FX-sensitivity portfolios are well diversified.

Panel B1 in Figure 1 depicts excess returns for 25 FX-sensitivity portfolios. Firms that are extremely sensitive (in absolute value) to FX fluctuations (portfolios ranked 1 and 25) have slightly higher mean excess returns than firms that are not extremely sensitive to FX changes (portfolios ranked 2 to 24). To test for statistical significance, we follow Kolari, Moorman, and Sorescu (2008) and calculate the return difference, XMI (or sensitive minus insensitive), as the average return on the two sensitivity portfolios minus the average return on the insensitivity portfolios.

$$XMI_t = \frac{(FX_{1t} + FX_{25t})}{2} - \frac{1}{23}\sum_{i=2}^{24} FX_{it} \tag{2}$$

where FX_{it} is the excess return of the FX-sensitivity portfolio *i* on day *t*,. As we can see from Panel B of Table 1, the daily return difference between the sensitivity and the insensitivity stocks (i.e., the mean return of XMI) on all days reported in Column "All" is 1.86 bps with a t-statistic of 1.58, which is not statistically significant. This result is consistent with previous studies (Jorion, 1991), suggesting that FX risk generally is not priced.

Table 1. Summary statistics for 25 FX-sensitivity-sorted portfolios and mean returns for the relevant factors

Panel A: Summary statistics for 25 FX-sensitivity-sorted portfolios

Foreign exchange-sensitivity portfolio	Sensitivity: Estimate	Sensitivity: Percent positive	Sensitivity: Percent significant at 10% level	Size	Average Number of firms
1	-2.66	0.00	0.53	242958	219
2	-1.16	0.00	0.36	384994	219
3	-0.85	0.00	0.26	564636	219
4	-0.66	0.00	0.19	840469	219
5	-0.53	0.00	0.14	1007438	219
6	-0.42	0.00	0.09	1156813	219
7	-0.34	0.00	0.06	1367471	219
8	-0.27	0.00	0.03	1559948	219
9	-0.21	0.02	0.01	1599416	219
10	-0.15	0.03	0.01	1732270	219
11	-0.09	0.10	0.00	1675528	220
12	-0.04	0.26	0.00	1807832	219
13	0.01	0.53	0.00	1837577	219
14	0.06	0.77	0.00	1925244	219
15	0.11	0.89	0.00	1917824	219
16	0.16	0.95	0.01	1787866	219
17	0.22	0.99	0.01	1683660	219
18	0.28	1.00	0.03	1546440	219
19	0.36	1.00	0.05	1376418	219
20	0.44	1.00	0.09	1189688	219
21	0.54	1.00	0.14	1024576	219
22	0.67	1.00	0.19	774581	219
23	0.86	1.00	0.26	580281	219
24	1.16	1.00	0.37	403312	219
25	2.95	1.00	0.52	209183	219

Panel B: Mean returns for the relevant factors

	All	A-day	N-day
XMI	1.86	9.21	0.86
	(1.58)	(3.19)	(0.71)
MKT	2.07	9.19	1.12
	(1.87)	(2.82)	(0.96)
SMB	0.95	3.86	0.55
	(1.61)	(2.35)	(0.89)
HML	1.88	-1.96	2.40
	(3.07)	(-1.30)	(3.78)

Panel A shows the daily mean returns and other relevant summary statistics of the 25 FX-sensitivity portfolios. Panel B presents mean returns for the relevant factors. Columns "All", "A-Day" and "N-day" contain mean returns on all days, announcement days, and non-announcement days.

Panel B: Summary statistics for the relevant factors

	Mean returns: All	Mean returns: A-day	Mean returns: N-day	Cumulative log returns: All	Cumulative log returns: A-day	Cumulative log returns: N-day	Standard deviation: All	Standard deviation: A-day	Standard deviation: N-day
XMI	1.88	9.21	0.89	1.28	0.98	0.29	103	95	104
	(1.61)	(3.19)	(0.73)		(77%)	(23%)			
MKT	2.07	9.19	1.12	1.42	0.97	0.45	107	109	107
	(1.87)	(2.82)	(0.96)		(68%)	(32%)			
SMB	0.95	3.86	0.55	0.75	0.42	0.33	55	54	55
	(1.61)	(2.35)	(0.89)		(56%)	(44%)			
HML	1.88	-1.96	2.40	1.65	-0.23	1.89	52	49	52
	(3.07)	(-1.30)	(3.78)		(-14%)	(114%)			

Next, we estimate mean excess returns for 25 FX-sensitivity portfolios separately for announcement days and non-announcement days. The results are reported in Panel B2 of Figure 1. Interestingly, mean excess returns of the FX-sensitivity portfolios on announcement days are different from those on non-announcement days. First, mean excess returns of the FX-sensitivity portfolios are higher on announcement days. Second, there is a U-shaped relationship between FX sensitivity and mean excess returns on announcement days. That is, FX-sensitivity stocks (portfolios ranked 1 and 25) have higher mean excess returns than FX-insensitivity stocks (portfolios ranked 2 to 24). The daily return difference between the sensitivity and the insensitivity stocks (i.e., the mean return of XMI) on announcement days reported in Column "A-Day" is 9.21 bps with a t-statistic of 3.19. However, on non-announcement days, there is no systematic relationship between FX-sensitivity and mean excess returns. The daily return difference between two types of stocks (i.e., the mean return of XMI) on non-announcement days reported in Column "N-Day" is only 0.86 bps with a t-statistic of 0.71.

The U-shaped relationship between FX sensitivity and mean excess returns (on announcement days) implies a nonlinear positive risk premium on FX risk (on announcement days), which is plausible. Firms such as exporters have negative FX sensitivity, while firms such as importers have positive FX sensitivity. For both negative- and positive-sensitivity firms, FX movements, *ceteris paribus*, increase the volatility of their cash flows and consequently their discount rates. Therefore, both negative- and positive-sensitivity firms should have higher expected returns than FX-insensitivity firms when important information about the economy is revealed, implying a nonlinear positive risk premium on FX risk on macroeconomic announcement days.

3.3 FX factor-mimicking portfolio (XMI)

Standard asset-pricing tests such as the Fama and MacBeth (1973) two-pass regression apply to linear asset-pricing models. However, Panel B2 of Figure 1 suggests a nonlinear relationship between FX exposures and mean excess returns (on announcement days). To transform the nonlinear relationship into a linear one, we construct a zero-investment portfolio that takes long positions in stocks that are extremely sensitive (in absolute value) to FX movements and short positions in stocks that are not extremely sensitive to FX fluctuations, which is essentially XMI we define in Equation (2).

This factor-mimicking portfolio approach of Fama and French (1992, 1993) also has a number of additional advantages. First, FX changes used in previous studies (e.g., Francis, Hasan, and Hunter 2008) are macroeconomic variables (not returns), which contain information that is irrelevant to asset pricing and may also have measurement errors. In contrast, the factor-mimicking portfolio captures only the information in FX movements that is pertinent to stock returns, and therefore should reduce the noise in estimations. See Chan, Karceski and Lakonishok (1998, 1999) and Hou, Karolyi and Kho (2011) for more discussion and applications of the mimicking-portfolio approach. Second, our approach estimates firms' FX sensitivities in a rolling regression fashion (recall that FX sensitivities at the beginning of a month are estimated with the prior one year of daily data), which allows time variation in firm-level exposure. See Doidge, Griffin, and Williamson (2006) for more discussion.

Since XMI is the factor-mimicking portfolio of FX risk, its mean return is an estimate of the FX risk premium, which, as we report in Panel B of Table 1, is 9.21 bps per day with a t-statistic of 3.19 on announcement days. To put the mean return of XMI on announcement days into perspective, we compute the mean returns of the Fama-French factors over the same sample period. We find that the mean return of XMI on announcement days is not smaller (in absolute value) than those of the Fama-French factors. Therefore, the mean return of XMI is not only statistically but also economically significant, suggesting that XMI may be a priced factor in the equity market on macroeconomic announcement days.

3.4 Discussion

Are the announcement effects associated with FX risk documented in Section 3.2 distinct or new? To answer this question, we perform two tests. The first test is based on 25 value-weighted beta-FX portfolios. Essentially, we first rank stocks into five portfolios based on their beta estimates from Equation (1). Then within each beta quintile, we rank stocks into five portfolios based on their FX-sensitivity. If the announcement effects associated with FX risk are distinct from those associated with the market risk, we expect to see a similar nonlinear relationship between FX sensitivity and mean excess returns within each beta quintile on announcement days. The results in the left panel of Table 2 confirm our conjecture. We also rank stocks first by FX-sensitivity then by beta, or construct the 25 portfolios with independent ranking on beta and FX-sensitivity. The results are all similar. Thus, the announcement effects associated with FX risk are distinct from those associated with the market risk.

The second test is based on 25 value-weighted size-FX portfolios. Panel A of Table 1 shows that the two extreme FX-sensitivity portfolios are considerably smaller in terms of size compared to other portfolios. Therefore, one worry is that the announcement effects associated with FX risk in Panel B2 of Figure 1 may simply pick up those associated with size effects documented in Savor and Wilson (2013b). To test this hypothesis, we construct 25 size-FX portfolios. Basically, we first rank stocks into five portfolios based on their size. Then within each size quintile, we rank stocks into five portfolios based on their FX-sensitivity. If the announcement effects associated with FX risk are distinct from those associated with size effects, we expect to see a similar nonlinear relationship between FX sensitivity and mean excess returns within each size quintile on announcement days. The results in the right panel of Table 2 confirm our conjecture. Thus, the evidence in Table 2 suggests that the announcement effects associated with FX risk are new (i.e., not simply a manifestation of known announcement effects).

Table 2. Mean excess returns for 25 Beta-FX portfolios and 25 size-FX portfolios

	Portfolio		Beta					Size				
			Low	2	3	4	High	Small				Big
All	FX	Negative	4.00	3.91	3.33	2.04	1.97	15.82	5.59	4.02	3.32	2.81
			(3.18)	(3.61)	(2.86)	(1.45)	(0.92)	(10.88)	(3.98)	(2.57)	(2.05)	(2.05)
		2	3.64	2.75	2.74	2.58	2.68	9.90	5.28	4.45	4.04	2.57
			(4.53)	(3.32)	(2.75)	(2.08)	(1.48)	(8.94)	(4.92)	(3.63)	(3.27)	(2.37)
		3	3.45	1.95	2.55	2.30	1.89	8.72	5.12	4.42	3.98	2.31
			(5.08)	(2.40)	(2.64)	(1.91)	(1.10)	(9.22)	(5.29)	(3.85)	(3.44)	(2.19)
		4	3.17	2.47	2.56	2.66	2.43	10.28	4.87	4.59	3.64	2.31
			(4.28)	(3.11)	(2.62)	(2.16)	(1.37)	(9.26)	(4.49)	(3.73)	(2.98)	(2.11)
		Positive	5.58	3.37	2.46	1.63	2.23	15.75	6.00	3.51	3.07	1.82
			(4.96)	(3.56)	(2.22)	(1.20)	(1.10)	(10.94)	(4.16)	(2.29)	(2.00)	(1.35)
A-day	FX	Negative	13.98	8.82	7.65	10.67	14.87	28.58	17.77	15.93	14.61	12.28
			(4.70)	(3.29)	(2.48)	(2.88)	(2.60)	(10.95)	(6.23)	(4.37)	(3.71)	(3.13)
		2	6.48	7.82	6.79	8.04	13.89	18.23	13.06	11.49	11.89	9.87
			(3.34)	(3.75)	(2.55)	(2.30)	(2.57)	(9.14)	(5.99)	(3.83)	(3.77)	(3.06)
		3	5.96	5.07	5.72	6.87	10.84	14.83	12.07	10.62	11.00	8.33
			(3.60)	(2.48)	(2.20)	(1.98)	(2.11)	(8.31)	(5.93)	(3.57)	(3.67)	(2.69)
		4	5.22	6.23	5.97	6.99	12.84	17.04	12.17	13.54	12.01	7.47
			(2.98)	(3.22)	(2.21)	(1.95)	(2.37)	(8.60)	(5.39)	(4.24)	(3.79)	(2.29)
		Positive	13.07	7.65	6.63	6.19	11.17	27.56	17.85	14.63	13.94	8.93
			(4.87)	(3.14)	(2.34)	(1.64)	(1.87)	(10.11)	(5.82)	(3.77)	(3.53)	(2.25)
N-day	FX	Negative	2.66	3.25	2.74	0.88	0.23	14.11	3.95	2.42	1.80	1.54
			(1.96)	(2.87)	(2.22)	(0.59)	(0.10)	(9.32)	(2.71)	(1.49)	(1.07)	(1.07)
		2	3.25	2.07	2.20	1.84	1.17	8.78	4.24	3.50	2.98	1.58
			(3.81)	(2.34)	(2.08)	(1.41)	(0.62)	(7.56)	(3.77)	(2.71)	(2.31)	(1.39)
		3	3.11	1.53	2.13	1.68	0.68	7.89	4.19	3.59	3.03	1.50
			(4.32)	(1.77)	(2.10)	(1.33)	(0.38)	(8.00)	(4.11)	(2.99)	(2.51)	(1.36)
		4	2.90	1.96	2.10	2.08	1.03	9.37	3.88	3.39	2.52	1.61
			(3.69)	(2.33)	(2.05)	(1.61)	(0.55)	(8.04)	(3.42)	(2.61)	(1.96)	(1.41)
		Positive	4.57	2.80	1.89	1.02	1.03	14.16	4.41	2.01	1.60	0.87
			(3.86)	(2.80)	(1.63)	(0.71)	(0.48)	(9.54)	(2.93)	(1.26)	(1.01)	(0.61)

Table 2 shows mean excess returns of 25 beta-FX portfolios and 25 size-FX portfolios. Sections “All”, “A-Day” and “N-day” contain mean excess returns on all days, announcement days, and non-announcement days.

4. Asset-pricing tests

4.1 Empirical methodology

Section 3 shows that mean excess returns of FX-sensitivity portfolios are different on macroeconomic announcement days. In this section, we intend to explain why that happens. As Savor and Wilson (2013b) point out, differences in mean excess returns between two types of trading days may be due to differences in risk exposure or differences in risk premium. Therefore, we conduct two sets of tests: one is time series and the other is cross-sectional.

To test whether test assets have significantly different exposure to the FX risk (XMI) on macroeconomic announcement days, we run the following time-series regressions asset by asset over the entire sample period.

$$r_{it} = \alpha_i + \beta_{i,MKT} MKT_t + \beta_{i,XMI} XMI_t + \beta_{i,A\_Day} XMI_t \times D_{t,A\_Day} + \varepsilon_{it} \tag{3}$$

where D_{t,A_Day} is announcement-day dummy. The t-statistics are based on Newey-West HAC standard errors with the lag parameter set equal to 5 for our daily data. We focus on $\beta_{i,\ XMI}$ and $\beta_{i,\ A\_Day}$ in our discussion. If FX risk matters for asset pricing, we expect that test assets are exposed to FX risk or $\beta_{i,\ XMI}$ is generally significant. Furthermore, if there are no significant differences in FX risk exposure between two types of trading days, we expect that $\beta_{i,\ A\_Day}$ is generally not significant. Thus, we report the percentage of test assets with significant $\beta_{i,\ XMI}$ (s_{XMI}) and that with significant $\beta_{i,\ A\_Day}$ ($s_{XMI\times D}$) at the 10% significance level. As we will see, in all cases, test assets are generally exposed to XMI, but the FX exposure is generally not significantly different on announcement days.

To test whether the FX risk premium is significantly different on announcement days, we use the standard Fama and MacBeth (1973) two-pass regression. Since (as we will see) the FX exposure is not significantly different on announcement days, our first-pass regression is based on the following two-factor model.

$$r_{it} = \alpha_i + \beta_{i,MKT} MKT_t + \beta_{i,XMI} XMI_t + \varepsilon_{it} \tag{4}$$

For the second stage, we follow Savor and Wilson (2013b) and estimate risk premium separately for announcement and non-announcement days. Specifically, for each period *t*, we estimate the following cross-sectional regressions:

$$r_{it}^{A} = \gamma_{t,0}^{A} + \gamma_{t,MKT}^{A} \hat{\beta}_{it,MKT} + \gamma_{t,XMI}^{A} \hat{\beta}_{it,XMI} + e_{it} \tag{5a}$$

and

$$r_{it}^{N} = \gamma_{t,0}^{N} + \gamma_{t,MKT}^{N} \hat{\beta}_{it,MKT} + \gamma_{t,XMI}^{N} \hat{\beta}_{ii,XMI} + e_{it} \tag{5b}$$

where r_{it}^{A} and r_{it}^{N} are the excess returns of test asset *i* on announcement and non-announcement days, and $\hat{\beta}_{i,MKT}$ and $\hat{\beta}_{i,XMI}$ are test asset *i*'s exposures to the market and the FX risk estimated with prior one year of daily data from the first-pass regression of Equation (4). Again, following Savor and Wilson (2013b), we estimate the risk premium as the average across time of the cross-sectional estimates, and the standard error equals the time-series standard deviation of the cross-sectional estimates divided by the square root of the respective sample lengths. We then test whether the risk premium is significantly different on announcement days by applying a simple t-test for a difference in means. As we will see, the FX risk premium generally is statistically higher on announcement days.

The time-series and the cross-sectional tests help show the statistical significance of the FX risk on announcement days. To shed light on its economic significance, we calculate and report the mean excess return on announcement days explained by the FX risk ($\overline{r_{A-Day,XMI}}$), which is the product of the average absolute FX exposure from the time-series regressions ($\overline{|\beta_{XMI}|}$) and the FX risk premium on announcement days from the cross-section regression. We also report the percentage of the mean excess return on announcement days explained by the FX risk as the ratio of $\overline{r_{A-Day,XMI}}$ to $\overline{r_{A-Day}}$ (the mean excess return of test assets on announcement days). To put the economic significance of the FX risk into perspective, we also report the corresponding estimates for the market risk.

In terms of test assets, we start with the 10 beta-sorted portfolios used in Savor and Wilson (2013b). The idea is to be comparable to Savor and Wilson (2013b). However, if XMI is a priced factor in the equity market (on announcement days), it should help price other cross-sections (on announcement days) too. Therefore, we expand our test assets to 115 portfolios, including 10 beta-sorted portfolios, 25 beta and FX-sensitivity portfolios, 25 size and FX-sensitivity portfolios, 25 size and BM portfolios, and 30 industry portfolios. An additional benefit of expanding test assets is to ensure that our results are not spurious in the Lewellen, Nagel and Shanken 2010) sense. All the test assets are value-weighted portfolios to mitigate the effects of small/illiquid stocks.

4.2 Main results

Time-series regression results

In Table 3, we report the results based on 10 beta-sorted portfolios used in Savor and Wilson (2013b). Panel A presents excess returns on 10 beta-sorted portfolios on the left-hand side and their risk exposures based on the time series regressions of Equation (4) on the right-hand side.

On the left-hand side of Panel A, Columns "All", "A-Day", "N-Day", and "Diff" contain the average excess returns on all days, those on announcement days, those on non-announcement days, and

Table 3. 10 Beta-sorted portfolios as test assets: January 2nd, 1974 – December 30th, 2011

Panel A: Excess returns and risk exposure

	All	A-Day	N-Day	Diff	Alpha	β_{MKT}	β_{XMI}	$\beta_{XMI\times A}$	R^2
Low	1.01	4.73	0.51	4.22	0.33	0.17	0.18	-0.01	0.11
	(1.02)	(1.84)	(0.49)	(1.58)	(0.37)	(9.13)	(6.59)	(-0.15)	
2	2.86	6.99	2.30	4.69	2.15	0.31	0.05	-0.02	0.31
	(3.81)	(4.03)	(2.89)	(2.56)	(3.59)	(22.07)	(3.41)	(-0.79)	
3	2.57	4.76	2.27	2.49	1.75	0.42	-0.01	-0.03	0.50
	(3.50)	(2.64)	(2.95)	(1.32)	(3.51)	(36.62)	(-0.77)	(-0.87)	
4	1.96	5.84	1.43	4.40	0.89	0.54	-0.02	-0.01	0.65
	(2.40)	(2.85)	(1.66)	(2.04)	(1.85)	(42.45)	(-0.84)	(-0.41)	
5	2.78	6.48	2.28	4.19	1.48	0.65	-0.02	-0.01	0.75
	(3.11)	(2.74)	(2.43)	(1.69)	(3.33)	(51.46)	(-1.20)	(-0.43)	
6	2.17	6.68	1.57	5.12	0.60	0.78	-0.02	-0.01	0.80
	(2.19)	(2.47)	(1.49)	(1.80)	(1.36)	(52.62)	(-0.90)	(-0.20)	
7	2.19	5.94	1.68	4.26	0.27	0.93	-0.01	0.01	0.87
	(1.96)	(1.89)	(1.44)	(1.29)	(0.67)	(78.56)	(-0.69)	(0.44)	
8	2.03	8.28	1.19	7.09	-0.25	1.07	0.02	0.02	0.90
	(1.62)	(2.28)	(0.90)	(1.87)	(-0.63)	(90.72)	(1.29)	(0.66)	
9	1.59	9.60	0.51	9.09	-1.28	1.28	0.10	0.03	0.90
	(1.07)	(2.16)	(0.33)	(1.95)	(-2.64)	(94.95)	(5.35)	(0.95)	
10	1.61	13.99	-0.05	14.04	-2.32	1.59	0.34	-0.00	0.86
	(0.81)	(2.40)	(-0.03)	(2.29)	(-2.91)	(73.15)	(14.42)	(-0.00)	
Summary	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$			$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
Statistics	2.08	7.33	1.37			0.77	0.08	40	0

Panel B: Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	2.09	2.53	-0.44	3.28	2.68	0.60
	(1.20)	(3.58)	(-0.23)	(1.55)	(3.28)	(0.26)
MKT	7.63	-0.94	8.57	5.92	-0.96	6.88
	(1.97)	(-0.66)	(2.08)	(1.45)	(-0.64)	(1.58)
XMI				17.34	-2.06	19.40
				(2.40)	(-0.73)	(2.50)
R^2	0.45	0.44		0.57	0.55	

Panel C: Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\overline{r_{A-Day,MKT}}/\overline{r_{A-Day}}$	$\overline{r_{A-Day,XMI}}/\overline{r_{A-Day}}$
Estimate	4.58	1.33	62	18

Panel A presents excess returns on 10 beta-sorted portfolios. Columns "All", "A-Day", "N-Day", and "Diff" contain the average excess returns on all days, those on announcement days, those on non-announcement days, and the return differences between announcement and non-announcement days, respectively. Section "Summary Statistics" shows the average excess returns on all days ($\overline{r_{All}}$), announcement days ($\overline{r_{A-Day}}$), and non-announcement days ($\overline{r_{N-Day}}$). Panel A also presents the risk exposures of 10 beta-sorted portfolios. Section "Summary Statistics" shows the percentage of test assets with significant exposure to XMI (s_{XMI}) and the percentage of test assets with significantly different exposure to XMI on announcement days ($s_{XMI\times D}$) as well as the average absolute exposures to MKT ($\overline{\lvert\beta_{MKT}\rvert}$) and XMI ($\overline{\lvert\beta_{XMI}\rvert}$).

The two-pass regression results are reported in Panel B. Columns "A-Day", "N-Day", and "Diff" contain the premium estimates on announcement days, those on non-announcement days, and the premium differences between announcement and non-announcement days, respectively.

Panel C reports the economic significance of XMI. The mean excess return on announcement days explained by XMI ($\overline{r_{A-Day,XMI}}$) is the product of the average absolute FX exposure ($\overline{\lvert\beta_{XMI}\rvert}$) and the FX risk premium on announcement days. The percentage of the mean excess return on announcement days explained by XMI is the ratio of $\overline{r_{A-Day,XMI}}$ to $\overline{r_{A-Day}}$. To put the economic significance of XMI into perspective, we also report the corresponding estimates for the market risk.

the return differences between announcement and non-announcement days, respectively. Consistent with Savor and Wilson (2013b), all of 10 beta-sorted portfolios have significantly higher excess returns on announcement days. Section "Summary Statistics" shows that, for 10 beta-sorted portfolios, the average excess returns on all days ($\overline{r_{All}}$), announcement days ($\overline{r_{A-Day}}$), and non-announcement days ($\overline{r_{N-Day}}$) are 2.08 bps, 7.33 bps, and 1.37 bps, respectively. Thus, as Savor and Wilson (2013b) point out, the test assets earn disproportionate fraction of their total excess returns on announcement days.

Now the question is why mean excess returns on announcement days are different. Savor and Wilson (2013b) emphasize the role of the market risk. We extend their analysis by taking into account the FX risk. We first examine if the FX exposure is significantly different on announcement days by running the time-series regressions of Equation (3). As we can see from Panel A of Table 3, four beta-sorted portfolios have significant exposure to the FX risk, but none has significantly different FX exposure on announcement days. Thus, Section "Summary Statistics" shows that s_{XMI} is 40%, and $s_{XMI \times D}$ is 0%. We also report the average absolute exposures, which will be used to estimate the economic significance of each risk factor. For the market risk, $\overline{|\beta_{MKT}|}$ is 0.77. For the FX risk, $\overline{|\beta_{XMI}|}$ is 0.08.

The key take-away from Panel A is that the differences in mean excess returns for 10 beta-sorted portfolios cannot be due to differences in FX exposure. Thus, we next estimate the risk premiums with the two-pass regression.

Two-pass regression results

The two-pass regression results are reported in Panel B of Table 3. We present the results based on the CAPM as in Savor and Wilson (2013b) on the left-hand side (for comparison), and those based on the two-factor model of Equations (4) and (5) on the right-hand side. Columns "A-Day", "N-Day", and "Diff" contain the premium estimates on announcement days, those on non-announcement days, and the premium differences between announcement and non-announcement days, respectively.

Consistent with Savor and Wilson (2013b), with the CAPM, the market risk carries a statistically significant risk premium on announcement days (the announcement-day premium is 7.63 bps with a t-statistic of 1.97), but not on non-announcement days (the non-announcement-day premium is -0.94 bps with a t-statistic of -0.66). The difference is 8.57 bps with a t-statistic of 2.08. On announcement days, the market risk explains 45% of the variation in excess returns across 10 beta-sorted portfolios. Our results are slightly weaker than those in Savor and Wilson (2013b) due to that we use a shorter sample period. For the Savor and Wilson (2013b) sample period, we get the same results.

On the right-hand side of Panel B, we report the results based on the two-factor model that augments the CAPM with the FX risk factor (XMI). Interestingly, even with the presence of the market factor, XMI still carries a significantly positive risk premium on announcement days (the announcement-day premium is 17.34 bps with a t-statistic of 2.40), but not on non-announcement days (the non-announcement-day premium is -2.06 bps with a t-statistic of -0.73). The difference is 19.40 bps with a t-statistic of 2.50. However, the significance of the market factor decreases. The results suggest that although XMI and MKT may have some common information, XMI does have marginal or incremental information relative to MKT. As a result, we see an increase in the Adjusted R^2 on announcement days from 0.45 to 0.57 when XMI is added to the model.

Economic significance

Panels A and B suggest that XMI is a statistically significant factor for asset pricing on announcement days as the market factor. But is it also economically significant? To answer this question, we report the relevant results in Panel C.

The mean excess return explained by the market factor, $\overline{r_{A-Day,MKT}}$, is $\overline{|\beta_{MKT}|}$ times the risk premium of the market factor on announcement days from the two-factor model. The parameter estimates in Panels A and B suggest that it is 4.58 bps or 62% of the mean excess return on announcement days for the 10 beta-sorted portfolios. The explanatory power of the market factor is expected, since the test assets are constructed based on their exposure to the market factor. Similarly, we can calculate the mean excess return on announcement days explained by the FX factor, which is 1.33 bps or 18 percent of the mean excess return on announcement days for 10 beta-sorted portfolios. Thus, even for a set of test assets that are not constructed based on the exposure to the FX risk, the FX risk (i.e., XMI) still explains a non-trivial fraction of the mean excess return on announcement days, which suggests that FX risk is not only statistically but also economically significant.

4.3 Robustness checks

We conduct extensive robustness checks to ensure that our main results are not spurious. First, we experiment with alternative test assets. Nest, we examine subsamples. Then, we employ alternative specifications of XMI. Finally, we use robust standard errors in the two-pass regressions.

Alternative test assets

Table 4 reports the results based on alternative test assets in the same fashion as Table 3. We focus on different sets of test assets first individually then collectively. The idea is to get both fine details as well as the big picture.

Panel A shows the summary statistics for the 25 beta-FX portfolios. First, the average excess returns on all days ($\overline{r_{All}}$), announcement days ($\overline{r_{A-Day}}$), and non-announcement days ($\overline{r_{N-Day}}$) are 2.08 bps,

Table 4. Robustness checks with alternative test assets

Panel A: 25 beta-FX portfolios as test assets

Excess returns and risk exposure

	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	S_{XMI}	$S_{XMI\times D}$
Summary Statistics	2.82	8.62	2.04	0.80	0.13	80	4

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	4.30	3.90	0.39	3.62	4.08	-0.47
	(2.59)	(5.78)	(0.22)	(2.06)	(5.86)	(-0.25)
MKT	6.08	-1.75	7.83	5.58	-2.18	7.76
	(1.62)	(-1.26)	(1.96)	(1.41)	(-1.53)	(1.85)
XMI				13.24	1.25	12.00
				(3.69)	(0.80)	(3.07)
R^2	0.31	0.29		0.37	0.36	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	4.47	1.67	52	19

Panel B: 25 size-FX portfolios as test assets

Excess returns and risk exposure

	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	S_{XMI}	$S_{XMI\times D}$
Summary Statistics	5.53	14.23	4.86	0.72	0.20	100	4

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	18.35	10.56	7.78	14.12	11.01	3.10
	(10.09)	(12.68)	(3.89)	(9.54)	(16.46)	(1.91)
MKT	-6.31	-8.74	2.42	-4.87	-9.35	4.49
	(-1.71)	(-6.42)	(0.62)	(-1.33)	(-6.85)	(1.15)
XMI				19.37	-1.20	20.58
				(4.32)	(-0.64)	(4.23)
R^2	0.27	0.27		0.37	0.36	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	-3.48	3.97	-24	28

Panel C: 25 size-BM portfolios as test assets

Excess returns and risk exposure

	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	S_{XMI}	$S_{XMI\times D}$
Summary Statistics	3.00	10.51	1.99	0.87	0.14	100	0

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	5.69	4.91	0.78	6.51	5.56	0.95
	(2.18)	(4.65)	(0.28)	(2.45)	(5.57)	(0.33)
MKT	5.85	-3.05	8.90	3.44	-3.70	7.14
	(1.48)	(-2.02)	(2.11)	(0.83)	(-2.47)	(1.63)
XMI				18.57	-2.05	20.62
				(3.76)	(-0.98)	(3.84)
R^2	0.20	0.18		0.33	0.31	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	3.00	2.59	29	25

Panel D: 30 Industry portfolios as test assets

Excess returns and risk exposure

Summary Statistics	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\vert\beta_{MKT}\vert}$	$\overline{\vert\beta_{XMI}\vert}$	S_{XMI}	$S_{XMI\times D}$
	2.66	8.82	1.83	0.96	0.13	73	7

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	-0.91	1.81	-2.72	2.70	1.67	1.04
	(-0.32)	(1.63)	(-0.88)	(0.93)	(1.51)	(0.33)
MKT	10.85	0.37	10.48	6.64	0.42	6.22
	(2.64)	(0.23)	(2.37)	(1.55)	(0.26)	(1.36)
XMI				10.42	-1.03	11.45
				(2.12)	(-0.52)	(2.16)
R^2	0.12	0.12		0.19	0.18	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	6.38	1.34	72	15

Panel E: 115 portfolios as test assets

Excess returns and risk exposure

Summary Statistics	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\vert\beta_{MKT}\vert}$	$\overline{\vert\beta_{XMI}\vert}$	S_{XMI}	$S_{XMI\times D}$
	3.34	10.19	2.42	0.84	0.14	83	3

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	7.26	5.00	2.26	6.40	4.72	1.67
	(4.70)	(7.64)	(1.35)	(4.26)	(7.72)	(1.03)
MKT	3.91	-2.73	6.64	2.92	-2.84	5.76
	(1.09)	(-2.06)	(1.74)	(0.80)	(-2.14)	(1.48)
XMI				18.96	2.42	16.54
				(5.22)	(1.58)	(4.19)
R^2	0.22	0.21		0.29	0.29	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	2.44	2.70	24	27

Table 4 reports the results based on alternative test assets. In each case, we report three sets of results as in Table 3. Section "Excess returns and risk exposure" shows the average excess returns of test assets on all days ($\overline{r_{All}}$), announcement days ($\overline{r_{A-Day}}$), and non-announcement days ($\overline{r_{N-Day}}$). This section also reports the percentage of test assets with significant exposure to XMI (s_{XMI}), the percentage of test assets with significantly different exposure to XMI on announcement days ($s_{XMI\times D}$), and the average absolute exposures to MKT ($\overline{|\beta_{MKT}|}$) and XMI ($\overline{|\beta_{XMI}|}$).

Section "Risk premium" reports the two-pass regression results. "A-Day", "N-Day", and "Diff" contain the premium estimates on announcement days, those on non-announcement days, and the premium differences between announcement and non-announcement days, respectively.

Section "Economic significance" shows the economic significance of XMI. The mean excess return on announcement days explained by XMI ($\overline{r_{A-Day,XMI}}$) is the product of the average absolute FX exposure ($\overline{|\beta_{XMI}|}$) and the FX risk premium on announcement days. The percentage of the mean excess return on announcement days explained by XMI is the ratio of $\overline{r_{A-Day,XMI}}$ to $\overline{r_{A-Day}}$. To put the economic significance of XMI into perspective, we also report the corresponding estimates for the market risk.

7.33 bps, and 1.37 bps, respectively. Thus, the test assets have higher mean excess returns on announcement days. Second, the time-series regressions suggest that the percentage of the test assets with significant exposure to XMI (s_{XMI}) is 80%, and the percentage of the test assets with significantly different exposure to XMI on announcement days ($s_{XMI \times D}$) is 4%. Thus, the differences in mean excess returns for the test assets between two types of trading days cannot be due to differences in FX exposure. Third, even with the presence of the market factor, XMI still carries a significantly positive risk premium on announcement days (the announcement-day premium is 13.24 bps with a t-statistic of 3.69), but not on non-announcement days (the non-announcement-day premium is 0.80 bps with a t-statistic of 0.36). The premium difference is 12.00 bps with a t-statistic of 3.07. Fourth, The mean excess return explained by the market factor, $\overline{r_{A-Day,MKT}}$, is 4.47 bps or 52% of the mean excess return on announcement days, while that for the FX factor is 1.67 bps or 19 percent. Thus, FX risk is not only statistically but also economically significant.

Similar results are found for 25 size-FX portfolios, 25 size-BM portfolios and 30 industry portfolios in Panels B, C and D. First, the test assets always have higher mean excess returns on announcement days. Second, the differences in mean excess returns for the test assets between two types of trading days cannot be explained by differences in FX exposure. Third, XMI always carries a significantly positive risk premium on announcement days. Fourth, economically, XMI explains a non-trivial fraction of the mean excess return of test assets on announcement days, ranging from 15% to 28%.

To assess the overall pricing power of XMI, we use all 115 portfolios as test assets. The results are presented in Panel E. First, the average excess returns on all days, announcement days, and non-announcement days are 3.34 bps, 10.19 bps, and 2.42 bps, respectively. Second, the percentage of the test assets with significant exposure to XMI is 83%,[4] and that with significantly different exposure to XMI on announcement days is 3%. Third, the announcement-day premium of XMI is 18.96 bps with a t-statistic of 5.22, where the non-announcement-day premium is 2.42 bps with a t-statistic of 1.58. The premium difference is 16.54 bps with a t-statistic of 4.19. Fourth, The mean excess return explained by the market factor is 2.44 bps or 24% of the mean excess return on announcement days, while that for the FX factor is 2.70 bps or 27 percent. Thus, for a wide variety of test assets, FX risk is not only statistically but also economically significant.

[4] We find more significant FX exposure than previous studies (e.g., Jorion, 1990). This may be due to two reasons. First, we use the FX factor-mimicking portfolio instead of FX changes, which as we have pointed out should help reduce noise in estimation. Second, we use daily data instead of monthly data. If the market is efficient, information should be incorporated into asset prices instantaneously. This idea drives the FX announcement literature (e.g., Faust et al. 2007) to use intra-day data. This idea also suggests that it may be more advantageous to use daily instead of monthly data in asset pricing tests.

Subsample evidence

To test if our results are robust over time, we divide our sample period into two equal-length subsample periods, 1974 to 1992 and 1993 to 2011. We then repeat our exercises with 115 portfolios as test assets to assess the overall pricing power of XMI. Again, using such a variety of test assets also ensures that our results are not spurious in the Lewellen, Nagel and Shanken 2010) sense. The subsample results are reported in Table 5, and are qualitatively similar as those for the whole sample period in Panel E of Table 4. First, the test assets always have higher mean excess returns on announcement days in both subsamples. Second, the differences in mean excess returns for the test assets between two types of trading days cannot be explained by differences in FX exposure in both subsamples. Third, XMI always carries a significantly positive risk premium on announcement days in both subsamples. Fourth, economically, XMI explains a non-trivial fraction of the mean excess return on announcement days in both subsamples, 39% in the 1974-1992 period and 22% in the 1993-2011 period.

Alternative XMI specifications

We experiment with alternative XMI specifications. Specification 1 is to use 25 equal-weighted FX-sensitivity portfolios to construct XMI. Specification 2 is to exclude low-priced illiquid stocks by using the filter in Cooper, Gutierrez and Hameed (2004). Specification 3 is to use a three-year window to estimate firm-level FX sensitivity instead of one year. Specification 4 is to exclude outlier returns (i.e., returns outside the three standard deviation bands) to estimate firm-specific FX sensitivity. The mean excess returns for the FX-sensitivity portfolios separately for announcement days and non-announcement days are depicted in Figure 2. In all cases, consistent with the benchmark case, mean excess returns of the FX-sensitivity portfolios on announcement days are different from those on non-announcement days. First, mean excess returns of the FX-sensitivity portfolios are higher on announcement days. Second, there is a U-shaped relationship between FX sensitivity and mean excess returns on announcement days.

The asset-pricing results with alternative XMI specifications are reported in Table 6. Again, we use 115 portfolios as test assets to assess the overall pricing power of XMI and to ensure that our results are not spurious in the Lewellen, Nagel and Shanken 2010) sense. As we can see, the results are qualitatively similar as those in Panel E of Table 4. First, the differences in mean excess returns for the test assets between two types of trading days still cannot be explained by differences in FX exposure. Second, XMI always carries a significantly positive risk premium on announcement days. Third, economically, XMI explains a non-trivial fraction of the mean excess return of test assets on announcement days, ranging from 21% to 33%.

Table 5. Subsample evidence with 115 test assets

Panel A: 1974 - 1992

Excess returns and risk exposure

	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
Summary Statistics	3.15	8.64	2.44	0.80	0.17	90	11

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	10.63	4.95	5.68	6.40	3.88	2.52
	(5.08)	(5.60)	(2.50)	(3.44)	(5.21)	(1.26)
MKT	-2.43	-1.91	-0.52	-0.15	-1.19	1.04
	(-0.55)	(-1.24)	(-0.11)	(-0.03)	(-0.78)	(0.23)
XMI				19.28	1.50	17.78
				(4.65)	(0.96)	(4.02)
R^2	0.23	0.22		0.29	0.28	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	-0.12	3.34	-1	39

Panel B:1993 - 2011

Excess returns and risk exposure

	$\overline{r_{All}}$	$\overline{r_{A-Day}}$	$\overline{r_{N-Day}}$	$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
Summary Statistics	3.53	11.61	2.40	0.87	0.14	83	5

Risk premium

	A-day	N-day	Diff.	A-day	N-day	Diff.
Alpha	4.04	4.33	-0.29	6.45	4.97	1.48
	(1.73)	(4.32)	(-0.11)	(2.69)	(4.95)	(0.57)
MKT	10.66	-3.03	13.69	6.50	-4.04	10.54
	(1.85)	(-1.35)	(-2.22)	(1.08)	(-1.80)	(1.64)
XMI				18.79	2.78	16.01
				(3.11)	(1.02)	(2.41)
R^2	0.22	0.21		0.30	0.30	

Economic significance

	$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
Estimate	5.68	2.55	49	22

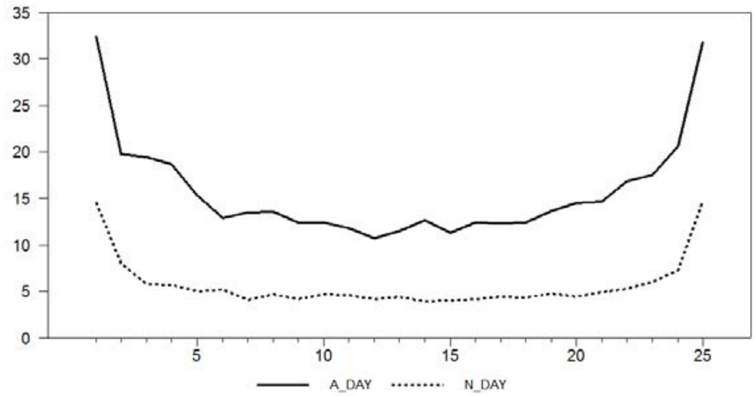
Table 5 reports the results for two equal-length subsamples. In each case, we report three sets of results as in Table 3. Section "Excess returns and risk exposure" shows the average excess returns of test assets on all days ($\overline{r_{All}}$), announcement days ($\overline{r_{A-Day}}$), and non-announcement days ($\overline{r_{N-Day}}$). This section also reports the percentage of test assets with significant exposure to XMI (s_{XMI}), the percentage of test assets with significantly different exposure to XMI on announcement days ($s_{XMI\times D}$), and the average absolute exposures to MKT ($\overline{\lvert\beta_{MKT}\rvert}$) and XMI ($\overline{\lvert\beta_{XMI}\rvert}$).

Section "Risk premium" reports the two-pass regression results. "A-Day", "N-Day", and "Diff" contain the premium estimates on announcement days, those on non-announcement days, and the premium differences between announcement and non-announcement days, respectively.

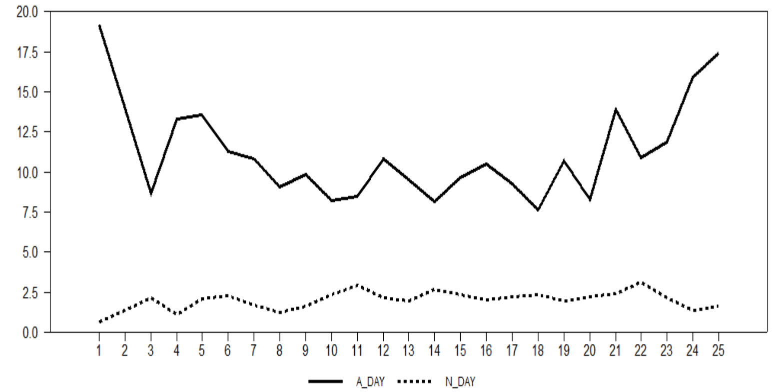
Section "Economic significance" shows the economic significance of XMI. The mean excess return on announcement days explained by XMI ($\overline{r_{A-Day,XMI}}$) is the product of the average absolute FX exposure ($\overline{\lvert\beta_{XMI}\rvert}$) and the FX risk premium on announcement days. The percentage of the mean excess return on announcement days explained by XMI is the ratio of $\overline{r_{A-Day,XMI}}$ to $\overline{r_{A-Day}}$. To put the economic significance of XMI into perspective, we also report the corresponding estimates for the market risk.

Figure 2. Mean excess returns for various FX-sorted portfolios

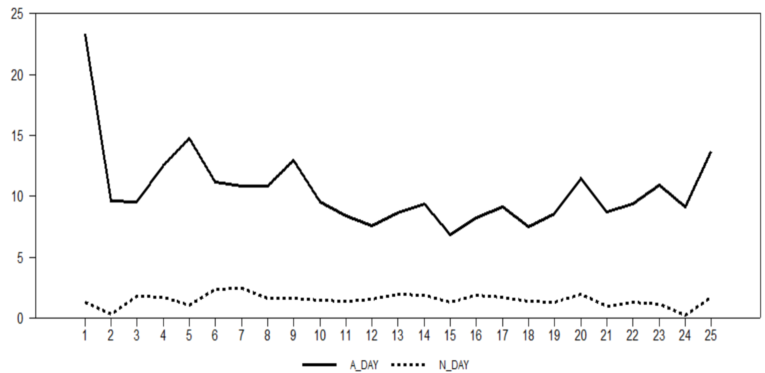
Panel A: 25 equal-weighted FX-sensitivity portfolios



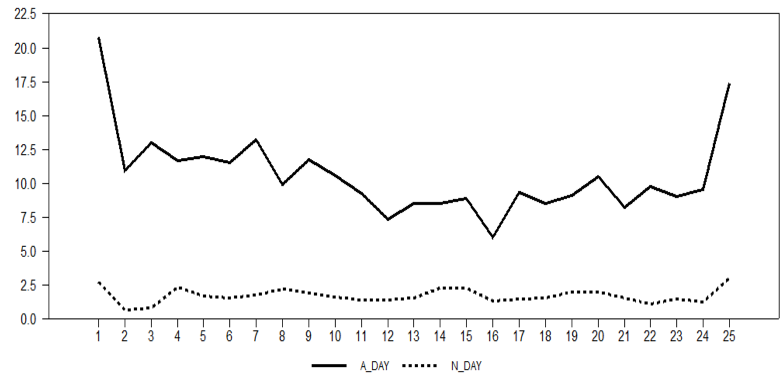
Panel C 25 FX-sensitivity portfolios with three-year estimation window



Panel B: 25 FX-sensitivity portfolios with low-priced stocks excluded



Panel D 25 FX-sensitivity portfolios with outliers excluded



We experiment with alternative XMI specifications. Specification 1 is to use 25 equal-weighted FX-sensitivity portfolios to construct XMI. Specification 2 is to exclude low-priced illiquid stocks by using the filter in Cooper, Gutierrez and Hameed (2004). Specification 3 is to use a three-year window to estimate FX sensitivity. The mean excess returns for the FX-sensitivity portfolios separately for announcement days and non-announcement days are depicted in Figure 2.

Table 6. Robustness checks with alternative XMI specifications and 115 test assets

Panel A: 25 equal-weighted FX portfolios			
Risk exposure			
$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
0.85	0.16	83	10
Risk premium			
	A-day	N-day	Diff.
Alpha	3.21	3.26	-0.05
	(2.18)	(5.49)	(-0.03)
MKT	6.32	-1.52	7.84
	(1.76)	(-1.15)	(2.05)
XMI	20.48	7.86	12.61
	(8.25)	(7.64)	(4.69)
R^2	0.28	0.28	
Economic significance			
$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
5.40	3.34	53	33

Panel C:Use three-year window			
Risk exposure			
$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
0.84	0.15	83	3
Risk premium			
	A-day	N-day	Diff.
Alpha	7.25	4.39	2.86
	(4.83)	(6.86)	(1.76)
MKT	2.22	-2.78	5.00
	(0.59)	(-2.01)	(1.25)
XMI	14.44	1.04	13.40
	(4.14)	(0.68)	(3.52)
R^2	0.30	0.29	
Economic significance			
$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
1.87	2.13	18	21

Panel B:Exclude low-priced stocks			
Risk exposure			
$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
0.83	0.15	83	4
Risk premium			
	A-day	N-day	Diff.
Alpha	7.05	4.93	2.12
	(4.73)	(8.04)	(1.32)
MKT	2.43	-2.95	5.38
	(0.66)	(-2.22)	(1.38)
XMI	16.36	1.14	15.22
	(4.80)	(0.79)	(4.11)
R^2	0.29	0.28	
Economic significance			
$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
2.03	2.49	20	24

Panel D: Exclude outlier returns			
Risk exposure			
$\overline{\lvert\beta_{MKT}\rvert}$	$\overline{\lvert\beta_{XMI}\rvert}$	s_{XMI}	$s_{XMI\times D}$
0.83	0.15	83	3
Risk premium			
	A-day	N-day	Diff.
Alpha	7.30	4.91	2.39
	(4.95)	(8.06)	(1.50)
MKT	2.25	-2.96	5.22
	(0.62)	(-2.24)	(1.35)
XMI	16.50	1.27	15.23
	(4.88)	(0.89)	(4.15)
R^2	0.29	0.28	
Economic significance			
$\overline{r_{A-Day,MKT}}$	$\overline{r_{A-Day,XMI}}$	$\frac{\overline{r_{A-Day,MKT}}}{\overline{r_{A-Day}}}$	$\frac{\overline{r_{A-Day,XMI}}}{\overline{r_{A-Day}}}$
1.87	2.49	18	24

Table 6 reports the results based on alternative XMI specifications. In each case, we report three sets of results. Section "Risk exposure" reports the percentage of test assets with significant exposure to XMI (s_{XMI}), the percentage of test assets with significantly different exposure to XMI on announcement days ($s_{XMI\times D}$), and the average absolute exposures to MKT ($\overline{\lvert\beta_{MKT}\rvert}$) and XMI ($\overline{\lvert\beta_{XMI}\rvert}$).

Section "Risk premium" reports the two-pass regression results. "A-Day", "N-Day", and "Diff" contain the premium estimates on announcement days, those on non-announcement days, and the premium differences between announcement and non-announcement days, respectively.

Section "Economic significance" shows the economic significance of XMI. The mean excess return on announcement days explained by XMI ($\overline{r_{A-Day,XMI}}$) is the product of the average absolute FX exposure ($\overline{\lvert\beta_{XMI}\rvert}$) and the FX risk premium on announcement days. The percentage of the mean excess return on announcement days explained by XMI is the ratio of $\overline{r_{A-Day,XMI}}$ to $\overline{r_{A-Day}}$. To put the economic significance of XMI into perspective, we also report the corresponding estimates for the market risk.

Robust Fama and MacBeth (1973) cross-sectional regressions

The simple Fama and MacBeth (1973) two-pass regression methodology used in Savor and Wilson (2013b) is designed to easily test the differences between announcement-day and non-announcement-day premium estimates. However, this methodology may bring in the well-known errors-in-variables (EIV) bias (since this methodology estimates factor loadings in the first pass and using those to obtain risk premiums in the second pass) and misspecification (MIS) biases (since the CAPM or the two-factor model may have model specifications). To test if our results are robust to these biases, we modify the Savor and Wilson (2013b) methodology.

First, since there are no significant differences in FX exposure between announcement and non-announcement days, we divide our sample into two subsamples, the announcement-day subsample and the non-announcement-day subsample. Second, within each subsample, we apply the Shanken (1992) correction to obtain EIV-robust standard errors, accounting for the fact that factor sensitivities are estimated, and the Shanken and Zhou (2007) correction to generate MIS-robust standard errors. We also take into account the suggestions of Lewellen, Nagel and Shanken (2010) regarding cross-sectional asset-pricing tests: (1) we still use the expanded set of test assets (115 portfolios); (2) we report not only the OLS results but also the GLS results.

The results are reported in Table 7. γ is the estimated risk premium associated with each factor. t_{EIV} and t_{MIS} are the Shanken (1992) EIV-robust t-ratio and the Shanken and Zhou (2007) MIS-robust t-ratio, respectively. We also report the cross-sectional adjusted R^2. As we can see, our results are qualitatively similar as those reported in Panel E of Table 4. Based on the OLS regressions, the announcement-day premium of XMI is 16.02 bps (t_{EIV} = 3.92 or t_{MIS} = 3.90), where the non-announcement-day premium is 1.72 bps (t_{EIV} = 1.07 or t_{MIS} = 1.07). Based on the GLS regressions, the announcement-day premium of XMI is 10.80 bps (t_{EIV} = 3.15 or t_{MIS} = 2.98), where the non-announcement-day premium is 1.04 bps (t_{EIV} = 0.74 or t_{MIS} = 0.72). Thus, our results are robust to EIV or MIS biases.

Discussion

The evidence so far suggests that FX risk is not only statistically and economically significant in the equity market but also distinct from the market risk. What is the macroeconomic rational for this phenomenon? One possible perspective is that the market factor (MKT) and the FX factor-mimicking portfolio (XMI) may capture different information contents in the underlying macroeconomic state variables. MKT may capture mainly the “domestic” implications of the state variables, since movements of positive FX-sensitivity assets may to some degree offset those of negative FX-sensitivity assets. In contrast, XMI largely captures the “international”

Table 7. Robust Fama and MacBeth (1973) cross-sectional regressions

	OLS				GLS			
Panel A: A-Day								
	γ	t_{EIV}	t_{MIS}	R^2	γ	t_{EIV}	t_{MIS}	R^2
Alpha	9.96	(6.38)	(6.34)	-0.01	7.99	(8.57)	(7.60)	-0.08
MKT	0.28	(0.08)	(0.08)		1.30	(0.39)	(0.38)	
Alpha	10.00	(6.30)	(6.29)	0.37	8.41	(8.88)	(7.88)	0.31
MKT	-1.37	(-0.39)	(-0.39)		0.89	(0.26)	(0.26)	
XMI	16.02	(3.92)	(3.90)		10.80	(3.15)	(2.98)	
Alpha	10.42	(6.98)	(6.90)	0.37	8.33	(8.58)	(7.56)	0.31
MKT	-1.54	(-0.43)	(-0.43)		0.98	(0.29)	(0.29)	
XMI	15.66	(3.46)	(3.36)		10.14	(2.86)	(2.66)	
SMB	4.60	(2.74)	(2.71)		3.47	(2.15)	(2.14)	
HML	-2.20	(-1.28)	(-1.25)		-1.63	(-1.09)	(-1.08)	
Panel B: N-Day								
	OLS				GLS			
	γ	t_{EIV}	t_{MIS}	R^2	γ	t_{EIV}	t_{MIS}	R^2
Alpha	5.82	(8.83)	(8.83)	0.28	6.63	(15.77)	(15.05)	0.22
MKT	-3.94	(-2.97)	(-2.97)		-5.27	(-4.23)	(-4.21)	
Alpha	5.86	(8.85)	(8.84)	0.32	6.77	(15.84)	(15.09)	0.29
MKT	-4.28	(-3.22)	(-3.22)		-5.41	(-4.33)	(-4.31)	
XMI	1.72	(1.07)	(1.07)		1.04	(0.74)	(0.72)	
Alpha	5.91	(9.45)	(9.42)	0.31	6.81	(15.50)	(14.71)	0.24
MKT	-4.34	(-3.26)	(-3.26)		-5.45	(-4.35)	(-4.32)	
XMI	2.25	(1.29)	(1.29)		1.72	(1.18)	(1.14)	
SMB	0.89	(1.39)	(1.39)		0.36	(0.59)	(0.59)	
HML	0.80	(1.20)	(1.20)		2.35	(4.02)	(4.01)	

Table 7 reports the Fama and MacBeth (1973) two-pass OLS regressions (with a constant) with 115 portfolios as the test assets. γ is the estimated risk premium associated with each factor. t_{EIV} and t_{MIS} are the Shanken (1992) errors-in-variables robust t-ratio and the Shanken and Zhou (2007) misspecification robust t-ratio, respectively. We also report the cross-sectional adjusted R^2.

implications of the state variables, since by construction it is a zero-investment portfolio that takes long positions in stocks that are extremely sensitive (in absolute value) to FX movements and short positions in stocks that are not extremely sensitive to FX fluctuations. Different information contents, in principle, can have different asset-pricing implications. Therefore, we need two factors (i.e., MKT and XMI) to capture the information in the state variables.

Are the results in this paper relevant to the literature? We argue that the present paper contributes to the literature in three ways. First, there are two largely isolated literatures on FX risk. One is the FX announcement effects literature (e.g., Faust et al. 2007), and the other is the FX risk literature (e.g., Jorion, 1990, 1991). The present paper helps bridge these two previously-isolated literatures by showing that FX risk is a priced factor on macro announcement days.

Second, although FX risk is expected to be a priced factor in the equity market, the FX risk literature has generally failed to find supporting evidence. Therefore, a recent explanation for the exposure puzzle is that firms use financial hedging to reduce their FX exposure (e.g., Bartram, Brown, and Minton, 2010). We provide an alternative perspective by showing that at times when investors expect to learn important information about the state of the economy (i.e., on macroeconomic announcement days), they do demand higher returns to hold FX-sensitivity assets. However, because macro announcement days are a small fraction of trading days (about 12% in our sample), if we do not distinguish announcement from non-announcement days, we likely miss the risk-return trade-off associated with the FX risk.

Third, the present paper strengthens the macroeconomic announcement approach in Savor and Wilson (2013a, 2013b), which has significant theoretical as well as empirical implications for asset pricing. Savor and Wilson (2013b) discuss the theoretical implications. For empirical asset pricing, this macroeconomic announcement approach may help develop empirical models based on macroeconomic state variables.

5. Conclusion

Savor and Wilson (2013a, 2013b) suggest that the tradeoff between state variable risk and asset returns underlying standard asset-pricing theories should be particularly strong on prescheduled macroeconomic announcement days, because important information about the state of the economy is revealed at such times. We apply this insight to foreign-exchange risk, and find robust evidence that foreign-exchange risk is priced on prescheduled macroeconomic announcement days. Our results make important contributions to both international finance and empirical asset-pricing literature.

References

Adler, M., and Dumas, B., 1983. International portfolio choice and corporate finance: a synthesis. Journal of Finance 38, 925-984.

Allayannis, G., and Ihrig, J., 2001. Exposures and markups, Review of Financial Studies 14, 805-835

Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega, 2007. Real-time price discovery in global stock, bond and foreign exchange markets, Journal of International Economics 73, 251–277.

Bartov, E., and G.M. Bodnar 1994. Firm Valuation, Earnings Expectations, and the Exchange Rate Exposure Effect, Journal of Finance 44:5: 1755-1785.

Bartram, Sohnke M., 2008, "What Lies Beneath: Foreign Exchange Rate Exposure, Hedging and Cash Flows," Journal of Banking and Finance, 32, 1508-1521.

Bartram, S. M., G.W. Brown, and B. Minton, 2010, Resolving the exposure puzzle: the many facets of exchange rate exposure, Journal of Financial Economics 95, 148-173.

Bodnar, G. M., Dumas, B., and Marston, R. C., 2002. Pass-though and exposure. Journal of Finance 57, 199-232.

Chan, L. K. C., J. Karceski, and J. Lakonishok, 1998, The risk and return from factors, Journal of Financial and Quantitative Analysis 33, 159-188.

Chan, L. K. C., J. Karceski, and J. Lakonishok, 1999, On portfolio optimization: Forecasting covariances and choosing the risk model, The Review of Financial Studies 12, 937-974.

Chow, E.H., Lee, W.Y., and Solt, M.E., 1997. The exchange-rate risk exposure of asset returns. Journal of Business 70, 105-123.

Cooper, M. J., R. C. Gutierrez, and A. Hameed, 2004. Market States and Momentum, Journal of Finance, 59, 1345-1365.

Doidge, C., J. Griffin, and R. Williamson, 2006, Does exchange rate exposure matter?, Journal of Empirical Finance 13, 550-576.

Dominguez, K. M. E., and Tesar, L. L., 2001. A re-examination of exchange rate exposure. American Economic Review 91, 396–399.

Evans, M. D. D., and R. K. Lyons, 2008. How is macro news transmitted to exchange rates?, Journal of Financial Economics 88, 26–50.

Fama, E.F., MacBeth, J.D., 1973. Risk, return, and equilibrium: Empirical tests. Journal of Political Economy 81, 607-636.

Fama, E. F., and K. R. French, 1992, The cross-section of expected stock returns, Journal of Finance 47, 427-465.

Fama, E. F., and K. R. French, 1993, Common risk factors in the returns on stocks and bonds, Journal of Financial Economics 33, 3-56.

Faust, J., J. H. Rogers, S. B. Wang, and J. H. Wright, 2007. The high-frequency response of exchange rates and interest rates to macroeconomic announcements, Journal of Monetary Economics 54, 1051-1068.

Frankel, J., & A. Rose, 1995. Empirical research on nominal exchange rates. G. Grossman, K. Rogoff (Eds.), Handbook of International Economics, Elsevier Science, Amsterdam, pp. 1689–1729.

Hou, K., A. Karolyi, and B. Kho, 2011, What factors drive global stock returns?, Review of Financial Studies 24, 2527-2574.

Jorion, P., 1990. The exchange-rate exposure of U.S. multinationals. Journal of Business 63, 331-345

Jorion, P. 1991. The Pricing of Exchange Rate Risk in the Stock Market, Journal of Financial and Quantitative Analysis 26: 363-376.

Kolari, J., Moorman, T., and Sorescu, S. M.., 2008. Foreign Exchange Risk and the Cross-Section of Stock Returns. Journal of International Money and Finance 27, 1074-1097.

Lewellen, J. W., S. Nagel, and J. A. Shanken, 2010, A skeptical appraisal of asset pricing tests, Journal of Financial Economics 96, 175-194.

Lintner, J., 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. The Review of Economics and Statistics 47,

Savor, P., and Wilson, M. 2013a. How Much Do Investors Care About Macroeconomic Risk? Evidence From Scheduled Economic Announcements, Journal of Financial and Quantitative Analysis 48, 343-375.

Savor, P., and Wilson, M. 2013b. Asset Pricing: A Tale of Two Days. Journal of Financial Economics, forthcoming.

Sercu, P., 1980. A generalization of the international asset pricing model. Revue de l'Association Française de Finance 1, 91-135.

Sharpe, W.F., 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance 19, 425-442.

Shanken, J., 1992, On the Estimation of Beta-Pricing Models, Review of Financial Studies 5, 1-33.

Shanken, J., and G. Zhou, 2007, Estimating and Testing Beta Pricing Models: Alternative Methods and Their Performance in Simulations, Journal of Financial Economics 84, 40-86.

Solnik, B., 1974. An equilibrium model of the international capital market. Journal of Economic Theory 8, 500-524.