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The FX exposure puzzle: insights from SEC disclosures

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Abstract

Purpose – Using firm-specific SEC currency risk disclosures, this paper aims to provide insight into the puzzling absence of significant returns-based foreign exchange exposure (FXE). Such a hand gathered disclosure data identify the bilateral exchange rate to which the firm is most vulnerable (BRV) and the firm's FX hedge techniques.

Design/methodology/approach – The BRV-based estimates of FXE are compared to the FXE estimates using the broad trade-weighted index (TWI) data that are prevalent in prior research. Multivariate regression and sample partitioning by level of value and size premiums are used to analyze these alternative FXE estimates.

Findings – The univariate results reveal a higher percentage of firms with significant BRV-estimated FXE compared to TWI-estimated FXE. Multivariate tests indicate a negative relation between firm-specific financial hedging and BRV-estimated FXE (but not TWI-estimated FXE), controlling for firm-specific non-financial/operational hedging, size and industry effects. Moreover, firms in the first and fifth quintiles for measures of value/growth and size have higher levels of FXE.

Practical implications – Using SEC currency risk disclosures improves the analysis of firm-specific FXE, allowing investors to better estimate risk and cost of capital.

Originality/value – The paper helps resolve the FX exposure puzzle using a unique dataset of firm-specific currency risk disclosures. The improved estimates of FXE provide a more detailed risk profile of multinational firms.

Keywords Foreign exchange exposure, Hedging, Currency risk disclosure, Foreign exchange options

Paper type Research paper

1. Introduction

As global markets become more integrated and volatile, understanding the pricing of foreign exchange exposure (FXE) has become more important. Numerous studies have long suggested that firm value is sensitive to exchange rate changes and hedging techniques (Shapiro, 1975; Smith and Stulz, 1985; Levi, 1994). Despite such theoretical predictions, empirical researchers have been surprisingly unsuccessful in documenting returns-based FXE, using a market model approach (Jorion, 1990; He and Ng, 1998; Bodnar and Wong, 2003; Chue and Cook, 2008). This discrepancy between FXE theory and evidence, as reviewed in Bartram and Bodnar (2007), is referred to as the "exchange rate exposure puzzle."

A primary challenge in resolving this puzzle is the difficulty in identifying the exchange rate(s) particular to each firm's FX exposure (Bartram *et al.*, 2010). Confronted by such data challenges, much of the returns-based FXE research continues to rely

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on a broad trade-weighted exchange rate index (TWI), despite its recognized limitations in measuring firm-specific FXE (Miller and Reuer, 1998; Ihrig, 2001; Dominguez and Tesar, 2006). We avoid these FX rate concerns by hand gathering SEC disclosure data on the currency that each firm identifies as the bilateral rate to which it is most vulnerable (BRV). In this way, we also improve upon FXE studies that infer the FX rate(s) particular to a firm's exposure-based on its geographic location and industry membership (Williamson, 2001; Koutmos and Martin, 2003; Fraser and Pantzalis, 2004).

We compare FXE estimates using this firm-specific BRV data to the FXE estimates using the broad TWI data. In addition to the BRV data, we take advantage of hand gathered data on firm-specific currency hedge techniques (both financial and non-financial/operational). Extant research emphasizes the importance of incorporating these multiple hedge techniques into analyses of firm-specific FXE (Bartram and Bodnar, 2007). To date, no study has used firm-specific SEC disclosure data on BRV and hedge techniques in resolving the FX exposure puzzle.

Although researchers continue to rely on broad TWI data, recent studies have improved returns-based FXE estimations by incorporating the Fama and French (FF) value and size factors into the market model approach (Choi and Jiang, 2009; Aggarwal and Harper, 2010; Huffman *et al.*, 2010). Using this more complete approach based on the asset pricing literature, these studies have documented a higher percentage of statistically significant FXE estimates at the firm level. We take the next step in integrating the asset pricing and FXE literatures, by expanding the FXE analysis to distinguish firms based on their sensitivities to the value and size factors (Fama and French, 1993).

Our expectations for the relation between FXE and the FF factors are based on theories of optimal hedging (Froot *et al.*, 1998) and hedge information mispricing (Gigler *et al.*, 1997). These theories suggest that multinationals with extremely low and high sensitivities to the value factor (i.e. growth and value firms, respectively) have lower hedge incentives and thus, higher levels of FXE net of such hedging[1]. Similarly, optimal hedge theory predicts that our sample of multinationals classified as the largest and smallest firms may experience higher FXE due, in part, to lower hedge incentives (Warner, 1977). More generally, there is strong empirical evidence that firm size is associated with the use of FX hedges and net FXE levels (Bartram and Bodnar, 2007).

In this paper, we examine alternative FXE estimates in relation to firm-specific FX hedge techniques and other FXE determinants, for US multinationals with *ex ante* exposure to FX rate changes. We employ the more complete FF model to estimate FXE using either the firm-specific BRV data or the broad TWI data. Our primary contribution is the analysis of the relationship between BRV-estimated FXE and the firm's associated hedge techniques, using a unique dataset of hand gathered SEC disclosure data. We also incorporate the FF value and size factors into the FXE analysis by adopting a partitioning method similar to Houge and Loughran (2006).

Consistent with our expectations, we find an inverse relationship between FX financial hedging (i.e. either FX derivatives or FX denominated debt) and BRV-estimated FXE. In contrast, we do not find any FXE-financial hedging relationship employing the broad TWI measure that is prevalent in prior studies. These primary multivariate results are consistent with our univariate evidence and suggest that using SEC currency risk disclosure data improves the analysis of firm-specific FXE. We also find that firms in the first and fifth quintiles for measures of value/growth and size have higher levels of FXE, consistent with our theory-based expectations. We provide evidence that these primary results are not sensitive to non-financial/operational hedging, firm size, or industry membership, and are robust to alternative model specifications.

This paper is organized as follows. Section 2 describes the sample data; Section 3 presents the FF model and univariate tests of FF model FXE estimates using either the firm-specific BRV data or the broad TWI data; Section 4 provides multivariate analyses of such alternative FXE estimates; and Section 5 concludes the paper.

2. Data and sample description

We examine the FXE of US multinationals with *ex ante* exposure to FX rate changes by sampling firms with foreign sales ratios of at least 10 percent in the 2001-2006 period (Geczy *et al.*, 1997). We hand gathered firm-specific data on the bilateral rate to which each firm is most vulnerable (BRV) and the firm's FX hedge techniques from 10 − K report disclosures under Financial Reporting Release (FRR) No. 48 (United States Securities and Exchange Commission, 1997). To enhance comparisons with prior FXE research, we use the broad trade-weighted FX rate index (TWI) data published in the *Federal Reserve Bulletin*. The FX rate data for our hand gathered BRV disclosures are also from the *Federal Reserve Bulletin*[2]. Data for excess returns on the stock market and FF risk premiums for value (HML) and size (SMB) data are from the web site provided by Professor French. All other data (e.g., fiscal reporting period, standard industrial classification code, book and market value of equity) are from Standard and Poor's Compustat.

We screen manufacturing multinationals (Standard Industrial Classification codes 2000-3999) in light of evidence that these firms are major users of FX hedges (Bodnar *et al.*, 1998, 2011). Reducing this initial sample of 296 firms (1,719 firm-years) to exclude firms that lack complete returns and hand gathered data for the 2001-2006 sample period, our final sample of 1,602 unique firm-years (289 firms) is used in all univariate and multivariate analyses.

As introduced above, the primary distinguishing feature of our study is the use of a unique hand gathered FRR No. 48 dataset. Under the SEC's FRR No. 48, firms are required to provide disclosure information that enables financial statement users to understand the firm's current and future market risks, including its FX risk. These FX risk disclosures include the identification of the particular currency to which the firm is most vulnerable and the associated hedge techniques (Linsmeier and Pearson, 1997)[3]. Table I provides a description of the BRV and FX hedge disclosure data for our sample firms.

Table I Panel A details the currencies that our sample firms identify as the primary bilateral rate to which they are most vulnerable (BRV). The BRV data are in foreign currency per US dollar, for our total sample of 1,602 unique firm-years. As detailed in the first four rows, more than 80 percent of our sample are most vulnerable to changes in the euro, the British pound sterling (BPS), the Canadian dollar, or the Japanese yen. The dominance of the euro (818 observations) is consistent with recent studies of customer order flows in the FX market (Cerrato *et al.*, 2011). At the other frequency extreme, it also is interesting to note that 3 percent of our sample (62 observations) pertains to firms that are not vulnerable to any one currency. Similarly, only 5 percent of our sample's BRV disclosures (88 observations) encompass the Brazilian real, the Mexican Peso or the Australian dollar. Finally, the "other BRV currencies" (73 observations) encompass 12 currencies not identified separately in Table I Panel A. In sum, we use BRV data for

	2001	2002	2003	2004	2005	2006	Total
Panel A: number of firms by bilateral rate to which firm is most vulnerable (BRV)							
Euro	136	144	148	143	127	120	818
British pound sterling	40	40	39	35	26	27	207
Canadian dollar	22	23	25	27	27	26	150
Japanese yen	24	24	20	20	15	14	117
Brazilian real	5	5	5	5	7	6	33
Mexican peso	5	5	5	5	5	4	29
Australian dollar	4	4	5	5	4	4	26
Other BRV currencies	13	8	13	12	16	13	73
No_BRV_Exposure	14	12	12	13	6	5	62
No_BRV_Disclosure	11	8	10	9	24	25	87
Total sample	274	273	280	274	257	244	1,602
Panel B: number of firms using FX hedging							
No reported usage of FX denominated debt (FDD = 0)	205	206	211	209	187	177	1,195
Reported FX denominated debt hedge use (FDD = 1)	69	67	69	65	70	67	407
No reported usage of FX derivatives hedge (FXD = 0)	164	162	163	165	130	126	910
Reported FXD hedge use (FXD = 1)	110	111	117	109	127	118	692
Only FDD hedge use	43	42	42	39	41	36	243
Only FXD hedge use	84	86	90	83	98	87	528
Neither FDD nor FXD hedge use (FHEDGE = 0)	121	120	121	126	89	90	667
Both FDD and FXD hedge use	26	25	27	26	29	31	164
Total sample	274	273	280	274	257	244	1,602
Reported using FX hedges other than FDD or FXD (NFHEDGE = 1)	82	85	88	91	70	68	484
Either FDD or FXD hedge use (FHEDGE = 1)	153	153	159	148	168	154	935

Table I. Sample description – FRR No. 48 FX risk disclosures data

19 currencies (i.e. four primary currencies, three secondary currencies, and 12 other currencies) in the FF model to improve the estimation of firm-specific FXE, where these returns-based FXE estimations are net of FX hedging (Bartram, 2008)[4].

Required disclosures under FRR No. 48 also include the identification of hedge techniques, by class of market risk (e.g. FX risk, interest rate risk). As summarized in Table I Panel B, the predominant FX hedge technique is derivatives (692 observations). Together with FX denominated debt, over one-half of our sample pertain to financial hedging (FHEDGE = 1 for 935 observations). In contrast, less than one-third of our sample use FX hedges other than financial hedges (NFHEDGE = 1 for 484 observations). These descriptive results are consistent with extant survey evidence of the dominant role of financial hedges in FX risk management (Bodnar *et al.*, 1998; Naylor and Greenwood, 2008; Bodnar *et al.*, 2011). We are interested primarily in examining whether the firm-specific FX hedge technique data (summarized in Table I Panel B) explain net FXE estimates, using either the firm-specific BRV data (described in Table I Panel A) or the broad TWI data in the FF model.

3. Estimating FXE

As discussed in Section 1, recent studies have improved the traditional market model approach to estimating FXE at the firm level, by incorporating the FF factors for the value (HML) and size (SMB) premiums (Choi and Jiang, 2009; Aggarwal and

Harper, 2010; Huffman *et al.*, 2010). In their seminal study, Adler and Dumas (1984) introduced a regression approach to estimating FXE, based on the argument that measuring FX risk is similar to market risk estimation. Recent asset pricing research, however, indicates that the FF model is often superior to the traditional market model (Lawrence *et al.*, 2007; Simpson and Ramchander, 2008). Augmenting the market model by including the HML and SMB factors, recent studies find a higher percentage of statistically significant FXE estimates[5].

We extend the analysis of FF model FXE estimates in two notable directions. First and foremost, we take advantage of hand gathered FRR No. 48 disclosures that identify the bilateral exchange rate to which each of our sample firms is most vulnerable (BRV) and the firm's specific FX hedge techniques. We compare such BRV-based FXE estimates to those FXE estimates using the broad trade-weighted index (TWI) that is prevalent in the FXE literature. Second, we integrate the FXE and asset pricing literatures by expanding the analysis of FF model estimates of FXE (using either the firm-specific BRV data or the broad TWI data) to distinguish firms in the first and fifth quintiles for measures of value/growth (HML) and size (SMB).

To measure FXE, we estimate the equation (1) FF model using weekly data (Wednesday to Wednesday) for each of the 1,602 unique firm-year observations in our sample[6]:

$$R_{it} - RF_t = \alpha + \lambda_f R_{fx} + \lambda_m (R_{mt} - RF_t) + \lambda_s SMB_t + \lambda_h HML_t + \varepsilon \qquad (1)$$

where R_{it} is the return on firm i over time t, R_{fx} is the return on either the bilateral rate to which the firm is most vulnerable (BRV) or the broad TWI over time t, R_{mt} is the return of the market index over time t, RF_t is the return on 30-day treasury bills over time t, SMB_t is the return on "small minus big" benchmark portfolios (bottom 50 percent, small-cap stocks, less the return on top 50 percent, large-cap stocks) over time t, and HML_t is the return on "high minus low" (returns on high book-to-market value stocks, top 30 percent, less the returns on low book-to market stocks, bottom 30 percent) over time t.

As introduced in Section 1, a secondary contribution of our study is the analysis of FXE panel data from equation (1) in relation to market-based estimates of sensitivities to the value and size premiums, for our sample of multinationals with *ex ante* exposure to FX rate changes. In developing our expectations for this relation, we draw on theories of optimal hedging and hedge information mispricing[7]. These theories suggest that sample multinationals with extreme measures for value/growth (HML) and size (SMB) are likely to have lower hedge incentives and thus, higher FXE levels net of hedging. We operationalize these extreme measures using coefficients from the estimation model for HML and SMB. Following Houge and Loughran (2006), we form quintiles for the estimates of each factor loading. Firms in the first and fifth quintiles for HML and SMB are defined as having extreme measures for value/growth and size, respectively.

Sample multinationals with extremely low HML levels (growth firms) are likely to experience lower external financing costs, in part, from the increased competition in global capital markets (Butler, 2000; Stulz, 1999). Optimal hedge theory (Froot *et al.*, 1998) predicts that firms with lower external failure costs will have lower hedge incentives. At the other extreme, value firms in our sample can be said to be underpriced (i.e. low market to book values). In general, a primary source of mispricing is information uncertainty (Zhang, 2006). In the context of our sample, recent empirical evidence (Campbell, 2010; Chung *et al.*, 2012; Makar *et al.*, 2013) suggests that hedge accounting provides incomplete information on a firm's risk management efforts, and thus, increases information uncertainty and mispricing, consistent with hedge information mispricing theory (Gigler *et al.*, 1997). To the extent that value firms seek to reduce FX hedge information uncertainty, they will have lower hedge incentives.

Unlike our HML-FXE priors, theoretical predictions of the relation between size (SMB) and FXE are ambiguous. On one hand, smaller firms are less likely to benefit from scale economies in using FX derivatives and/or from geographic diversification operating hedges, and thus, experience higher levels of net FXE (Pantzalis *et al.*, 2001). On the other hand, smaller firms are likely to face higher relative costs of financial distress and thus, have increased hedge incentives and lower FXE levels (Warner, 1977). Although the SMB-FXE relation is ultimately an empirical question, there is strong evidence that firm size (SMB) explains net FXE (Bodnar and Wong, 2003).

Table II summarizes the magnitude of FXE estimates (i.e. absolute level of net FXE) using either firm-specific BRV or broad TWI data in equation (1), partitioned by HML

	Quintiles based on HML coefficients from FF model					
	Lowest quintile "negative value premium" (growth stock)	HML quintile 2	HML quintile 3	HML quintile 4	Highest quintile "positive value premium" (value stock)	Total for size quintiles
Panel A: median values for |FXE| determined by using BRV						
Highest SMB quintile → large cap stock	0.57	0.39	0.33	0.38	0.70	0.43
SMB quintile 2	0.40	0.32	0.30	0.31	0.32	0.32
SMB quintile 3	0.50	0.44	0.35	0.42	0.39	0.42
SMB quintile 4	0.61	0.58	0.44	0.38	0.58	0.53
Lowest SMB quintile → small cap stock	0.63	0.64	0.63	0.54	0.74	0.65
Total for value premium quintiles	0.57	0.45	0.37	0.39	0.57	0.46
Panel B: median values for |FXE| determined by using TWI						
Highest SMB quintile → large cap stock	1.17	0.88	0.93	1.25	1.31	1.09
SMB quintile 2	1.20	0.71	0.74	0.90	0.94	0.89
SMB quintile 3	1.58	0.83	1.06	1.07	1.43	1.15
SMB quintile 4	1.97	1.07	1.07	1.17	1.52	1.35
Lowest SMB quintile → small cap stock	1.75	1.49	1.54	1.38	1.80	1.59
Total for value premium quintiles	1.55	0.95	0.98	1.12	1.47	1.19

Notes: This table summarizes median values for FF model FXE estimates, using either the bilateral rate to which each firm is most vulnerable (BRV) data (Panel A) or the TWI data (Panel B); the absolute FXE amounts are partitioned by the FF value (HML) and size (SMB) factors

Table II.
FXE estimates – |FXE| quintiles using FF factors

and SMB levels employing a method similar to Houge and Loughran (2006). Focusing first on the HML quintiles (i.e. the "total for value premium quintiles" row), the median |FXE| estimates (in both Table II panels) indicate that firms with extremely low HML levels (growth firms) or extremely high HML levels (value firms) have the largest |FXE| amounts. In addition, when SMB levels are considered, the larger BRV-based |FXE| amounts in Table II Panel A are in the four HML_SMB corners: 0.57 and 0.70 for the largest extreme growth or largest extreme value firms, and 0.63 and 0.74 for the smallest extreme growth or smallest extreme value firms, respectively. As detailed in Table II Panel B, this "four corner" pattern generally describes the median TWI-based |FXE| estimates. Overall, Table II descriptive evidence is consistent with our theory-based expectations of higher |FXE| amounts at extreme HML_SMB levels[8]. This "four corner" HML_SMB pattern is explored further in our Section 4 multivariate analyses[9].

Table III provides univariate results for the tests of difference in FXE magnitudes, using paired observations of the BRV-based |FXE| and TWI-based |FXE| from equation (1). As reported in Table III Panel A, the difference in the median (or mean) values of these |FXE| estimates is statistically significant (at a <0.0001 level) and indicates that the BRV-based estimates are smaller than the TWI-based estimates[10].

	Median (sign rank test)	Mean (student *t*-test)	Number	|FXE| significant at 10 percent level Percent
Panel A – full sample (*n* = 1,602), *BRV-based |FXE| less TWI-based |FXE|*				
BRV-based |FXE|	0.4569	0.7011	204	12.73
TWI-based |FXE|	1.1861	1.7760	162	10.11
Test of median/mean difference in |FXE| or proportion of significant |FXE| at 10 percent, for full sample	-0.6459^{***} (<0.0001)	-1.0749^{***} (<0.0001)		2.62^{**} (0.0163)
Panel B – FHEDGE sub-samples, BRV-based |FXE| less TWI-based |FXE|				
FHEDGE = 1 (*n* = 935)				
BRV-based |FXE|	0.4212	0.5785	113	12.09
TWI-based |FXE|	1.1195	1.6158	94	10.05
Test of median/mean difference in |FXE| or proportion of significant |FXE| at 10 percent, for FHEDGE = 1 sub-sample	-0.6273^{***} (<0.0001)	-1.0373^{***} (<0.0001)		2.03 (0.1534)
FHEDGE = 0 (*n* = 667)				
BRV-based |FXE|	0.5498	0.8730	91	13.64
TWI-based |FXE|	1.2941	2.0006	68	10.19
Test of median/mean difference in |FXE|, for FHEDGE = 0 sub-sample	-0.6768^{***} (<0.0001)	-1.1276^{***} (<0.0001)		3.45^{**} (0.0428)

Note: Significant at: *10, **5 and ***< 0.01 percent two-sided levels

Table III.
Univariate tests of differences in FXE

Keeping in mind that such returns-based FXE estimates are net of hedging (Bartram, 2008), we posit that the smaller BRV-based |FXE| levels are due, in part, to firm-specific FX hedge techniques[11]. For example, extant research attributes the negative relation between returns-based FXE estimates and the use of FX derivatives or FX denominated debt to effective financial hedging (Allayannis and Ofek, 2001; Makar and Huffman, 2008; Bartram *et al.*, 2010).

Moving to the last two columns of Table III Panel A, the use of firm-specific BRV data produces more significant |FXE| estimates (at a 0.10 level) than the broad TWI data. In particular, 12.73 percent of the BRV-based |FXE| are statistically significant, compared to 10.11 percent of the TWI-based |FXE|. The difference in these sample proportions is statistically significant (at a 0.05 level).

As introduced in Section 1 and described in Section 2, the primary contribution of our study is the use of a unique dataset of SEC disclosures to better understand firm-specific FXE levels, net of hedging. The univariate evidence in Table III Panel B provides initial insight into our sample's FXE levels and firm-specific hedging, based on such SEC data. Specifically, the magnitude of |FXE| for the sub-sample of firms using financial hedges (i.e. FHEDGE = 1, in Table I Panel B) is compared to that for the sub-sample of firms not using financial hedges (i.e. FHEDGE = 0, in Table I Panel B). Testing the difference in the median or mean |FXE| amounts across these two FHEDGE sub-samples, firms using financial hedges have lower |FXE| levels. This is consistent with extant research and effective financial hedging[12]. Within each FHEDGE sub-sample, the BRV-based |FXE| remain smaller than the TWI-based |FXE| (significant at a <0.0001 level), consistent with Table III Panel A full sample results. The effective use of firm-specific FX hedge techniques is explored further in our Section 4 multivariate analyses.

4. Explaining FXE estimates

In this section, we use multivariate analyses to explain variations in our panel data of FXE estimates. As discussed in Section 3, Table III Panel B univariate evidence suggests that sample firms effectively use the financial hedges that they identify as being part of their FX risk management. Following recent studies (Choi and Jiang, 2009; Bartram *et al.*, 2010) and our univariate tests, we employ an indicator variable approach to operationalize the use of financial hedges (either FX derivatives or FX denominated debt) and non-financial/operational hedges (FX hedges other than financial hedges)[13]. Taking advantage of our unique SEC disclosure data, we consider the use of firm-specific FX hedges in relation to |FXE| estimates from equation (1), based on either the bilateral exchange rate to which each firm is most vulnerable (BRV) or the broad TWI prevalent in extant research.

Researchers have drawn on the asset pricing literature to augment the traditional market model FXE estimates for FF value (HML) and size (SMB) factors. A secondary contribution of our study is to build on this research by incorporating extreme levels of HML and SMB factors into the FXE analysis. Table II descriptive evidence discussed in Section 3 indicates that firms with extreme HML_SMB levels have higher |FXE| estimates, using either the firm-specific BRV data or the broad TWI data in equation (1). This descriptive evidence is consistent with the notion that sample multinationals with extreme HML_SMB levels have lower hedge incentives, and thus, higher net FXE levels.

As developed in Section 3, our FXE-HML_SMB expectations for sample multinationals with *ex ante* exposure to FX rate changes are based on extant theories of optimal hedging and hedge information mispricing. Optimal hedge theory (Froot *et al.*, 1998), together with the empirical evidence on costs of equity in global markets (Butler, 2000; Stulz, 1999), suggests that high growth multinationals are likely to experience lower external financing costs, and thus, lower hedge incentives. Similarly, sample multinationals categorized as extreme value firms have incentive to reduce hedging and the corresponding information uncertainty, consistent with extant theory and empirical research on FX hedge information mispricing (Gigler *et al.*, 1997; Makar *et al.*, 2013). For sample firms with extreme SMB levels, optimal hedge theory and FX hedging evidence (Geczy *et al.*, 1997; Warner, 1977) suggest that the FXE implications are ambiguous. Nonetheless, there is strong empirical evidence that firm size is associated with FXE levels (Bodnar and Wong, 2003). In total, the net FXE effect of market-assigned premiums for size (SMB) and value (HML) is an empirical question, and is investigated in our multivariate tests.

Building on our descriptive and univariate results, primary multivariate tests regress alternative |FXE| firm-year estimates on the firm's use of financial hedges and extreme HML_SMB values. Following our univariate analyses and prior studies (Allayannis and Ofek, 2001), we use the absolute level of FXE estimates as the dependent variable[14]. Specifically, we estimate equation (2) for the 1,602 unique firm-year observations in our total sample:

$$|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it} + \varepsilon \tag{2}$$

where $|FXE|_{it}$ is the absolute level of the λ_f estimated coefficient from equation (1), using either the bilateral rate to which the firm is most vulnerable (BRV) or the broad TWI for firm *i* over time *t;* FHEDGE is an indicator variable that equals 1 if the firm uses either FX derivatives or FX denominated debt to hedge its FX risk, else 0; *HML_SMB* is an indicator variable that equals 1 if the firm-year observation is in any of the four extreme HML_SMB quintiles detailed in Table II, else 0; and lnMVE is an accounting measure of firm size, using the natural log of market value of equity[15].

As developed in Section 3, we expect a negative relation between |FXE| and the FHEDGE variable, consistent with effective financial FX hedging. In contrast, we expect |FXE| to be positively associated with the HML_SMB variable; consistent with the notion that sample multinationals with extreme levels of HML and SMB have lower hedge incentives, and thus, higher net FXE levels. In light of extant evidence of scale economies in FX hedging (Geczy *et al.*, 1997; Allayannis and Ofek, 2001), we expect a negative relation between |FXE| and the accounting measure of firm size, lnMVE.

To examine the robustness of our equation (2) primary tests, we expand the model to control for the use of non-financial/operational FX hedges and industry membership. Paralleling our equation (2) tests, we estimate the expanded equation (3) for the 1,602 firm-year observations in our total sample:

$$\begin{aligned}|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it}\\ + B_{nf}NFHEDGE_{it} + B_{sic}IND_{ij} + \varepsilon\end{aligned} \tag{3}$$

where *NFHEDGE* is an indicator variable that equals 1 if firm *i* uses FX hedges other than financial hedges over time *t*, else 0; and *IND* is a series of indicator variables equal to 1 if the firm operates in two digit Standard Industrial Classification code *j*, else 0. All other variables are as defined in equation (2). Estimates of equation (3) also use an indicator variable for accounting measures of value (BV/MV) and size (SMB) in place of the extreme HML_SMB levels indicator variable[16]. To the extent the firm effectively uses non-financial/operational FX hedges, the relation between |FXE| and the NFHEDGE variable will be negative. The control variable IND may be positively or negatively associated with |FXE|, depending on the net FX exposure of the industry.

Table IV provides the OLS regression estimation results for the equation (2) primary model, using either the firm-specific BRV-based |FXE| dependent variable (in models 1 and 3) or the broad TWI-based |FXE| dependent variable (in models 2 and 4). The BRV-based results indicate that the FHEDGE variable is significant (at a <0.0001 level) and negative, consistent with Table III univariate results and our expectation based on extant evidence of effective financial hedging (Allayannis and Ofek, 2001; Makar and Huffman, 2008; Bartram *et al.*, 2010).

Continuing to focus on the BRV-based |FXE| results in Table IV, the HML_SMB variable is significant (at a <0.0001 level) and positive, as expected. This is consistent with Table II descriptive evidence and supports the notion that extreme HML and SMB levels proxy FX hedge incentives. These market assigned premiums are important in explaining |FXE| variations, despite the inclusion of the HML and SMB variables in equation (1) estimates of FXE. Finally, the lnMVE variable results (negative and significant at a <0.0001 level) are consistent with extant evidence of scale economies in FX derivatives use (Geczy *et al.*, 1997; Allayannis and Ofek, 2001).

	Model 1	Modle 2	Model 3	Model 4
N	1,602	1,602	1,602	1,602
Dependent variable	BRV-based |FXE|	TWI-based |FXE|	BRV-based |FXE|	TWI-based |FXE|
Intercept	1.5555* (<0.0001)	3.6518* (<0.0001)	1.441* (<0.0001)	3.3539* (<0.0001)
FHEDGE	−0.1715* (<0.0001)	−0.8706 (0.4095)	−0.1621* (<0.0001)	−0.0621 (0.5531)
HML_SMB			0.2666* (<0.0001)	0.7131* (<0.0001)
lnMVE	−0.1052* (<0.0001)	−0.2546* (<0.0001)	−0.0975* (<0.0001)	−0.2339* (<0.0001)
F-statistic	89.96* (<0.0001)	63.08* (<0.0001)	70.300* (<0.0001)	53.04* (<0.0001)
Adjusted R^2	0.1000	0.0720	0.1149	0.0888

Notes: Significant at: *< 0.01 percent two-sided level; this table details the results for ordinary least squares (OLS) regressions of the absolute amounts of FXE estimates on extreme levels of the FF value (HML) and size (SMB) factors and other FXE determinants; models 3 and 4 represent the full model depicted in equation (2) and models 1 and 2 demonstrate the robustness of full model results; *p*-values are shown parenthetically:

$$|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it} + \varepsilon \quad (2)$$

where $|FXE|_{it}$ is the absolute level of the equation (1) λ_f estimated coefficient using either the bilateral rate to which the firm is most vulnerable (BRV) or the broad TWI for firm *i* over time *t;* FHEDGE is an indicator variable that equals 1 if the firm uses either FX derivatives or foreign currency denominated debt to hedge its FX risk, else 0; *HML_SMB* is an indicator variable that equals 1 if the firm-year observation is in any of the four extreme HML_SMB quintiles detailed in Table II, else 0; and lnMVE is an accounting measure of firm size, using the natural log of market value of equity; for additional analysis of HML_SMB factors, please refer to Table AI

Table IV.
Primary results – OLS estimates of equation (2)

Moving to Table IV results for the broad TWI-based |FXE| dependent variable (models 2 and 4), both the HML_SMB and lnMVE variables remain statistically significant (at a < 0.0001 level) and of the expected sign. Like the BRV-based results, the positive relationship between the TWI-based |FXE| and the HML_SMB variable also is consistent with Table II descriptive evidence. However, unlike the BRV-based results, the FHEDGE variable does not explain changes in the TWI-based |FXE| estimates. All together, the results in Tables III and IV suggest that using the BRV data from SEC currency risk disclosures improves the analysis of firm-specific FXE, net of hedging.

As further evidence of the robustness of our Table IV primary results, Table V details the OLS regression estimation results of the equation (3) expanded model. The models 1 and 2 results use the market-based HML_SMB variable comparable to Table IV, and models 3 and 4 pertain to the accounting-based BV/MV_MVE variable. With regard to the firm-specific FX hedging techniques, the FHEDGE variable remains negative and significant (at a 0.10 level or better) for both BRV-based models, consistent with our primary results. In contrast, the NFHEDGE variable is not significant (at a 0.10 level) in any of the models. Together, these results are consistent with extant evidence that financial hedges dominate non-financial/operational hedges in reducing FX risk (Bartram *et al.*, 2010)[17].

Like Table IV primary results, the HML_SMB variable remains positive and significant in models 1 and 2 (at a < 0.0001 level); however, the BV/MV_MVE variable

	Model 1	Model 2	Model 3	Model 4
N	1,602	1,602	1,602	1,602
Dependent variable	BRV-based |FXE|	TWI-based |FXE|	BRV-based |FXE|	TWI-based |FXE|
Intercept	1.7594*** (<0.0001)	3.5688*** (<0.0001)	1.8757*** (<0.0001)	3.703*** (<0.0001)
FHEDGE	−0.1186* (0.0647)	0.0416 (0.8001)	−0.1353** (0.0365)	0.0061 (0.9704)
HML_SMB	0.2593*** (<0.0001)	0.6367*** (<0.0001)		
BV/MV_MVE			0.0157 (0.7473)	0.2401* (0.0535)
lnMVE	−0.0960*** (<0.0001)	−0.2333*** (<0.0001)	−0.1036*** (<0.0001)	−0.2490*** (<0.0001)
NFHEDGE	0.0479 (0.4971)	0.0914 (0.6120)	0.0289 (0.6843)	0.0278 (0.8781)
IND	Included	Included	Included	Included
F-statistic	10.78*** (<0.0001)	8.52*** (<0.0001)	9.54*** (<0.0001)	7.58*** (<0.0001)
Adjusted R^2	0.1279	0.1013	0.1135	0.0898

Notes: Significant at: *10, **5 and *** < 0.01 percent two-sided levels; this table details the results of ordinary least squares (OLS) regressions of equation (3), which expands the primary analysis summarized in Table IV for the use of non-financial FX hedges (NFHEDGE) and industry membership (IND); results using BV/MV_MVE quintiles in place of HML_SMB quintiles also are provided; *p*-values are shown parenthetically:

$$|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it} + B_{nf}NFHEDGE_{it} + B_{sic}IND_{ij} + \varepsilon \quad (3)$$

where *NFHEDGE* is an indicator variable that equals 1 if firm i uses FX hedges other than financial hedges over time t, else 0; and *IND* is a series of indicator variables equal to 1 if the firm operates in two digit standard industrial classification code j, else 0; all other variables are as defined in equation (2)

Table V.
Robustness checks of primary results – OLS estimates of equation (3)

is positive, but significant only for the model 4 TWI-based results (at a 0.10 level). These results suggest that the market-based HML and SMB estimates of the factor loadings are better able to explain |FXE| variations, compared to the corresponding accounting-based measures. Finally, these Table V results are not sensitive to firm size (lnMVE) or industry membership (IND).

To explore the FXE-HML relation further, we replace the HML_SMB variable in equation (2) with an indicator variable to distinguish three investment style categories of firms (based on the HML quintiles detailed in Table II): growth firms (HML quintile 1), core firms (HML quintile 3) and value firms (HML quintile 5):

$$|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HMLQ_k + B_{sz}lnMVE_{it} + \varepsilon \quad (4)$$

where $HMLQ_k$ is an indicator variable that equals 1 if the firm i is in the first, third, or fifth HML quintile (as detailed in Table II) representing growth stocks (GROWTH), core stocks (CORE) or value stocks (VALUE), respectively. All other variables are as defined in equation (2).

Table AI provides the OLS results for equation (4) for BRV-based |FXE| and TWI-based |FXE|. Focusing on the extreme HML quintiles (i.e. quintile 1 GROWTH firms, and quintile 5 VALUE firms), the positive FXE-HML relation (significant at a 0.05 level or better) is consistent with our primary results. It also is interesting to note that the sign of this relation reverses for CORE firms (HML quintile 3) in model 1. That is, firms with moderate HML amounts experience lower levels of |FXE|. Together, these HMLQ results support our theory-based expectations that firms with extreme HML levels experience higher |FXE|. Finally, the FHEDGE and lnMVE variables remain negative and significant (at a <0.0001 level), consistent with our primary results.

The primary distinctive feature of our study is the use of a unique dataset of SEC disclosures, including data on the particular bilateral rate to which each sample firm is most vulnerable (BRV). As detailed in Table I Panel A, more than 80 percent of our sample are exposed primarily to one of four currencies: the euro, the BPS, the Canadian dollar, or the Japanese yen. To explore our sample firms' exposure to their reported BRV currencies further, we expand equation (2) to include an indicator variable for each of these four primary currencies. For completeness, we also include an indicator variable for firms that are most vulnerable to a currency other than these four primary currencies (i.e. Brazilian real, Mexican Peso, Australian dollar, Other BRV currencies; in Table I Panel A) or do not provide such FRR No. 48 disclosures (No BRV disclosure, in Table I Panel A), and an indicator variable for firms not vulnerable to any one currency (No BRV exposure, in Table I Panel A):

$$|FXE|_{it} = \alpha + B_{BRV}FX_{it} + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it} + \varepsilon \quad (5)$$

where FX_{it} is a zero-one indicator variable that equals 1 if the currency to which the firm is most exposed is the euro (EURO), BPS, Canadian dollar (CanD) or Japanese yen (YEN); or the firm indicates it is most vulnerable to currencies other than these four primary currencies, or does not disclose its BRV currency (OTHER_BRV); or the firm is not exposed to any one currency (NO_BRV_EXPOSURE). All other variables are as defined in equation (2).

Table VI provides the OLS estimation results for equation (5), using either the BRV-based |FXE| dependent variable (models 1 and 2) or the TWI-based |FXE| dependent variable (models 3 and 4). Focusing on the four predominant primary

Table VI. Additional tests – OLS estimates of equation (5)

	Model 1	Model 2	Model 3	Model 4
N	1,602	1,602	1,602	1,602
Dependent variable	BRV-based |FXE|	BRV-based |FXE|	TWI-based |FXE|	TWI-based |FXE|
Intercept	1.7792** (<0.0001)	1.3080** (<0.0001)	3.7388** (<0.0001)	3.1739** (<0.0001)
EURO	−0.5075** (<0.0001)	−0.0403 (0.5519)	−0.3818** (<0.0001)	0.1570 (0.3737)
BPS	−0.4096** (<0.0001)	0.0592 (0.4652)	−0.5930** (0.0009)	−0.0443 (0.8339)
CanD	−0.4700** (<0.0001)		−0.5569** (0.0047)	
Yen	−0.4851** (<0.0001)	−0.0194 (0.8380)	0.0530 (0.8086)	0.5825* (0.0184)
OTHER_BRV		0.4254**(<0.0001)		0.2696 (0.1855)
NO_BRV_EXPOSURE		0.2209* (0.0417)		1.423** (<0.0001)
FHEDGE	−0.1133** (0.0051)	−0.1008* (0.0137)	−0.0657 (0.5355)	0.01464 (0.8906)
HML_SMB	0.2449** (<0.0001)	0.2449** (<0.0001)	0.6872** (<0.0001)	0.6650** (<0.0001)
lnMVE	−0.0930** (<0.0001)	−0.0935** (<0.0001)	−0.2420** (<0.0001)	−0.2450** (<0.0001)
F-statistic	46.81** (<0.0001)	41.56** (<0.0001)	25.66** (<0.0001)	25.97** (<0.0001)
Adjusted R^2	0.1669	0.1685	0.0973	0.1109

Notes: Significant at: *5 and **< 0.01 percent two-sided levels; this table details the results of ordinary least squares (OLS) regressions of equation (5), which expands the primary analysis summarized in Table IV by including the FX currency indicator variable (FX); all other variables are as defined in equation (2); p-values are shown parenthetically:

$$|FXE|_{it} = \alpha + B_{BRVt}FX_{it} + B_{fh}FHEDGE_{it} + B_{ff}HML\_SMB_{it} + B_{sz}lnMVE_{it} + \varepsilon \quad (5)$$

where FX is an indicator variable that equals 1 for the BRV currency of firm i in time t; else 0

currencies (i.e. Euro, BPS, CanD or YEN), the evidence for models 1 and 3 indicates that the average level of |FXE| is significantly lower for each of these currencies (at a <0.005 level or better). In contrast, the positive estimated coefficient on the OTHER_BRV variable and the NO_BRV_EXPOSURE variable in models 2 and 4 indicates that these firms face significantly higher average levels of |FXE| (at a 0.05 level or better). All together, Table VI evidence supports our primary results that |FXE| levels decrease (increase) with financial FX hedging (extreme HML_SMB levels), and indicates that firms that are most vulnerable to any of the four primary currencies (i.e. EURO, BPS, CanD or YEN) experience lower FXE levels[18].

In summary, we have demonstrated the importance of using SEC disclosure data on the firm's FX hedge techniques and the bilateral rate to which each firm indicates that it is most vulnerable (BRV) in understanding FXE. Univariate results indicate that BRV-based |FXE| represent a higher percentage of statistically significant FF model coefficients, compared to the TWI-based |FXE| data prevalent in prior research. Multivariate results show that only the BRV-based |FXE| is explained by SEC data on financial FX hedging. In addition, we expand the FXE analysis by incorporating the factor sensitivities of the FF variables for value (HML) and size (SMB) premiums. Multivariate results indicate that extreme HML_SMB levels contribute to explaining variations in FXE panel data. We also provide evidence that our primary multivariate results are not sensitive to particular BRV currencies or to alternative measures of extreme value and size premiums. Multivariate tests also control for the use of non-financial/operational hedging, firm size, and industry membership.

5. Conclusions

Previous studies have been surprisingly unsuccessful in documenting the relation between stock returns and FX rate changes. Our primary contribution to resolving this "exchange rate exposure puzzle" is the insights we provide using a unique dataset of SEC disclosures that identify the bilateral exchange rate to which each sample firm is most vulnerable (BRV) and its specific FX hedge techniques. We also extend recent research that integrates the asset pricing and FXE literatures, by expanding the analysis of returns-based FXE to include the FF value and size factors.

Our results suggest the following conclusions. First, using firm-specific BRV data in place of the broad trade-weighted FX rate index (TWI) data improves FF model estimates of FXE, net of hedging. Second, financial hedge techniques (FX derivatives or FX denominated debt) play a dominant role in managing FX risk for our sample firms. Third, extreme levels of HML_SMB factors explain both BRV-based |FXE| and TWI-based |FXE|, consistent with our expectations based on theories of optimal hedging and hedge information mispricing. Fourth, in contrast to the market assigned measures of sensitivities to the value and size factors, neither the BRV-based |FXE| nor the TWI-based |FXE| are associated with the corresponding accounting-based measures (BV/MV_MVE).

Notes

1. These theory-based expectations for the relation between FXE and FF value and size factors represent a secondary contribution of our study, and are developed in Section 3.
2. Bilateral exchange rate data are from the *Federal Reserve Bulletin* except in instances where the firm identifies a euro legacy currency as its BRV (e.g. French Franc BRV data are from the Oanda.com web site).
3. Linsmeier *et al.* (2002) find that FRR No. 48 disclosures provide useful market risk information to financial statement users. As an example of a sample firm's FX risk disclosures under FRR No. 48 (*emphasis added* for principal currency and hedge technique information), the following is an excerpt from Amgen's 2006 10 − K report. "Our results of operations are affected by fluctuations in the value of the US dollar as compared to foreign currencies, predominately the euro, as a result of the sales of our products in foreign markets. Both positive and negative impacts to our international product sales from movements in foreign exchange rates are partially mitigated by the natural, opposite impact that foreign exchange rates have on our international operating expenses. To further reduce our exposure to foreign exchange rate fluctuations in our results of operations, we enter into foreign currency forward exchange contracts and foreign currency option contracts."
4. As an alternative to our use of FRR No. 48 disclosure data on BRV, previous studies have inferred firm-specific bilateral exchange rate exposure based on the geographic location of the firm's subsidiaries (Ihrig, 2001; Koutmos and Martin, 2003; Fraser and Pantzalis, 2004), the firm's industry (Glaum *et al.*, 2000; Williamson, 2001) or the host country's primary trading partners (Verschoor and Muller, 2007; Aggarwal and Harper, 2010; Kodongo and Ojah, 2011). The primary distinctive feature of our study is the use of such firm-specific hand gathered data; thus, we are interested in firm-specific FXE. Alternatively, prior studies have examined FXE at the industry level (Bodnar and Gentry, 1993; Francis *et al.*, 2008; Tai, 2010).
5. For example, Huffman *et al.* (2010, Table 1) report that 38.4 percent of the FF model FXE coefficients are statistically significant, compared to 21 percent of the market model FXE coefficients, for their full sample. Similarly, Choi and Jiang (2009, Table 2) find more significant FXE coefficients using the FF model. Other studies estimating FXE at the firm level do not

contrast their FF model estimates to the market model estimates of FXE (Francis *et al.*, 2008; Aggarwal and Harper, 2010; Bartram and Bodnar, 2012). De Santis and Gerard (1998, p. 376) assert that because prior studies have found that currency risk is different from zero that "models of international asset pricing that only include market risk are misspecified". Bekaert and Hodrick (1992) and Ferson and Harvey (1993) find that the ability to explain expected returns increases with the use of time-varying risk premiums, thereby, indicating that dynamic models produce better results. The models we employ are more dynamic because of our 40 week estimation technique for each sample year, and the inclusion of the Fama-French risk-premiums.

6. Our use of Wednesday to Wednesday returns is comparable to extant asset pricing research (Gutierrez and Kelly, 2006). For each of the 1,602 firm years in our total sample, we estimate equation (1) using the 40 weeks of data beginning 12 weeks after the firm's fiscal year end. This 12 week lag accommodates the 10-K report filing date.

7. We chose to base our FXE-HML_SMB expectations on theories of optimal hedging, in part, due to the limitations in extant asset pricing literature. In a recent review of this literature, Subrahmanyam (2010, p. 35) observes that although "the industry standard generally is still to use Fama and French factors [...] the research at this point presents a rather unsatisfying picture of a morass of variables, and an inability of us finance researchers to understand which effects are robust".

8. Table II median |FXE| evidence is qualitatively similar using the mean values of |FXE|.

9. As an alternative to Table II partitioning, we use accounting measures of value (BV/MV) and size (MVE) in place of the HML and SMB factors, respectively. Although not tabulated, the |FXE| levels increase monotonically with value (BV/MV). When size (MVE) is considered, the larger |FXE| are not at the extreme value levels, in contrast to the "four corner" HML_SMB pattern in Table II.

10. For example, the difference in the mean values of |FXE| for our full sample is -1.0749 (BRV-mean value of 0.7011 minus TWI-mean value of 1.7760) and is statistically significant (at a <0.0001 level). Such negative values indicate that the mean BRV-based |FXE| is smaller than the mean TWI-based |FXE|.

11. In addition to the effects of firm-specific hedging, the larger TWI-based |FXE| levels are indicative of the broad nature of this index. The TWI may measure global risks other than FX risk, such as political risk. In light of our research objective, we focus our TWI-based |FXE| analysis on FX risk, and encourage future researchers to explore the broader nature of the TWI.

12. For example, the median (mean) BRV-based |FXE| for financial hedgers of 0.4212 (0.5785) is less than the 0.5498 (0.8730) for those firms not using financial hedges. Although not tabulated, the differences in the median or mean |FXE| amounts between the two sub-samples are statistically significant (at a <0.0001 level).

13. Non-financial or operational hedge techniques include aligning FX denominated cash inflows with outflows, passing through costs from FX rate changes to customers, and international diversification (Pantzalis *et al.*, 2001; Bartram *et al.*, 2010). Given the limited FRR No. 48 disclosures of specific operational hedge techniques, we define non-financial hedging as firms that disclose that they hedge FX risk, but do not use either FX derivatives or FX denominated debt to manage such risk.

14. Using the absolute level of FXE as our dependent variable also avoids concerns about the generalizability of results when the FXE sign is distinguished (Miller and Reuer, 1998). For example, the economic interpretation of a positive FXE estimate (i.e. positive correlation between returns and FX rate changes) depends upon the firm's net FX position (e.g. long or short in BRV foreign currency) and the FX rate change (e.g. BRV foreign currency strengthens or weakens *vis-à-vis* the US dollar). Primary multivariate regression tests are robust to using either positive or negative FXE values as the dependent variable. The mean

(median) BRV-estimated FXE is 0.0742 (0.0262), with 834 positive FXE values and 768 negative FXE values. For TWI-based FXE estimates, the mean (median) is −0.8976 (0.0419), with 818 (784) positive (negative) FXE values.

15. For our sample firms, FRR No. 48 disclosures of FX derivative hedging correspond to notional value financial instrument data disclosed in accordance with Statement of Financial Accounting Standard No. 133 (Financial Accounting Standards Board, 1998).
16. The extreme BV/MV_MVE levels used in equation (3) robustness tests pertain to sample partitions (not tabulated) comparable to the HML_SMB partitions detailed in Table II.
17. Bartram *et al.* (2010) express surprise at the predominance of financial hedging in their study, and attribute this result, in part, to the lower costs and greater availability of such hedge techniques. Nonetheless, other studies note the importance of considering non-financial/operational hedge techniques (Pantzalis *et al.*, 2001; Choi and Jiang, 2009).
18. We exclude the Canadian dollar from some models presented in Table VI so that the regressions are specified correctly when we use our variable defined as UNIDENTIFIED_FX. In unreported models, which include all four predominant BRV currencies, the results for HML_SMB and FHEDGE are consistent with our previously reported results.

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Appendix

Table AI. Additional tests – OLS estimates of equation (4)

N Dependent variable	Model 1 1,602 BRV-based |FXE|	Model 2 1,602 TWI-based |FXE|
Intercept	1.4674** (< 0.0001)	3.3125** (< 0.0001)
FHEDGE	−0.1635** (< 0.0001)	−0.0665 (0.5252)
GROWTH_q	0.1994** (0.0002)	0.7078** (< 0.0001)
CORE_q	−0.0855 (0.1090)	0.0295 (0.8286)
VALUE_q	0.1215* (0.0248)	0.4471** (0.0012)
LnMVE	−0.1001** (< 0.0001)	−0.2418** (< 0.0001)
F-statistic	41.76** (< 0.0001)	32.44** (< 0.0001)
Adjusted R^2	0.1129	0.0894

Notes: Significant at: *5 and **< 0.01 percent two-sided levels; this table details the results of ordinary least squares (OLS) regressions of equation (4), which expands the primary analysis summarized in Table IV by replacing the HML_SMB variable with three variables representing the first, third and fifth HML quintiles ($HMLQ_k$) detailed in Table II; p-values are shown parenthetically:

$$|FXE|_{it} = \alpha + B_{fh}FHEDGE_{it} + B_{ff}HMLQ_k + B_{sz}lnMVE_{it} + \varepsilon \quad \text{(A1)}$$

where $HMLQ_k$ is an indicator variable that equals 1 if firm i is in the first, third, or fifth HML quintile representing growth stocks (GROWTH), core stocks (CORE) or value stocks (VALUE), respectively; all other variables are as defined in equation (2)