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Abstract

We empirically investigate the real effects of exchange rate risk on investment activities of international firms. We provide cross-country, firm-level evidence that greater unexpected currency volatility leads to significantly lower capital expenditures. The effect is stronger for countries with higher economic openness and for firms that do not use currency derivatives to hedge. We empirically test the implications of two potential mechanisms: Real options and precautionary savings. Our findings are consistent with both explanations. Two historical events in the FX markets strengthen the identification of our results.

JEL Classification: G31, G32, F31

Keywords: Exchange rate, uncertainty, corporate investment

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The Real Effects of Exchange Rate Risk on Corporate Investment: International Evidence

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Abstract

Through an analysis of over 4,000 multinational firms with foreign exchange (FX) exposures in 44 countries over a 30-year period to 2017, we provide cross-country evidence that greater firm-level unexpected FX volatility leads to significantly lower capital expenditures. The effect is stronger for countries with higher economic openness and for firms that do not use currency derivatives to hedge. We empirically test the implications of two potential driving mechanisms: real options and precautionary savings. Our findings are consistent with both explanations. Two groups of historical events in the FX markets strengthen the identification of our results.

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1. Introduction

Uncertainty plays a central role in shaping real investment decisions. Early theoretical studies such as Bernanke (1983), Rodrik (1991), and Dixit and Pindyck (1994) suggest that investment projects have real options to delay if these projects are (partially) irreversible. Due to the presence of capital and labor adjustment costs, higher uncertainty tends to depress investment, as the value of the option to delay increases (Bloom, 2009). With the acceleration of globalization and the expansion of the global supply chain since the 1990s, large multinational firms with international involvement (trade, investment, or financing) are more exposed to global uncertainty. A notable and inevitable type of uncertainty facing these multinational firms is exchange rate risk.[1] As the largest financial market in the world in terms of trading volume,[2] the foreign exchange (FX) market plays a systemically important role in the global economy. Exchange rate fluctuations have considerably real and negative impacts on firm value (Dominguez and Tesar, 2006) and the aggregate economy (Frankel and Rose, 2002; Aghion, Bacchetta, Rancière, and Rogoff, 2009). However, international firm-level empirical evidence regarding the impact of FX volatility on corporate operations is still limited.

To address this gap, we empirically examine the real effect of exchange rate risk on corporate investment through a comprehensive cross-country, firm-level investigation. Our sample consists of multinational firms with FX exposures in 44 countries from 1987 to 2017. We focus on 4,082 multinational firms. Following the corporate investment literature (e.g.,

[1] Risk and uncertainty may refer to different concepts in different contexts. They can reflect the same concept when discussing second moments (e.g. macroeconomic risk or macroeconomic uncertainty). They may also indicate different concepts. For example, risk may refer to unknown outcomes when the probability distribution is known (known unknowns), while uncertainty may reflect unknown outcomes when the probability distribution is unknown (unknown unknowns), according to Knight (1921). Throughout this paper, we do not distinguish risk and uncertainty. We use exchange rate risk, exchange rate uncertainty, or foreign exchange (FX) uncertainty interchangeably.

[2] According to the tri-annual survey by the Bank of International Settlement (BIS), the daily trading volume in the global FX markets is over five trillion dollars. https://www.bis.org/publ/rpfx16fx.pdf

Gulen and Ion, 2016), we use capital expenditure as the main dependent variable to measure corporate investment activities. Data for constructing capital expenditure as well as other firm-level variables are obtained from Worldscope.

We measure the exchange rate risk using unexpected volatility (i.e. volatility shock) and focus on the exogenous variations of exchange rate fluctuations that firms can hardly anticipate, which mitigates potential endogeneity concerns.[3] We obtain each firm's foreign sales information in each country from Worldscope and therefore are able to construct a firm-year level foreign sales exposure measure. We then construct a firm-year level, rather than country-year level, exchange rate risk measure as the weighted average of exchange rate risk, weighted by firms' foreign sales in each country. We find that exchange rate risk negatively affects the following year's capital expenditure. The effect is not only statistically significant but also economically meaningful: A one standard deviation increase in exchange rate risk is followed by a 3.4% decline in the ratio of the capital expenditure to total assets.

Our results are robust after controlling for country-level policy uncertainty. We also conduct falsification and placebo tests to mitigate the potential reverse-causality concern and to show that our results are not driven by chance. We document the cross-sectional heterogeneity of the adverse effect at both the country level and firm level. While the negative effect is stronger for firms in countries with a higher level of economic openness, firms actively using currency

[3] We treat FX volatility shocks as exogenous, analogous to the way in which interest rate volatility shocks are viewed as exogenous in in Fernández-Villaverde, Guerrón-Quintana, Rubio-Ramirez, and Uribe (2011). As Fernández-Villaverde et al (2011) suggest, in doing so we follow an established tradition in macroeconomics, exemplified by work such as Kydland and Prescott (1982), Mendoza (1995), and Neumeyer and Perri (2005) which treat productivity shocks, terms of trade shocks, and country spread shocks as exogenous. Also, the literature regarding the equilibrium model to endogenize volatility shock is still lacking; taking FX volatility shocks as given allows us to concentrate on the impact of FX volatility shocks, rather than how FX volatility shocks are determined. Stein and Stone (2013) suggest that macroeconomic fluctuations provide a natural source of exogenous variations. Stein and Stone (2013), Bloom (2014), and Alfro, Bloom, and Lin (2018) consider various types of volatility shocks from energy, currency, policy, and treasuries as instruments for uncertainty and to identify the impact of the exogenous variations in uncertainty on real economic activities. We also use a falsification test, placebo test, and instrumental variable analysis to mitigate the potential endogeneity issues.

derivatives to hedge against FX risk are less affected.

We examine two potential mechanisms that may be driving these results, the real option value of deferred investment and precautionary savings balances. We find that these two mechanisms are not mutually exclusive and that both help explain our main findings. First, previous theoretical studies such as Bernanke (1983), Rodrik (1991), Dixit and Pindyck (1994), and Chen and Funke (2003) suggest that firms have real options to delay investment; under a higher level of uncertainty, firms are better off postponing their (at least partially) irreversible investment projects because the option value of delay may increase. We thus expect the negative relation to be stronger for firms with more irreversible investments, given their higher adjustment costs, which is a direct and testable prediction. We find that the negative relation between exchange rate risk and investment is indeed stronger for firms with a higher capital intensity ratio. Hence, our results are consistent with the theoretical prediction of the real options mechanism.

The second mechanism is that firms exposed to greater risk may tend to increase precautionary savings and thus reduce capital expenditure. The idea of precautionary savings dates back to Keynes (1936). Previous studies have investigated the implications of precautionary savings on cash flow risk (Opler, Pinkowitz, Stulz, and Williamson, 1999), future risk (Carroll, Christopher, and Kimball, 2007), uninsurable investment risk (Sandri, 2010), funding gaps (Acharya, Almeida, and Campello, 2007), and external financing constraints (Riddick and Whited, 2009). When uncertainty is higher, firms are more likely to increase cash holdings to sustain day-to-day business operations or avoid future potential adverse outcomes. Hence, two testable predictions are 1) that firms indeed hold more cash after a period of higher

exchange rate risk, and 2) that the negative risk-investment relation may be stronger for firms with higher financial constraints. Since it is more difficult for more constrained firms to rely on internal or external financing to sustain investment projects, they are more likely to cut investment and maintain necessary cash reserves. Our findings support both predictions: Firm cash holdings increase after a period of higher exchange rate risk, and both the negative effect on investment and the positive effect on cash are stronger for more financially constrained firms. In short, both real options and precautionary savings help explain the negative association between exchange rate risk and corporate investment.

To further strengthen the identification of our analysis, we use two categories of historical events in the FX markets as exogenous shocks in addition to the unexpected exchange rate volatility used in the main analysis. First, we construct an instrumental variable for exchange rate risk using the shift in foreign exchange regimes, such as (but not limited to) the shift from fixed to floating exchange rates, based on the classification by Ilzetzki, Reinhart, and Rogoff (2019). Second, we use downgrades of sovereign debt as exogenous shocks to the FX markets. We use the downgrading events by three major credit rating agencies (Fitch, Moody's, and Standard and Poor's), as in Michaelides, Milidois, and Nishiotis (2019). Our results not only confirm our main findings but also strengthen the causal interpretation.

Our main results remain valid in robustness tests using alternative measures of exchange rate risk. We also examine the impact of exchange rate risk over different horizons. Our analysis of longer-term horizons shows that the exchange rate risk effect on investment only appears in the single next year, followed by a partial reversal in the second year, and the effect disappears after the third year. We also show that an unexpected increase in expected FX volatility affects

capital investment more than does an unexpected reduction in FX volatility, i.e. that the impact is asymmetric.

Our paper makes at least two contributions to the literature. First, we extend existing studies on exchange rate risk by exploring the real effects of exchange rate risk on corporate investment activities. Previous work has investigated exchange rate risk largely from four angles. Initially, early macro studies beginning with Hansen and Hodrick (1980), Fama (1984), and Hodrick (1989) examined how exchange rate risk affects the determination of exchange rates. The second group of studies applies different approaches to measure exchange rate risk. This literature has documented currency option implied volatility (Garman and Kohlhagen, 1983), GARCH volatility (Baillie and Bollerslev, 1991; Bollerslev and Melvin, 1994), and realized volatility based on high-frequency data (Andersen, Bollerslev, Diebold, and Labys, 2001; Andersen, Bollerslev, Diebold, and Vega, 2007).

The third set of (more recent) studies has discussed FX risk from an asset pricing perspective. Lustig and Verdelhan (2007), Lustig, Roussanov, and Verdelhan (2011), Menkhoff, Sarno, Schmeling, and Schrimpf (2012), Mancini, Ranaldo, and Wrampelmeyer (2013), Lettau, Maggiori, and Weber (2014), and Filippou, Gozluklu and Taylor (2018) propose different risk factors in currency markets. Mueller, Tahbaz-Salehi, and Vedolin (2017), Berg and Mark (2018), Husted, Rogers, and Sun (2018), and Della Corte and Krecetovs (2019) investigate how different forms of uncertainty impact currency returns.

The fourth approach emphasizes firm-level FX risk exposures, focusing primarily on measuring exchange rate exposures and investigating the impact of exchange rate fluctuations on firm values. Early theoretical work includes Shapiro (1975), Dumas (1978), Hodder (1982),

and Bodnar, Dumas, and Marston (2002). Jorion (1990), Amihud (1994), and Bartov and Badnor (1994), which consider different approaches to measuring exchange rate exposures. Allayannis and Weston (2001), Dominguez and Tesar (2006), Bartram, Brown, and Minton (2010), and Allayannis, Lel, and Miller (2012) provide empirical evidence of the effect of FX exposure and the use of currency derivatives on firm values.

We contribute to these four categories of existing studies by investigating the real effect of exchange rate risk on corporate investment activities.

Our paper also adds to the literature on the effect of uncertainty on corporate investment by considering a previously underexplored but nevertheless important dimension of uncertainty: exchange rate risk. Several empirical studies, in addition to the early theoretical work mentioned above, examine the relation between uncertainty and corporate investment. Leahy and Whited (1996) and Bloom, Bond and Van Reenen (2007) use individual stock volatility to measure firm-level uncertainty. Julio and Yook (2012) and Jens (2017) use political elections as a proxy for political uncertainty, while Gulen and Ion (2016) use a news-based index to investigate the impact of policy uncertainty. Kim and Kung (2017) analyze the role of asset redeployment in the uncertainty-investment relation. Azzimonti (2018) provides both aggregate and firm-level evidence for the effect of partisan conflicts on investment. Wang, Wu, and Xu (2019) investigate how geopolitical risk affects investment. While existing studies consider the effects of various types of uncertainty on corporate investment activities, we focus on investigating the real effect of another important global uncertainty that every large international firm must deal with, namely exchange rate risk.

Our paper is closely related to but also significantly different from three existing studies.

First, whereas Li, Li, and Wu (2019) use a sample of Chinese manufacturing firms to explore the Hartman-Abel effect in the exchange rate risk-investment relation, our study is cross-county. Second, our investigation is at the firm-level, in contrast to both Servén (2003), who investigates the relation between exchange rate volatility and private investments at the country level for developing economies, and Jeanneret (2016), who provides theoretical and country-level aggregate evidence of the effect of exchange rate risk on foreign direct investment (FDI). Third, our paper investigates the effect of exchange rate risk on overall corporate investment, in comparison to the analysis of country-level foreign direct investment in Jeanneret (2016). Finally, we also investigage potential underlying economic mechanisms driving these effects and use historical events to strengthen identification.

The remainder of the paper is organized as follows. Section 2 describes data and variable construction. Section 3 reports our main empirical findings. Section 4 discusses potential underlying driving mechanisms. In Section 5, we first present the results of historical events and then summarize the results of robustness tests of alternative specifications. Section 6 concludes the paper.

2. Data and Variables

2.1. Exchange Rate Data and Firm-Level Exchange Rate Risk Measures

We use 45 US dollar (USD) based exchange rates to construct pairwise exchange rates (one currency against another currency) spanning the period from January 1, 1987 to December 29, 2017.[4] Exchange rate data are collected from Datastream. USD-based exchange rates are

[4] These 44 countries and regions are Australia, Austria, Belgium, Brazil, Canada, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Egypt, Spain, Finland, France, UK, Greece, Hong Kong, Croatia, Hungary, Indonesia, India, Ireland,

commonly used in the FX asset pricing literature (e.g., Menkhoff et al., 2012). The USD exchange rate is directly quoted, with a higher value indicating the appreciation of the currency relative to USD.[5]

To obtain our main firm-level measure of exchange rate risk, we proceed with the following two steps. First, we calculate the country-level exchange rate risk measure. Second, we use firm-year level foreign sales exposure to weight the country-level measure and construct the firm-level measure.

We construct the *country-level* exchange rate risk measure using the generalized autoregressive conditional heteroskedasticity (GARCH) model of order (1,1) due to Bollerslev (1986) to estimate the conditional exchange rate volatility. The annualized GARCH volatility is estimated as follows,

$$r_{c,t,k} = \mu + \sqrt{h_{c,t,k}}\varepsilon_{i,t,k}, \qquad \varepsilon_{c,t,k} \sim N(0,1) \tag{1a}$$

$$h_{c,t,k+1} = \omega + \alpha h_{c,t,k} + \beta \varepsilon_{c,t,k}^2 \tag{1b}$$

$$GARCH\_VOL_{c,t+1} = \sqrt{\sum_{k=1}^{K} h_{c,t,k+1}} \tag{1c}$$

where $r_{c,t,k}$ is the daily log return for exchange rate c on day k in year t. We assume that the exchange rate change has a constant mean μ and that it is driven by a Gaussian shock $\varepsilon_{c,t,k}$, scaled by the conditional daily volatility $\sqrt{h_{c,t,k}}$. We estimate model parameters (ω, α, β) by maximum likelihood estimation (MLE) and obtain the conditional variance. We use daily returns within a year to obtain daily conditional volatility and then aggregate daily conditional

Israel, Italy, Japan, Korea, Luxemburg, Mexico, Malta, Malaysia, Netherland, Norway, New Zealand, Philippine, Portland, Portugal, Russia, Saudi Arabia, Singapore, Slovak, Slovenia, Sweden, Thailand, and South Africa. We choose them to match with the available cross-country firm-level data from Worldscope. The United States is not included in this international sample. The 45 exchange rates include currencies of the 44 economies and the euro used by euro-zone countries after 1999. Appendix Table A2 provides more details about the sample distribution.

[5] To facilitate our calculation of firm-level exchange rate risk measure, we focus on USD-based exchange rates. In an unreported analysis, we also consider effective exchange rates, i.e., domestic exchange rate vs. a basket of exchange rates, from Bank of International Settlement (BIS). The results are available upon request.

volatility over the year to estimate annual volatility.

We do not directly use the volatility measure as the country-level exchange rate risk proxy. Because volatility is persistence, firms may partially foresee the future volatility and hence adjust their corporate policies accordingly ex-ante. As a result, the observed association between exchange rate risk and corporate investment may be contaminated by the prior exchange rate volatility movement, and hence does not accurately reflect the current impact of exchange rate risk on investment.

To mitigate this concern, we resort to the *unexpected* exchange rate volatility or volatility *shock* to measure exchange rate risk. We construct the annual realized volatility as follows,

$$VOL_{c,t} = \sqrt{\sum_{k=1}^{K}\left(r_{c,t,k} - \overline{r_{c,t}}\right)^2} \quad (2)$$

where $VOL_{c,t}$ is the annual realized volatility for exchange rate *c* in year *t*.

Compared to ex-post realized volatility, the conditional volatility obtained from GARCH is ex-ante and thus provides an appropriate forecast for future volatility. We remove the predictive component from the realized volatility and use the difference between realized volatility and GARCH volatility – the conditional expected volatility - as the unexpected exchange rate risk measure:

$$UNEXP\_GARCH\_VOL_{c,t} = VOL_{c,t} - GARCH\_VOL_{c,t} \quad (3)$$

where $UNEXP\_GARCH\_VOL_{c,t}$ is the unexpected volatility in year *t*, and $GARCH\_VOL_{c,t}$ is the conditional volatility obtained from the GARCH (1,1) model in year t-1 forecast for year *t*.[6]

[6] In a robustness check, we also consider another measure based on the first difference of realized volatility, which is equivalent to assuming that volatility follows a random walk process. A similar approach has also been used in the literature by Ang, Hodrick, Xing, and Zhang (2006) and Menkhoff et al. (2012). In an unreported analysis, we further consider the use of currency option implied volatility and then use the first difference of implied volatility to obtain exchange rate risk measure. Our main results remain unchanged.

Secondly, we construct a *firm-level* exchange rate risk measure. Different firms in the same country may present heterogeneous exposures to exchange rate risk, depending on their revenue structures. Firms are not only affected by the exchange rate risk associated with the domestic currency to USD, but also may be exposed to exchange rate risk stemming from other foreign countries if a significant proportion of the firm's products are sold abroad. The firm-level measure is important as it captures the within-country cross-firm variations of exchange rate risk, and matches with the firm-level capital investment behaviors.

To obtain a firm-specific exchange rate risk measure, we resort to the foreign sales information from the Worldscope database to calculate the weight as an exposure measure, and then measure the firm-level exchange rate risk as a weighted average of country-level exchange rate risks. Specifically, we calculate the firm-level exposure ($exposure_{i,c,t}$) to a specific country *c* as the ratio of sales in country *c* to total foreign sales. We use the total foreign sales rather than the total sales as the denominator because our sample focuses only on those foreign exchange exposed firms (i.e., those firms with foreign sales). The higher the weight, the more dependence of the total revenue of the firm to sales in the specific country, and hence to the specific exchange rate risk. We then calculate the weighted average exchange rate risk as follows,

$$UNEXP\_GARCH\_VOL_{i,c,t} = \sum_{c=1}^{n} FX\_RISK_{c,t} * exposure_{i,c,t} \quad (4)$$

where $FX\_RISK_{c,t}$ is the foreign exchange risk measure for firm *i* in country *c* in year *t* using $UNEXP\_GARCH\_VOL_{i,c,t}$, $exposure_{i,c,t}$ is the weight we obtained above. To capture the exchange rate risk of firm *i* located in country *c* but sold in another country *d*, we use two USD exchange rates for country *c* and country *d* to obtain the cross-rates between these two countries,

and calculate the exchange rate risk measure as in equation (3), and then obtain the firm-specific exchange rate risk measure for firm *i* in year *t* following equation (4).[7]

In addition to our exchange rate risk measures, we also control for the effects of exchange rate movements. We define the log exchange rate return as follows:

$$r_{c,t} = \Delta s_{c,t} = lnS_{c,t} - lnS_{c,t-1} \quad (5)$$

where $S_{c,t}$ refers to the exchange rate *c* in the year *t*, and $\Delta s_{c,t}$ refers to the log exchange rate return/change for year *t* (FX_USD_LN).

2.2. FX-Exposed Firms and Currency Derivatives Usage

Our sample focuses on FX-exposed firms with total assets over 100 million USD. These firms are directly affected by exchange rate risk. We define a firm as FX exposed if it has a foreign income record in the Worldscope database, similar to Allayannis and Weston (2001) and Allayannis, Lel, and Miller (2012).

Among firms exposed to FX fluctuations, some may choose to hedge against exchange rate risk using currency derivatives (Brown, 2001). Other firms do not hedge, perhaps due to the lack of availability of appropriate financial instruments in underdeveloped domestic financial markets. To understand firm-level heterogeneity, we follow Allayannis, Lel, and Miller (2012) and hand collect the data of currency derivatives usage from Form 20-F and annual reports filed with the US Securities and Exchange Commission (SEC). We treat a firm as using

[7] Foreign sales information in the Worldscope database may include some regions without clear identified countries, such as Eastern Europe. When calculating our exposure measure, we focus only on those with clearly identified countries/regions and hence link to specific exchange rates. In a robustness check, we also consider an alternative measure which we fill all non-identified sales by assuming these sales are traded in USD. Results are virtually unaffected.

derivatives (i.e., indicator variable FX_DERI=1) if their SEC filings indicate so and as not using derivatives otherwise (FX_DERI = 0). Since Form 20-F is only submitted by US-listed international firms, the analysis of currency derivatives usage is restricted to this subsample.

2.3. Corporate Investment

We use two measures of capital expenditure to proxy corporate investment: The ratio of capital expenditure to beginning-of-year total assets (CAPEX/AT) and the natural logarithm value of capital expenditure (CAPEX_USD_LN). In addition, we consider cash holdings both in ratio (CASH/AT) and in natural logarithms (CASH_USD_LN) when we examine the potential precautionary savings mechanism.

2.4. Control Variables

We also control for a set of commonly used firm-level characteristics. The following control variables are scaled by total assets: earnings before interest, taxes, depreciation and amortization (EBITDA); standard deviation of EBITDA (EBITDA_VOL); long-term debt (LEVERAGE); pretax book income (PTBI); standard deviation of PTBI (PTBI_VOL); and change in sales (SGA_DELTA). We also control for the natural logarithm of total assets (SIZE) and the natural logarithm of firm age (FIRM_AGE). All firm-level dependent variables and control variables are constructed using data from the Worldscope database.

We further control for a set of country-level characteristics, given the cross-country nature of our analysis. The following country-level variables are scaled by GDP: market capitalization of domestic listed companies (CAPITAL_RATIO), exports of goods and services

(EXPORT_RATIO), imports of goods and services (IMPORT_RATIO), and total value of stocks traded (STOCK_RATIO). We also control for the natural logarithm of GDP per capita (GDP_CAP_LN), natural logarithm of GDP (GDP_LN), and GDP growth rate (GDP_GROWTH). These country-level variables are collected from the World Bank database.

Appendix Table A1 presents detailed descriptions of all main variables. Appendix Table A2 describes the cross-country sample distributions we considered. Table 1 provides summary statistics.

3. Empirical Analysis

In this section, we report our main empirical results. We first present our baseline results on the average effect of exchange rate risk on corporate investment. We then discuss the heterogeneous effects of exchange rate risk at both the country level and firm level.

3.1. Baseline Results

We start with the average effect of exchange rate risk on corporate investment. Our baseline investment regression is as follows,

$$Invest_{i,c,t+1} = \alpha + \beta FXRisk_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (6)$$

where the main dependent variable $Invest_{i,c,t+1}$ is either CAPEX/AT or CAPEX_USD_LN. In addition to investment, we also consider cash holdings (CASH/AT and CASH_USD_LN) as dependent variables to reflect potential precautionary savings. We replace the dependent variable in equation (6) with one of these four variables.

Our main independent variable, $FXRisk_{i,c,t}$, refers to one of our firm-level measures of exchange rate risk. We present the main results with unexpected volatility from a GARCH

volatility model ($UNEXP\_GARCH\_VOL_{i,c,t}$) as the independent variable. Note that the dependent variable is one year ahead of all independent variables, which reflects the effect of exchange rate risk on firms' investment decisions in the next year. $X_{i,c,t}$ and $X_{c,t}$ are vectors of firm and country-level control variables. To absorb unobserved omitted variables related to specific firms and time trends, we also add firm fixed effects (Φ_i) and year fixed effects (Φ_t). We cluster our standard errors at the firm level to correct for estimation errors related to specific firms.

Table 2 Panel A reports our main results from estimating equation (6). We find that the exchange rate risk negatively and significantly affects future capital expenditure. This finding is consistent regardless of whether we use the ratio or the natural logarithm to construct the corporate investment measures. The negative relation is not only statistically significant, but also economically meaningful. A one standard deviation increase of exchange rate risk is followed by a 3.4% decrease for CAPEX/AT and 0.1% for CAPEX_USD_LN in the subsequent year.[8] We also find that exchange rate risk leads to more cash holdings. A one standard deviation increase of exchange rate risk is associated with a 1.8% and a 0.1% increase in CASH/AT and CASH_USD_LN in the next year, respectively.[9] The positive relation between exchange rate risk and cash holdings is consistent with a precautionary savings motive. In other words, when exchange rates are unexpectedly volatile, firms tend to hold cash in case of future adverse outcomes.[10]

[8] -3.4% is calculated as -0.826(coefficient)*0.22(standard deviation of the independent variable)/5.37(mean of the dependent variable). -0.1% is calculated as (exponential of -0.099 (coefficient) minus 1) *0.22(standard deviation of the independent variable)/15.98(mean of the dependent variable).

[9] 1.8% is calculated as 1.24(coefficient)*0.22(standard deviation of the independent variable)/15.06(mean of the dependent variable). 0.1% is calculated as (exponential of 0.097 (coefficient) minus 1) *0.22(standard deviation of the independent variable)/17.12(mean of the dependent variable).

[10] In an unreported analysis, we drop the country-year level control variables and include country*year fixed effects instead of year fixed effects, and also control for firm fixed effects at the same time. The results are largely consistent and available

3.1.1. Robustness Tests: Economic Policy Uncertainty

One concern is whether the negative effect of exchange rate risk on investment can be subsumed by existing measures of uncertainty, such as the economic policy uncertainty used by Gulen and Ion (2016). To isolate the effect of exchange rate risk from economic policy uncertainty, we control for the economic policy uncertainty index provided by Baker, Bloom, and Davis (2016) in Panel B of Table 2. The index is constructed based on newspaper coverage frequency of terms related to "economic", "policy", and "uncertainty". It measures uncertainty over who will make economic policy decisions, what economic policy actions will be undertaken and why, and the economic consequence of the policy.[11]

Panel B shows that exchange rate risk significantly and negatively affects capital expenditure, consistent with what we find in Panel A. Similar results also hold when measures of cash holdings are used as dependent variables. In short, the adverse effect of exchange rate risk on corporate investment is not subsumed after the inclusion of economic policy uncertainty.

3.1.2. Robustness Tests: Falsification and Placebo Tests

We conduct falsification and placebo tests to enhance the identification of our results. We first consider a falsification test suggested by Roberts and Whited (2012). In Table 2 Panel C, we run the same baseline regression except for replacing our *t+1* dependent variable by its *t-1*

upon request.

[11] While we use the full sample of 44 countries and regions throughout the paper, only 27 international economic policy uncertainty (EPU) indexes are available on the policy uncertainty website (https://policyuncertainty.com/). The intersection of the available EPU sample with our original sample leaves 20 economies, including Australia, Belgium, Brazil, Canada, France, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, South Korea, Mexico, Netherlands, Russia, Singapore, Spain, Sweden, and UK. So, we control for the EPU index in this panel only.

to *t-3* lagged variables. The idea is straightforward: if the effect of exchange rate risk on future capital investment in *t+1* is indeed due to the unexpected exchange rate volatility shock in year *t*, then this shock should not affect prior investment levels one to three years before. Hence, this falsification test helps to mitigate the reverse causality concern. Consistent with our prediction, we do not find significant estimated regression coefficients for exchange rate risk in any of these specifications involving lagged dependent variables. Therefore, our results concerning the effect of exchange rate risk on corporate investment is unlikely to be subject to a reverse causality issue.

In addition to falsification tests in the time dimension, we also conduct another placebo test in the cross-section dimension. In each year, we randomly draw unexpected exchange rate volatility from another firm to replace the true volatility for the current firm, while holding everything else unchanged, and then run the baseline regression. We repeat the procedure 3000 times and plot the distribution of regression coefficient. Figure 1 plots the distributions of regression coefficients for unexpected exchange rate volatility when different dependent variables are used. The true regression coefficients consistently locate on the far left (right) of the distribution when capital expenditure (cash holding) is used as the dependent variables. In contrast, most of the pseudo random draws do not reproduce the documented negative (positive) effect of exchange rate risk on capital investment (cash holding). These results strongly suggest support that our empirical findings concerning the effect of exchange rate risk on corporate investment are unlikely to be purely due to chance.

In short, both falsification and placebo tests strengthen our finding of a significant effect of exchange rate risk on corporate capital investment.

3.2. Cross-Sectional Heterogeneity

In this section, we explore the cross-sectional heterogeneous treatment effects of exchange rate risk at both the country level and the firm level.

3.2.1. Economic Openness

At the country level, we examine the role of economic openness on the effect of exchange rate risk on investment. Intuitively, FX fluctuations should have a greater impact in more open economies, where more firms are more engaged in international trade. These firms may import raw materials from overseas and export their products abroad. Firm revenues are also expected to be more affected by exchange rate variations. Huston and Stevenson (2010), using a sample of firms from 23 developed countries, also find that firms are more exposed to exchange rate movements when the economy is more open. In contrast, since firms in more autarkic economies will depend less on cross-border trade, the effect of exchange rate risk should be smaller. Hence, we expect the degree of economic openness to amplify the adverse effect of exchange rate risk.

We use the import-export to GDP ratio (IMP_EXP_RATIO) constructed from World Bank data as the country-year level economic openness measure. A higher value of this measure indicates a higher degree of economic openness. We augment the baseline model by including IMP_EXP_RATIO and its interaction term with exchange rate risk,

$$Invest_{i,c,t+1} = \alpha + \beta_1 FXRisk_{i,c,t} * Open_{c,t} + \beta_2 FXRisk_{i,c,t} + \beta_3 Open_{c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (7)$$

where $Open_{c,t}$ is IMP_EXP_RATIO and $FXRisk_{i,c,t} * Open_{c,t}$ is the interaction term of

interest. We control for firm and country-level characteristics, as well as for firm and year fixed effects, and cluster standard errors at the firm level.

As shown in Table 3, the interaction term for investment is negative and significant, indicating that the negative exchange rate risk-investment effect is indeed stronger for firms in more open economies. The interaction term for cash holdings is positive and significant, strengthening the effects on cash holdings in our baseline results. In sum, economic openness indeed magnifies the real effects of exchange rate risk on corporate investment.

3.2.2. Currency Derivatives

At the firm level, we study two categories of firms, those that do and those that do not hedge with currency derivatives. The development of financial markets offers firms different financial instruments to manage financial risks. By using derivatives such as currency forwards or options, a firm can hedge against unfavorable movements of FX fluctuations, which mitigates the impact of exchange rate risk on firm operations. Some firms do not use currency derivatives, perhaps due to underdeveloped domestic financial markets and the unavailability of appropriate financial instruments. The benefit of using currency derivatives to enhance firm value for foreign exchanged exposed firms has already been documented by Allayannis and Weston (2001) and Allayannis, Lel, and Miller (2012). Huston and Stevenson (2010) also suggest that institutional incentive to value enhancing risk management activities is critical to manage foreign exchange exposure. We expect that hedging with currency derivatives mitigates the adverse effect of exchange rate risk on corporate investment.

We augment the baseline model by including currency derivative usage and its interaction

term with exchange rate risk and estimate the following regression,

$$Invest_{i,c,t+1} = \alpha + \beta_1 FXRisk_{i,c,t} * Deri_{i,c,t} + \beta_2 FXRisk_{i,c,t} + \beta_3 Deri_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (8)$$

where $Deri_{i,c,t}$ is an indicator variable of currency derivatives usage (FX_DERI) that equals one if the firm uses currency derivatives and zero otherwise. $FXRisk_{i,c,t} * Deri_{i,c,t}$ is the interaction term of interest. We control for country and firm characteristics, as well as for firm and year fixed effects, and cluster standard errors at the firm level.

As shown in Table 4 Panel A, the coefficient of the interaction term ($FXRisk_{i,c,t} * Deri_{i,c,t}$) is positive and significant, indicating that currency derivatives usage reduces the negative effect of exchange rate risk on corporate investment. We observe similar weakened effects for cash holdings. The estimated coefficients of the interaction terms have the opposite signs to the coefficients of $FXRisk_{i,c,t}$. To further control for other unobserved and omitted macroeconomic variables, we add country-year joint fixed effect into our model, thus absorbing all country-specific and time-varying omitted variables. We present the result in Table 4 Panel B. Our conclusions drawn from Panel A remain robust.

4. Potential Mechanisms

In this section, we analyze potential economic mechanisms through which exchange rate risk affects corporate investment activities. We examine two potential explanations: real options and precautionary savings.

4.1. Real Options

The first mechanism we investigate is real options, which has been widely analyzed in the

literature on investment under uncertainty. Real options analysis applies financial option valuation techniques to capital budgeting decisions. Like a financial option, a real option is the right, but not the obligation, to pursue a course of action. With a financial option, the course of action that is optioned is the purchase or sale of an underlying asset. Standard option pricing theory dating back to Black and Scholes (1973) relates the value of an option to the price volatility of the underlying asset; intuitively, higher volatility means the option is more valuable as a hedge, or alternatively, it means there is a higher probability of the exercise of the option making a profit. Real options analysis analogously sees business plans to make capital investments as having an option value, and the real option as exercised when the capital investment is made. The value of keeping the option open (not making the capital investment) will be higher when economic conditions are more volatile. Intuitively, a firm will not want to invest in times of high uncertainty since the capital expenditure involves sunk costs that cannot be recovered. The effect is stronger for firms with a higher degree of investment irreversibility. Given the higher adjustment costs, these firms tend to postpone or cease their investment projects in times of higher economic volatility. As a result, a testable implication for the real options-based explanation is that the negative exchange rate risk-investment relation is stronger in firms with a higher degree of investment irreversibility.

Previous studies (e.g., Gulen and Ion, 2016; Kim and Kung, 2017) consider different measures of investment irreversibility including the capital intensity ratio, asset redeployability, cost sunkness, and asset liquidation value. In this paper, we stick to the simplest measure of investment irreversibility: the capital intensity ratio (net property, plant and equipment, or PPE, divided by total asset), primarily for the data availability considerations in our cross-country

study. The implicit assumption as highlighted in Gulen and Ion (2016) is that firms with a higher capital intensity ratio tend to invest in projects with large upfront costs, mainly physical assets specific to their bustiness lines.

Our empirical specification is as follows,

$$Invest_{i,c,t+1} = \alpha + \beta_1 FXRisk_{i,c,t} * \ IR_{i,c,t} + \beta_2 FXRisk_{i,c,t} + \beta_3 \ IR_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (9)$$

where IR_{ict} is our measure of investment irreversibility. We use the capital intensity ratio (net PPE divided by total asset, PPENT/AT) as a proxy for investment irreversibility. $FXRisk_{i,c,t} * IR_{i,c,t}$ is the interaction term. Similar to the models above, we control for country and firm characteristics and for firm and year fixed effects; we cluster standard errors at the firm level.

Table 5 reports results for investment irreversibility. In line with our prediction, we show that the interaction term ($FXRisk_{i,c,t} * IR_{i,c,t}$) is negative and significant for capital expenditure. For firms with a higher degree of investment irreversibility, the negative effect of exchange rate risk on investment is strengthened. The effect of exchange rate risk on cash holdings is also stronger for this group of firms. In short, our empirical finding is consistent with a real options-based explanation.

4.2. Precautionary Savings

The second mechanism we study is precautionary savings balances. Our existing findings—that exchange rate risk has a positive effect on cash holdings--already provide evidence to support the precautionary savings explanation. When exchange rate risk increases, firms tend to hold more cash to sustain business operations and prevent future adverse

outcomes. Consequently, they reduce their capital investments.

In this section, we examine another implication of precautionary savings. We consider the role of financial constraints in the exchange rate risk-investment relation. Financially constrained firms have a shortage of internal funds, and face difficulty obtaining external financing. Campello, Graham and Harvey (2010) show that financially constrained firms cut capital spending more during financial crises. Alfaro, Bloom and Lin (2018) document that these firms react more strongly to uncertainty shocks. We suggest that financially constrained firms have to cut or delay investment projects to sustain day-to-day business operations or hold more cash, when an exchange rate risk shock arrives. The difficulty of obtaining internal and external financing makes these financially constrained firms react strongly to exchange rate risk shock. and the positive effect on cash holding to be more pronounced. To examine this implication, we consider the following specification,

$$Invest_{i,c,t+1} = \alpha + \beta_1 FXRisk_{i,c,t} * \ KZ_{i,c,t} + \beta_2 FXRisk_{i,c,t} + \beta_3 \ KZ_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (10)$$

where KZ_{ict} is the Kaplan and Zingales (1997) financial constraint index (KZ_INDEX) based on accounting information. The higher the index, the more constrained the firm. $FXRisk_{i,c,t} * KZ_{i,c,t}$ is the interaction term. As in earlier specifications, we control for country and firm characteristics, as well as firm and year fixed effects, and cluster standard errors at the firm level.

Table 6 presents results for financial constraints. We find that the interaction term ($FXRisk_{i,c,t} * \ KZ_{i,c,t}$) is negative and significant for capital expenditure. Specifically, the negative exchange rate risk-investment relation is stronger for firms with tightened financial

constraints, consistent with our prediction. The exchange rate risk effect on cash holdings is also stronger for these constrained firms.

In summary, our findings suggest that both real options and precautionary savings explanations are valid mechanisms through which exchange rate risk influences corporate investment activities.

5. Robustness Checks

5.1. Exchange Rate Regime Changes

Our main empirical analysis uses unexpected volatility to measure exchange rate risk. Since firms can hardly anticipate volatility shocks, the measure already largely mitigates the potential endogeneity concern. In addition, however, we applied both falsification and placebo tests to confirm that our results are unlikely to be driven by reverse causality or by chance. In this section, we conduct two additional identification tests to further address potential endogeneity issues and strengthen a causal interpretation of our empirical findings. We rely on historical major events in the FX markets as exogenous shocks to facilitate the causal inference.

We first consider the change of exchange rate regime as an instrumental variable for exchange rate risk. The change of exchange rate regime is naturally associated with greater uncertainty in FX markets. An extreme example is the change from a fixed to a floating rate regime after the collapse of the Bretton Woods system in the 1970s. From a firm's perspective, it is hard to anticipate the exact timing of the change, and hence the occurrence of a regime change can be viewed as an uncertainty shock to firms. When facing changes of exchange rate regimes, firms may be unable to instantaneously adjust their corporate policies in accordance

with the new regime due to high adjustment costs. Therefore, they are more likely to delay or drop new investment projects to sustain day-to-day business operations.

We use the exchange rate regime classification by Ilzetzki, Reinhart, and Rogoff (2019).[12] Our regime change measure is a dummy variable ($RegimeChange_{c,t}$), which takes the value of one if the exchange rate regime in this year is different from that in the previous year and zero otherwise. We focus on the change rather than the content of the exchange rate regime. To obtain a firm-level instrumental variable measure, we adopt the same procedure as used in exchange rate risk measure: we use the ratio of sales to a specific country to the total foreign sales to calculate the firm's exposure to specific country, and then we combine the weight and the country's exchange rate regime change dummy to calculate the weighted average, as the firm-specific exchange rate regime change variable ($RegimeChange_{i,c,t}$, FX_REGIME_CHANGE). We view the regime change as an instrumental variable which is directly linked to exchange rate risk (relevance condition) and is unlikely to affect corporate investments through channels (exclusion condition) beyond exchange rate risk. We use the conventional two-stage least squares (2SLS) regression approach to implement our instrumental variable analysis. In the first stage, we regress our main explanatory variable exchange rate risk on the instrumental variable and a set of control variables.

$$FXRisk_{i,c,t} = \alpha + \beta RegimeChange_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t} \qquad (11)$$

In the second stage, we use the fitted value ($\widehat{FXRisk_{i,c,t+1}}$) from the first stage to replace exchange rate risk in the baseline regression. Specifically, we regress capital expenditures on

[12] While different ways to classify exchange rate regime exist in the literature, we use the latest classification by Ilzetzki, Reinhart, and Rogoff (2019); we thank Carman Reinhart for making their exchange rate regime classification data from the paper publicly available on her website.

the fitted value of exchange rate risk and a set of control variables.

$$Invest_{i,c,t+1} = \alpha + \beta \widehat{FXRisk}_{c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \quad (12)$$

We include firm and country-level control variables, add firm and year fixed effects, and cluster standard errors at the firm level as we did in the baseline analysis.

Table 7 reports the results. In the first stage regression, we show that our instrument ($RegimeChange_{i,c,t}$) is positively and significantly associated with exchange rate risk, supporting the relevance condition. In the second stage regression, we find that the fitted value of exchange rate risk, obtained from the first stage regression, is negatively and significantly associated with corporate investments, just as we observed in the baseline analysis. We also observe the positive effect on cash holdings. In short, our instrumental variable analysis alleviates endogeneity concerns and supports the causal relation between exchange rate risk and corporate investments.

5.2. Sovereign Debt Downgrades

Our second identification test uses a sovereign debt downgrading event as an exogenous shock. Della Corte, Sarno, Schmeling and Wagner (2021) and Michaelides, Milidois, and Nishiotis (2019) have recently highlighted the importance of sovereign risk in affecting exchange rates. Augustin, Chernov and Song (2020) find that conditional on the sovereign credit default, the probability of the domestic currency devaluation in one week can be as high as 42%. Reinhart (2002) and Mano (2013) provide historical evidence that sovereign defaults are often followed by currency depreciation and heightened currency uncertainty. Della Corte et al (2021) show that the uncertainty generated by the event can be persistent as the

downgrading event of a country's sovereign debt is associated with depreciated and more volatile domestic currency. Hence, we view downgrading events as an important shock to the FX markets. While Michaelides, Milidois and Nishiotis (2019) recognize that there could be potential information leakage before the event, they also agree that it happens, at most, one month ahead of the event. Information leakage can therefore be largely ignored for an annual-based study.[13] We view these events as exogenous shocks in the FX markets and use them to identify the potential causal relation between exchange rate risk and corporate investments.[14]

We use sovereign debt downgrades by three major rating agencies (i.e., Fitch, Moody's, and Standard and Poor's).[15] The country-level downgrade shock variable is a dummy variable, which takes a value of one if downgrading happens and zero otherwise. As before, we also use foreign sales information to calculate weighted average downgrade shock at the firm level, and then use it to replace the exchange rate risk in our baseline model. We consider the following model specification,

$$Invest_{i,c,t+1} = \alpha + \beta DowngradeShock_{i,c,t} + \mathrm{X}_{i,c,t} + \mathrm{X}_{c,t} + \Phi_i + \Phi_t + \epsilon_{i,c,t+1} \qquad (13)$$

where $DowngradeShock_{i,c,t}$ is the firm-level downgrade shock variable (SOV_DEBT_DOWNGRADE). As before, we include firm and country-level country variables, add firm and year fixed effects, and cluster standard errors at the firm level.

Table 8 reports results for sovereign debt downgrading events.[16] We find that the

[13] One possible concern is that sovereign debt downgrades may affect the domestic economic condition due to higher sovereign risk and hence affect firm investments in channels beyond FX uncertainty. We control for country-level macroeconomic variables to mitigate this concern. We also deal with the concern by including sovereign CDS spread as an additional control in an unreported analysis. Results are qualitatively unchanged.

[14] We use a sovereign debt downgrading event as an exogenous shock, which is a difference-in-differences setting, as currencies in different countries are affected by downgrading events in different years. In the empirical analysis, we use the same procedure as our main firm-level exchange rate risk to construct firm-level downgrading shocks.

[15] We follow Michaelides, Milidois, and Nishiotis (2019) and focus on all sovereign debt rating announcements across 55 countries between 1988 to 2012 for the three largest rating agencies (Fitch, Moody's, and StandardandPoor's). We thank the authors to make their sovereign debt grading data publicly available on the *Journal of Financial Economics* website.

[16] Because there are not enough observations of SOV_DEBT_DOWNGRADE for the sample of multinational firms with total

downgrading event is associated with significantly lower capital expenditure. We also show that the event positively affects cash holdings. Therefore, our sovereign debt downgrading results are consistent with our baseline findings.

In sum, both identification tests confirm our main findings and support the causal interpretation of the negative effect of exchange rate risk on corporate investments.

5.3. Alternative FX Risk Measures

In our first additional robustness check, we use three alternative exchange rate risk measures, including unexpected realized volatility as well as an alternative version of unexpected GARCH and realized volatility. In the Worldscope database, some firms' foreign sales information only indicates general areas such as "Asia" instead of specific countries like "Japan." We exclude this type of information in the process of constructing the explanatory variables in our main analyses. Here we construct two additional unexpected GARCH and realized volatility measures by including this type of not specific information and weighting non-specific foreign sales by exchange rates against USD. Tables IA1 to IA5 of the Internet Appendix report the results using these alternative exchange rate risk measures, which are consistent with our main findings.

5.4. Long-Term Effect

We also investigate the effect of exchange rate risk on investment over a long-term horizon. Table 9 replicates baseline regressions but using capital expenditure from year $t+1$ to year $t+8$.

assets above 100 million USD, we use an extended sample of firms with total assets above 10 million USD for regressions in Table 9. Therefore, the number of observations is much larger than in other tables.

We show that the significantly negative effect of exchange rate risk appears only in year *t+1*, followed by a weak reversal in *t+2*, and then becomes insignificant afterwards. Moreover, the dynamic pattern is more pronounced in subsample of firms with a higher degree of investment irreversibility, consistent with the real options explanation. Our findings suggest that while the positive uncertainty effect or the Oi-Hartman-Abel effect (Oi, 1961; Hartman, 1972; Abel, 1983) may exist, the negative effect dominates in the short horizon. This finding is also consistent with existing studies, e.g., Bloom (2014), which show that the Oi-Hartman-Abel effect mainly shows in the mid to long horizons, given the adjustment costs, while the negative uncertainty effect matters more in the short horizon.

5.5. Rise and Fall of FX Volatility: Asymmetric Effects

We further separately examine the possibly asymmetric effects of rises as opposed to falls in FX volatility. We construct the unexpected increase (decrease) of the FX volatility measure, defined as whether the FX risk is positive (negative). Anecdotal evidence suggests that the rise of FX volatility should have a larger effect on corporate investment. Intuitively, a sudden increase of uncertainty results in a higher option value to delay and is more likely to make firms precautionary save, leading to a decrease in capital expenditure. On the other hand, a sudden decrease of uncertainty (or uncertainty resolution) may not necessarily encourage firms to invest more *immediately,* given the adjustment costs. Thus, the effects of negative and positive volatility shocks may not be symmetric and, in particular, the overall negative effect of exchange rate risk we have documented may be more attributed to positive rather than negative volatility shocks. To investigate this, we replace the exchange rate risk measure

(UNEXP_GARCH_VOL) with separate positive (UNEXP_GARCH_VOL (POSITIVE)) and negative (UNEXP_GARCH_VOL (NEGATIVE)) exchange rate risk measures in the baseline model.

As Table 10 shows, the positive FX volatility shock negatively and significantly affects future capital expenditures while positively and significantly influencing future cash holdings. In contrast, the negative volatility shock has negative but insignificant effects on capital expenditures while its effects on cash holdings are more mixed, depending on the specific measures. These findings suggest that the overall adverse effect of unexpected volatility on investment is mainly driven by the unexpected increase of FX volatility.

6. Conclusion

In this paper we have examined the real effects of exchange rate risk on corporate investment. Using firm-year level unexpected volatility to measure exchange rate risk, we document evidence that exchange rate risk leads to significantly lower future corporate investment activities. We also demonstrated that this finding is robust to including country-level policy uncertainty and is unlikely to be driven by reverse causality or purely by chance. We also showed that the effect is stronger for firms in countries with more open economies and for firms that do not use currency derivatives to hedge exchange rate risk.

We also investigated potential underlying economic driving mechanisms of these findings, and found that exchange rate risk has a stronger effect on the investment of firms with higher levels of investment irreversibility. Furthermore, we showed that exchange rate risk positively affects future cash holdings and that the exchange rate risk-investment relationship is stronger

for more financially constrained firms. Our findings thus suggest that both real options and precautionary savings explanations are valid explanations for the exchange rate risk-investment relationship we have documented.

We then used two sets of historical events to further identify the causal relationship between exchange rate risk and corporate investment. Using the change of exchange rate regime as an instrumental variable and sovereign debt downgrades as an exogenous shock, we confirmed our main findings and strengthen a causal interpretation of the exchange rate risk-investment relationship. We also showed that our results are robust to different measures of exchange rate risk. In addition, we found that the significantly negative effect is only in the single subsequent year, followed by a partial reversal in the second year, and then becoming insignificant. We also found that the unexpected volatility increase mainly drives the negative effect of exchange rate risk on investment.

Overall, our paper contributes to the exchange rate risk literature by analyzing the real effect of exchange rate risk on corporate operations, and also adds to the literature on investment under uncertainty by examining an important but previously under-researched source of uncertainty in the corporate environment, namely exchange rate risk.

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Table 1 Summary Statistics

Dependent Variables	Obs	Mean	Std	25%	Median	75%
CAPEX / AT	15,660	5.37	6.06	1.60	3.72	7.09
CAPEX_USD_LN	15,660	15.98	2.58	14.58	16.11	17.68
CASH / AT	15,660	15.06	16.47	4.51	10.06	20.15
CASH_USD_LN	15,660	17.12	2.03	15.85	17.17	18.52
Independent Variables	**Obs**	**Mean**	**Std**	**25%**	**Median**	**75%**
FX_REGIME_CHANGE	18,764	0.01	0.06	0.00	0.00	0.00
KZ_INDEX	17,491	-0.52	4.47	-0.67	0.63	1.40
SOV_DEBT_DOWNGRADE	18,764	0.01	0.07	0.00	0.00	0.00
UNEXP_VOL_FILL	18,764	0.14	0.55	-0.23	-0.01	0.36
UNEXP_GARCH_VOL_FILL	18,764	0.22	0.56	-0.16	0.05	0.45
UNEXP_GARCH_VOL	18,764	0.06	0.22	-0.03	0.00	0.07
UNEXP_VOL	18,764	0.04	0.21	-0.04	-0.00	0.05
Interaction Variables	**Obs**	**Mean**	**Std**	**25%**	**Median**	**75%**
FX_DERI	1,718	0.03	0.18	0.00	0.00	0.00
IMP_EXP_RATIO	18,764	125.13	114.24	50.80	73.15	138.48
PPENT / AT	18,456	0.35	0.27	0.14	0.31	0.51
Control Variables	**Obs**	**Mean**	**Std**	**25%**	**Median**	**75%**
EPU_INDEX	10,846	113.22	44.22	76.21	107.53	138.85
CAPITAL_RATIO	18,764	122.92	117.98	64.68	102.00	144.82
EBIDTA	18,764	0.08	0.16	0.05	0.09	0.14
EBIDTA_VOL	18,764	0.07	0.14	0.03	0.04	0.08
FIRM_AGE	18,764	2.39	0.58	1.95	2.48	2.83
FX_USD_LN	18,764	0.00	0.10	-0.06	0.00	0.07
GDP_CAP_LN	18,764	10.16	0.79	9.93	10.29	10.66
GDP_GROWTH	18,764	3.02	2.60	1.79	2.90	4.21
GDP_LN	18,764	27.03	1.09	26.27	26.87	27.96
LEVERAGE	18,764	0.16	0.18	0.01	0.10	0.24
LOSS	18,764	0.18	0.38	0.00	0.00	0.00
PTBI	18,764	0.04	0.18	0.01	0.05	0.11
PTBI_VOL	18,764	0.09	0.27	0.03	0.05	0.09
SGA_DELTA	18,764	-0.01	0.16	-0.03	-0.00	0.03
SIZE	18,764	19.63	1.92	18.31	19.49	20.87
STOCK_RATIO	18,764	71.83	73.43	33.22	60.71	94.05
TOBINQ	18,764	1.49	1.39	0.92	1.15	1.59

Table 2 Exchange Rate Risk and Corporate Investments

Panel A: Baseline Regression

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL	-0.826***	-0.099**	1.240***	0.097***
	(-3.958)	(-2.018)	(2.689)	(3.098)
FX_USD_LN	1.348**	0.346**	0.510	-0.008
	(2.051)	(2.103)	(0.323)	(-0.070)
GDP_LN	1.260	0.418	20.077***	1.594***
	(0.459)	(0.673)	(3.169)	(3.534)
GDP_CAP_LN	-1.061	-0.600	-18.554***	-1.548***
	(-0.343)	(-0.878)	(-2.620)	(-3.058)
GDP_GROWTH	0.133***	0.030***	-0.023	-0.003
	(4.620)	(4.244)	(-0.354)	(-0.534)
IMP_EXP_RATIO	-0.005	-0.001	-0.006	-0.001
	(-1.232)	(-0.066)	(-0.522)	(-0.804)
CAPITAL_RATIO	-0.001	0.001	0.007*	0.001*
	(-0.727)	(0.102)	(1.797)	(1.660)
STOCK_RATIO	0.005***	0.001	-0.001	0.001
	(2.647)	(0.766)	(-0.081)	(0.386)
TOBINQ	0.498***	0.126***	1.560***	0.068***
	(4.502)	(2.959)	(4.300)	(5.203)
EBIDTA	3.634**	0.793**	4.346	0.532***
	(2.356)	(2.076)	(1.072)	(2.627)
EBIDTA_VOL	1.369	0.438	6.250	0.335**
	(1.422)	(1.553)	(1.629)	(2.076)
LOSS	0.139	0.047	0.049	0.023
	(0.812)	(1.142)	(0.113)	(0.732)
LEVERAGE	-0.168	0.007	-3.838***	-0.235***
	(-0.290)	(0.059)	(-3.017)	(-2.697)
PTBI	5.423***	1.212***	8.596***	0.600***
	(7.305)	(5.403)	(3.334)	(4.641)
PTBI_VOL	-0.026	0.008	1.936	0.124
	(-0.045)	(0.051)	(0.918)	(1.353)
SGA_DELTA	-1.380***	-0.353**	-4.905**	-0.201***
	(-2.954)	(-2.406)	(-2.354)	(-2.876)
SIZE	-1.651***	0.924***	-5.867***	0.657***
	(-8.281)	(14.084)	(-8.376)	(17.405)
FIRM_AGE	-0.707	-0.342***	-0.315	-0.045
	(-1.577)	(-3.333)	(-0.266)	(-0.500)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660
R-Squared	0.703	0.905	0.785	0.932

Notes: This table presents the effects of unexpected exchange rate volatility at the firm level on firms' investments. The sample is at the firm-year level. The dependent variables listed in the table headers are investment activity measures in year t+1, including capital expenditure to total assets ratio (CAPEX/AT), natural logarithm of capital expenditure (CAPEX_USD_LN), cash holding to total assets ratio (CASH/AT), and natural logarithm of cash holding (CAHS_USD_LN). The independent variable of interest is firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL). The firm-level measure is calculated based on country-level measure then weighted by firm sales in a country divided by total foreign sales for the firm. In all regressions, we control for the mean change of the FX rate based on USD-based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Panel B: Robustness Tests Controlling for the Economic Policy Uncertainty Index

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL	-1.593***	-0.235**	2.357***	0.123**
	(-4.302)	(-2.544)	(2.911)	(2.476)
FX_USD_LN	0.882	0.332	4.305*	0.182
	(0.851)	(1.395)	(1.884)	(1.129)
EPU_INDEX	-0.008***	-0.001	-0.003	-0.001
	(-2.669)	(-0.874)	(-0.370)	(-1.624)
GDP_LN	-0.091	0.370	21.717**	1.474**
	(-0.025)	(0.432)	(2.320)	(2.392)
GDP_CAP_LN	-0.196	-0.568	-19.270*	-1.333*
	(-0.049)	(-0.618)	(-1.840)	(-1.906)
GDP_GROWTH	0.083*	0.028**	0.027	-0.008
	(1.789)	(2.294)	(0.262)	(-1.101)
IMP_EXP_RATIO	-0.009	0.001	-0.005	-0.001
	(-1.524)	(0.406)	(-0.314)	(-0.225)
CAPITAL_RATIO	-0.001	-0.001	0.004	0.001
	(-0.331)	(-0.350)	(0.940)	(1.056)
STOCK_RATIO	0.003	0.001	0.003	0.001
	(1.248)	(0.781)	(0.597)	(0.795)
TOBINQ	0.434***	0.130**	1.343***	0.056***
	(3.425)	(2.385)	(3.240)	(3.840)
EBIDTA	3.218*	0.867*	7.720	0.766***
	(1.662)	(1.783)	(1.540)	(2.979)
EBIDTA_VOL	1.447	0.579	5.919	0.368*
	(1.246)	(1.606)	(1.256)	(1.788)
LOSS	0.164	0.089	-0.594	-0.018
	(0.677)	(1.352)	(-1.013)	(-0.427)
LEVERAGE	-0.675	-0.146	-2.747	-0.286**
	(-0.883)	(-0.996)	(-1.486)	(-2.359)
PTBI	4.743***	1.031***	6.193*	0.420***
	(5.368)	(3.951)	(1.901)	(2.681)
PTBI_VOL	0.280	0.055	1.419	0.006
	(0.413)	(0.252)	(0.528)	(0.059)
SGA_DELTA	-1.305**	-0.309*	-5.495**	-0.232***
	(-2.546)	(-1.680)	(-1.981)	(-2.642)
SIZE	-1.602***	0.878***	-6.399***	0.658***
	(-6.361)	(10.554)	(-5.885)	(14.607)
FIRM_AGE	-0.734	-0.429***	-1.215	-0.198
	(-1.110)	(-2.667)	(-0.708)	(-1.599)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	8,857	8,857	8,857	8,857
R-Squared	0.746	0.910	0.798	0.936

Notes: This table presents effects of unexpected exchange rate volatility at the firm level on firms' investments. The sample is at the firm-year level. The dependent variables are the same as those in Panel A. The independent variable of interest is firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL). The firm-level measure is calculated based on country-level measure then weighted by sales in a country divided by total foreign sales for the firm. In all regressions, we control for the mean change of the FX rate based on USD-based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. In addition, we control for the Economic Policy Uncertainty Index (EPU_INDEX) constructed following Baker, Bloom, and Davis (2016). We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Panel C: Falsification Test

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN		
	t-3	*t-2*	*t-1*	*t-3*	*t-2*	*t-1*	*t-3*	*t-2*	*t-1*	*t-3*	*t-2*	*t-1*
UNEXP_GARCH_VOL	0.802	3.864	-0.529	0.036	0.015	-0.060	-1.509	4.500	0.898	-0.034	0.054	0.023
	(1.099)	(0.908)	(-1.335)	(0.486)	(0.209)	(-1.201)	(-0.509)	(1.059)	(0.911)	(-0.592)	(0.868)	(0.600)
FX_USD_LN	-3.067	-1.908	4.202***	-0.461*	-0.641***	0.204	-14.808	13.375	7.932***	-0.236	-0.449***	-0.109
	(-1.280)	(-0.678)	(3.171)	(-1.939)	(-2.765)	(1.027)	(-0.949)	(0.915)	(2.693)	(-1.303)	(-2.720)	(-0.670)
GDP_LN	5.198	4.374	5.605	-2.115***	-0.834	0.005	8.101	44.314**	36.018***	0.044	0.589	0.860*
	(0.482)	(0.353)	(1.237)	(-2.725)	(-1.064)	(0.007)	(0.397)	(2.208)	(4.004)	(0.070)	(1.042)	(1.742)
GDP_CAP_LN	-2.463	3.004	-4.794	2.213***	0.937	0.225	-17.627	-35.021**	-35.473***	-0.093	-0.601	-0.731
	(-0.243)	(0.213)	(-0.879)	(2.586)	(1.121)	(0.298)	(-1.208)	(-2.001)	(-3.542)	(-0.131)	(-0.938)	(-1.307)
GDP_GROWTH	-0.004	-0.166	0.041	-0.035***	-0.027***	-0.006	-0.178	0.308	0.131	-0.001	-0.012*	0.001
	(-0.039)	(-1.084)	(0.827)	(-3.052)	(-2.708)	(-0.805)	(-0.522)	(0.921)	(1.107)	(-0.068)	(-1.686)	(0.152)
IMP_EXP_RATIO	-0.016	0.002	0.008	-0.001	-0.001	0.002	-0.083	0.064	0.016	-0.001	-0.001	-0.001
	(-0.836)	(0.087)	(1.079)	(-0.788)	(-0.945)	(1.566)	(-0.808)	(0.696)	(0.870)	(-0.209)	(-1.208)	(-0.915)
CAPITAL_RATIO	0.012**	0.004	0.004	-0.001	0.001	-0.001	0.036	-0.019	0.007	-0.001	-0.001	0.001
	(2.416)	(0.677)	(1.437)	(-0.692)	(0.087)	(-0.522)	(1.130)	(-0.542)	(1.067)	(-1.376)	(-0.376)	(0.346)
STOCK_RATIO	-0.008	0.003	-0.002	-0.001	-0.001	-0.001	-0.011	0.042	-0.001	0.001	0.001	0.001
	(-1.098)	(0.484)	(-0.772)	(-0.351)	(-0.003)	(-0.087)	(-0.580)	(1.047)	(-0.112)	(0.833)	(0.763)	(0.058)
TOBINQ	0.099	1.980	0.500***	-0.027	0.028	0.030*	-0.553	2.738	2.449***	-0.033	0.011	0.055***
	(0.266)	(1.289)	(3.357)	(-0.971)	(1.100)	(1.881)	(-0.171)	(0.991)	(3.553)	(-1.552)	(0.549)	(3.110)
EBIDTA	-6.159*	-5.181	-7.711***	2.178***	2.113***	0.618	-22.209	-8.332	3.811	1.359***	1.393***	0.379
	(-1.720)	(-1.187)	(-3.302)	(4.319)	(4.593)	(1.573)	(-0.797)	(-0.353)	(0.263)	(3.459)	(4.207)	(1.424)
EBIDTA_VOL	-7.784**	-11.743**	-7.851***	1.395***	0.746**	-0.235	-13.470	-47.471*	-16.771*	1.450***	0.989***	0.079
	(-2.572)	(-2.034)	(-3.301)	(3.772)	(1.994)	(-0.688)	(-0.563)	(-1.750)	(-1.920)	(4.102)	(3.385)	(0.350)
LOSS	0.494	-0.092	0.331	-0.025	-0.042	0.006	-1.921*	1.546	-0.212	0.056	-0.001	-0.008
	(0.528)	(-0.118)	(0.912)	(-0.418)	(-0.771)	(0.138)	(-1.808)	(0.785)	(-0.250)	(1.000)	(-0.017)	(-0.164)
LEVERAGE	4.441	8.906	6.366***	-1.012***	-0.972***	-0.532***	-25.074	20.406	-3.373	-0.846***	-0.726***	-0.902***
	(0.832)	(1.450)	(3.302)	(-4.628)	(-5.449)	(-3.766)	(-0.870)	(0.770)	(-1.432)	(-4.877)	(-4.422)	(-7.562)
PTBI	-1.000	7.248	3.849	-2.435***	-1.909***	-1.186***	8.948	-4.884	15.003	-1.380***	-1.383***	-0.131
	(-0.443)	(0.719)	(1.115)	(-7.325)	(-5.310)	(-4.659)	(0.568)	(-0.306)	(1.214)	(-5.080)	(-4.145)	(-0.721)
PTBI_VOL	12.399**	15.603	8.067**	-1.232***	-0.714**	-0.004	69.937	110.140*	23.313**	-0.891**	-0.271	0.296***
	(2.122)	(1.555)	(2.025)	(-2.748)	(-2.012)	(-0.028)	(1.574)	(1.748)	(2.363)	(-1.995)	(-1.074)	(2.580)
SGA_DELTA	0.596	-3.221	-3.239	0.947***	0.872***	-0.021	-25.849	28.707	-9.100	0.678***	0.276	-0.350***
	(0.394)	(-0.426)	(-0.905)	(3.469)	(2.842)	(-0.159)	(-0.862)	(1.036)	(-0.699)	(3.582)	(0.818)	(-3.376)
SIZE	1.855***	0.638	0.707*	0.759***	0.893***	0.968***	0.329	5.849**	2.090*	0.673***	0.779***	0.818***
	(2.933)	(0.683)	(1.720)	(12.092)	(14.540)	(19.393)	(0.164)	(2.366)	(1.672)	(11.272)	(13.250)	(16.569)
FIRM_AGE	-12.006***	-13.914***	-6.866***	0.434**	0.160	-0.208*	-5.138	-25.192***	-13.038***	0.774***	0.417***	0.021
	(-2.753)	(-2.949)	(-5.363)	(2.378)	(1.117)	(-1.698)	(-0.628)	(-3.761)	(-4.953)	(4.398)	(2.896)	(0.175)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	13,537	14,364	14,980	14,339	14,998	14,979	13,652	14,461	15,033	14,510	15,137	15,033
R-Squared	0.578	0.526	0.648	0.847	0.853	0.883	0.627	0.558	0.919	0.849	0.860	0.887

Notes: This table presents effects of unexpected exchange rate volatility at the firm level on firms' investments using falsification test. The sample is at the firm-year level. The dependent variables listed in the table headers are investment activity measures in year t-1, t-2, and t-3 respectively, including capital expenditure to total assets ratio (CAPEX_RATIO), natural logarithm of capital expenditure (CAPEX_LN), cash holding to total assets ratio (CASH_RATIO), and natural logarithm of cash holding. The independent variable of interest is firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL). The firm-level measure is calculated based on country-level measure then weighted by sales in a country divided by total foreign sales for the firm. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in in Appendix Table A1. In addition, we control for the Economic Policy Uncertainty Index (EPU_INDEX) constructed following Baker, Bloom, and Davis (2016). We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 3: Country-Level Heterogeneous Effects: Economic Openness

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL * IMP_EXP_RATIO	-0.005***	-0.001***	0.015***	0.001***
	(-2.787)	(-2.608)	(3.126)	(3.981)
UNEXP_GARCH_VOL	-0.119	0.090	-0.705	-0.020
	(-0.379)	(1.377)	(-1.003)	(-0.426)
IMP_EXP_RATIO	-0.004	0.001	-0.010	-0.001
	(-0.855)	(0.316)	(-0.924)	(-1.114)
FX_USD_LN	1.265*	0.324**	0.739	0.006
	(1.924)	(1.962)	(0.467)	(0.056)
GDP_LN	1.579	0.503	19.201***	1.541***
	(0.579)	(0.816)	(3.044)	(3.418)
GDP_CAP_LN	-1.307	-0.666	-17.878**	-1.507***
	(-0.425)	(-0.980)	(-2.535)	(-2.983)
GDP_GROWTH	0.127***	0.029***	-0.004	-0.001
	(4.392)	(3.969)	(-0.067)	(-0.303)
CAPITAL_RATIO	-0.002	-0.001	0.008**	0.001*
	(-0.932)	(-0.103)	(2.022)	(1.867)
STOCK_RATIO	0.005***	0.001	-0.001	0.001
	(2.794)	(0.926)	(-0.261)	(0.216)
TOBINQ	0.500***	0.126***	1.556***	0.068***
	(4.499)	(2.960)	(4.296)	(5.196)
EBIDTA	3.618**	0.789**	4.388	0.534***
	(2.350)	(2.071)	(1.083)	(2.638)
EBIDTA_VOL	1.354	0.433	6.293	0.337**
	(1.408)	(1.543)	(1.644)	(2.094)
LOSS	0.142	0.048	0.040	0.022
	(0.829)	(1.163)	(0.094)	(0.716)
LEVERAGE	-0.209	-0.004	-3.726***	-0.228***
	(-0.360)	(-0.040)	(-2.933)	(-2.620)
PTBI	5.431***	1.214***	8.574***	0.599***
	(7.330)	(5.427)	(3.329)	(4.629)
PTBI_VOL	-0.005	0.014	1.877	0.120
	(-0.008)	(0.087)	(0.894)	(1.317)
SGA_DELTA	-1.370***	-0.351**	-4.933**	-0.203***
	(-2.940)	(-2.395)	(-2.370)	(-2.897)
SIZE	-1.655***	0.923***	-5.856***	0.658***
	(-8.316)	(14.059)	(-8.369)	(17.426)
FIRM_AGE	-0.696	-0.339***	-0.345	-0.046
	(-1.555)	(-3.316)	(-0.292)	(-0.521)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660
R-Squared	0.704	0.905	0.785	0.932

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms in countries with different degrees of economic openness. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the import-export to GDP ratio that measures the openness of an economy (IMP_EXP_RATIO), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 4: Firm-Level Heterogeneous Effects: The Usage of Currency Derivatives

Panel A: Firm FE and Year FE

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL * FX_DERI	12.581**	2.708**	-56.198**	-2.542**
	(2.102)	(2.317)	(-2.016)	(-2.235)
UNEXP_GARCH_VOL	-0.864*	-0.003	2.412	0.149
	(-1.840)	(-0.030)	(1.335)	(1.370)
FX_DERI	-2.089***	-0.276	-3.461	-0.142
	(-3.293)	(-1.563)	(-1.156)	(-1.514)
FX_USD_LN	3.954**	0.746**	7.947	0.048
	(2.285)	(2.478)	(1.309)	(0.161)
GDP_LN	9.118	1.610	-8.737	-0.442
	(1.338)	(0.800)	(-0.369)	(-0.310)
GDP_CAP_LN	-12.024	-2.088	5.585	0.321
	(-1.623)	(-0.967)	(0.208)	(0.209)
GDP_GROWTH	0.169**	0.018	-0.443*	-0.028*
	(2.564)	(1.234)	(-1.844)	(-1.901)
IMP_EXP_RATIO	0.010	0.004	-0.011	-0.001
	(0.605)	(1.201)	(-0.211)	(-0.312)
CAPITAL_RATIO	0.001	0.001	-0.005	-0.001
	(0.308)	(0.926)	(-0.449)	(-0.553)
STOCK_RATIO	0.001	-0.001	-0.014	-0.001
	(0.011)	(-0.184)	(-1.033)	(-0.375)
TOBINQ	0.891***	0.308***	0.586	0.025
	(3.310)	(2.581)	(0.572)	(0.614)
EBIDTA	2.875	-1.642	3.382	-0.421
	(0.739)	(-1.296)	(0.147)	(-0.537)
EBIDTA_VOL	4.084	0.470	20.594	1.153*
	(1.141)	(0.733)	(0.850)	(1.837)
LOSS	-0.588	0.056	-1.725	-0.101
	(-1.057)	(0.574)	(-1.052)	(-0.976)
LEVERAGE	0.241	-0.016	-6.368	-0.437
	(0.183)	(-0.081)	(-1.008)	(-1.629)
PTBI	0.028	0.658	15.426	0.526
	(0.012)	(1.205)	(1.052)	(1.568)
PTBI_VOL	-2.017	-0.638	-8.565	-0.802
	(-0.755)	(-1.116)	(-0.460)	(-1.107)
SGA_DELTA	0.675	-0.179	-22.188	-0.596**
	(0.559)	(-0.435)	(-1.088)	(-1.964)
SIZE	-1.785***	0.784***	-8.690	0.679***
	(-3.234)	(8.687)	(-1.588)	(5.062)
FIRM_AGE	0.372	-0.172	0.008	0.242
	(0.289)	(-0.766)	(0.002)	(0.742)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	1,187	1,187	1,187	1,187
R-Squared	0.747	0.963	0.755	0.923

Notes: This table presents the heterogeneous effects of unexpected currency volatility on investments of firms with or without the usage of currency derivatives. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the currency derivatives usage dummy, which takes the value of one if derivatives are used and zero otherwise (FX_DERI), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Panel B: Firm FE and Country*Year FE

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL * FX_DERI	27.345***	5.843***	-147.059*	-6.645*
	(3.150)	(2.635)	(-1.682)	(-1.832)
UNEXP_GARCH_VOL	-1.398	-0.249	0.093	0.010
	(-1.440)	(-1.180)	(0.017)	(0.055)
FX_DERI	-2.717**	-0.409*	0.032	-0.002
	(-2.393)	(-1.727)	(0.007)	(-0.013)
TOBINQ	0.745**	0.320*	0.253	0.003
	(2.127)	(1.809)	(0.140)	(0.050)
EBIDTA	4.571	-1.244	4.098	-0.841
	(0.710)	(-0.697)	(0.113)	(-0.695)
EBIDTA_VOL	4.526	0.448	24.586	0.828
	(0.973)	(0.468)	(0.643)	(0.926)
LOSS	-1.205	-0.045	-2.026	-0.225
	(-1.210)	(-0.243)	(-0.775)	(-1.486)
LEVERAGE	1.585	0.183	-9.539	-0.647*
	(0.852)	(0.624)	(-1.156)	(-1.690)
PTBI	-0.639	0.434	13.177	0.512
	(-0.183)	(0.531)	(0.693)	(1.220)
PTBI_VOL	-2.701	-0.665	-8.166	-1.267
	(-0.591)	(-0.635)	(-0.286)	(-1.386)
SGA_DELTA	0.747	0.022	-25.633	-0.645*
	(0.542)	(0.043)	(-1.030)	(-1.755)
SIZE	-1.406	0.907***	-10.323	0.730***
	(-1.590)	(5.161)	(-1.078)	(3.866)
FIRM_AGE	1.091	-0.175	-2.144	0.258
	(0.557)	(-0.458)	(-0.334)	(0.567)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Country*Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	1,187	1,187	1,187	1,187
R-Squared	0.840	0.976	0.835	0.959

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms with or without the usage of currency derivatives. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the currency derivatives usage dummy, which takes the value of one if derivatives are used and zero otherwise (FX_DERI), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and country and year joint fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 5: Investment Irreversibility

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL * PPENT / AT	-4.749***	-0.662***	2.982*	0.479***
	(-4.356)	(-3.589)	(1.881)	(4.051)
UNEXP_GARCH_VOL	0.944***	0.165**	0.086	-0.053
	(2.633)	(2.263)	(0.104)	(-1.015)
PPENT / AT	2.434***	0.600***	-5.494***	-0.427***
	(3.573)	(5.273)	(-4.189)	(-4.589)
FX_USD_LN	1.338**	0.369***	1.084	0.030
	(2.012)	(2.616)	(0.702)	(0.275)
GDP_LN	2.162	0.442	17.948***	1.426***
	(0.791)	(0.784)	(2.854)	(3.164)
GDP_CAP_LN	-2.109	-0.593	-16.332**	-1.389***
	(-0.681)	(-0.963)	(-2.339)	(-2.751)
GDP_GROWTH	0.130***	0.031***	-0.015	-0.001
	(4.435)	(4.527)	(-0.235)	(-0.127)
IMP_EXP_RATIO	-0.004	0.001	-0.006	-0.001
	(-1.017)	(0.214)	(-0.558)	(-1.006)
CAPITAL_RATIO	-0.001	-0.001	0.008*	0.001*
	(-0.685)	(-0.006)	(1.845)	(1.762)
STOCK_RATIO	0.005**	0.001	-0.001	0.001
	(2.487)	(0.996)	(-0.240)	(0.271)
TOBINQ	0.507***	0.106***	1.483***	0.065***
	(4.554)	(3.996)	(4.112)	(5.011)
EBIDTA	2.983*	0.559	3.653	0.495**
	(1.880)	(1.582)	(0.876)	(2.562)
EBIDTA_VOL	0.805	0.287	6.489*	0.321**
	(0.816)	(1.084)	(1.662)	(2.124)
LOSS	0.188	0.054	0.098	0.021
	(1.079)	(1.393)	(0.230)	(0.683)
LEVERAGE	-0.874	-0.163	-1.954	-0.090
	(-1.423)	(-1.512)	(-1.474)	(-0.980)
PTBI	5.218***	0.988***	10.953***	0.702***
	(6.883)	(5.137)	(4.406)	(5.649)
PTBI_VOL	0.167	0.089	0.847	0.096
	(0.285)	(0.537)	(0.394)	(1.048)
SGA_DELTA	-1.456***	-0.344**	-5.219**	-0.235***
	(-3.001)	(-2.319)	(-2.284)	(-3.335)
SIZE	-1.702***	0.805***	-5.740***	0.655***
	(-8.445)	(19.106)	(-7.955)	(17.371)
FIRM_AGE	-0.612	-0.256***	-0.591	-0.064
	(-1.394)	(-2.662)	(-0.502)	(-0.713)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,378	15,378	15,378	15,378
R-Squared	0.705	0.926	0.797	0.936

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms with different degrees of investment irreversibility. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the net PPE to total assets ratio that measures investment irreversibility (PPENET_RATIO_INTER), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 6: Financial Constraints

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL * KZ_INDEX	-0.171***	-0.048***	0.538***	0.025***
	(-3.985)	(-2.930)	(3.342)	(3.925)
UNEXP_GARCH_VOL	-0.872***	-0.131**	0.884**	0.104***
	(-4.087)	(-2.510)	(2.078)	(3.144)
KZ_INDEX	0.040**	0.013*	-0.490***	-0.029***
	(2.109)	(1.737)	(-5.925)	(-7.199)
FX_USD_LN	1.469**	0.383**	0.510	-0.070
	(2.210)	(2.335)	(0.341)	(-0.638)
GDP_LN	0.878	0.145	17.033***	1.417***
	(0.313)	(0.247)	(2.860)	(3.146)
GDP_CAP_LN	-0.549	-0.350	-15.858**	-1.407***
	(-0.173)	(-0.533)	(-2.391)	(-2.783)
GDP_GROWTH	0.136***	0.031***	-0.051	-0.003
	(4.733)	(4.220)	(-0.799)	(-0.661)
IMP_EXP_RATIO	-0.005	-0.001	-0.007	-0.001
	(-1.150)	(-0.741)	(-0.640)	(-1.092)
CAPITAL_RATIO	-0.002	0.001	0.005	0.001
	(-1.019)	(0.266)	(1.200)	(1.248)
STOCK_RATIO	0.005***	0.001	-0.001	0.001
	(2.652)	(1.311)	(-0.316)	(0.133)
TOBINQ	0.558***	0.130**	1.535***	0.073***
	(4.281)	(2.456)	(4.383)	(5.004)
EBIDTA	5.848***	1.086***	3.339	0.475**
	(3.964)	(3.161)	(0.709)	(2.059)
EBIDTA_VOL	2.628**	0.705**	4.036	0.250
	(2.227)	(2.400)	(1.065)	(1.438)
LOSS	0.192	0.029	0.128	0.032
	(1.074)	(0.735)	(0.313)	(1.009)
LEVERAGE	-0.645	-0.064	-3.094**	-0.209**
	(-1.076)	(-0.607)	(-2.276)	(-2.360)
PTBI	6.531***	1.391***	5.411*	0.436***
	(6.951)	(4.956)	(1.692)	(2.919)
PTBI_VOL	-0.881	-0.157	2.094	0.184**
	(-1.557)	(-0.946)	(1.017)	(1.966)
SGA_DELTA	-1.491**	-0.252*	-3.624	-0.211**
	(-2.481)	(-1.921)	(-1.409)	(-2.482)
SIZE	-1.781***	0.919***	-5.774***	0.640***
	(-8.335)	(13.865)	(-7.505)	(16.092)
FIRM_AGE	-0.606	-0.280***	0.115	-0.006
	(-1.365)	(-2.933)	(0.101)	(-0.066)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	14,724	14,724	14,724	14,724
R-Squared	0.716	0.910	0.792	0.936

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms with different degrees of financial constraints. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the KZ index that measures financial constraints (KZ_INDEX), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 7: Exchange Rate Regime Changes

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL	-16.709***	-3.106***	22.365***	1.540***
	(-2.866)	(-3.120)	(2.724)	(2.838)
Control	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660
Instrument		FX_REGIME_CHANGE		
F-Statistic	10.970	14.653	10.270	24.260

FX_REGIME_CHANGE	0.252***
	(4.458)
Control	Yes
Constant	Yes
Firm FE	Yes
Year FE	Yes
Cluster	Firm
Observations	15,660
R-Squared	0.409

Notes: This table presents the 2SLS regression results of firm-level unexpected exchange rate volatility on firms' investments. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variable in the second stage (Panel A) is firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL). The independent variable in the corresponding first stage (Panel B) is the firm-level FX regime change shock variable (FX_REGIME_CHANGE). The variable is calculated based on a country-level dummy variable that equals one if the country experiences the foreign exchange regime change in the year. Then similar to firm-level unexpected FX volatility, the firm-level measure is calculated based on country-level measure weighted by firm sales in a country divided by total foreign sales for the firm. In all regressions, we control for country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO as well as firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 8: Sovereign Debt Downgrade Shocks

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
SOV_DEBT_DOWNGRADE	-3.766**	-0.632*	5.241**	0.388***
	(-2.431)	(-1.751)	(2.385)	(2.672)
FX_USD_LN	1.387**	0.349**	0.447	-0.013
	(2.108)	(2.119)	(0.283)	(-0.118)
GDP_LN	1.399	0.444	19.891***	1.581***
	(0.510)	(0.719)	(3.139)	(3.504)
GDP_CAP_LN	-1.207	-0.627	-18.357***	-1.534***
	(-0.390)	(-0.921)	(-2.592)	(-3.029)
GDP_GROWTH	0.137***	0.031***	-0.028	-0.003
	(4.729)	(4.299)	(-0.432)	(-0.615)
IMP_EXP_RATIO	-0.006	-0.001	-0.005	-0.001
	(-1.278)	(-0.092)	(-0.490)	(-0.772)
CAPITAL_RATIO	-0.001	0.001	0.007*	0.001
	(-0.693)	(0.124)	(1.771)	(1.630)
STOCK_RATIO	0.005***	0.001	-0.001	0.001
	(2.588)	(0.728)	(-0.050)	(0.420)
TOBINQ	0.501***	0.126***	1.556***	0.068***
	(4.519)	(2.965)	(4.296)	(5.202)
EBIDTA	3.552**	0.780**	4.462	0.541***
	(2.306)	(2.047)	(1.103)	(2.679)
EBIDTA_VOL	1.355	0.435	6.269	0.336**
	(1.410)	(1.547)	(1.638)	(2.094)
LOSS	0.135	0.047	0.054	0.023
	(0.785)	(1.127)	(0.126)	(0.744)
LEVERAGE	-0.178	0.005	-3.825***	-0.234***
	(-0.305)	(0.047)	(-3.009)	(-2.689)
PTBI	5.447***	1.215***	8.559***	0.597***
	(7.344)	(5.418)	(3.324)	(4.632)
PTBI_VOL	0.017	0.015	1.873	0.119
	(0.030)	(0.090)	(0.892)	(1.295)
SGA_DELTA	-1.405***	-0.358**	-4.870**	-0.198***
	(-3.014)	(-2.438)	(-2.342)	(-2.855)
SIZE	-1.648***	0.925***	-5.872***	0.657***
	(-8.266)	(14.095)	(-8.373)	(17.391)
FIRM_AGE	-0.742*	-0.347***	-0.265	-0.041
	(-1.656)	(-3.375)	(-0.224)	(-0.459)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660
R-Squared	0.704	0.905	0.785	0.932

Notes: This table presents the effects of firm-level unexpected exchange rate volatility on firms' investments. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variable of interest is firm-level sovereign debt shock (SOV_DEBT_DOWNGRADE). The variable is calculated based on a country-level dummy variable that equals one if the country's sovereign debt is downgraded in the year. Then similar to firm-level unexpected FX volatility, the firm-level measure is calculated based on country-level measure weighted by firm sales in a country divided by total foreign sales for the firm. In all regressions, we control for country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO as well as firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table 9: Future Trends

		UNEXP_GARCH_VOL	t-stat	Controls + Constant + Firm FE + Year FE	Cluster	Obs	R-Squared
				Panel A: CAPEX / AT (Full sample)			
(1)	*t+1*	-0.826***	(-3.958)	Yes	Firm	15,660	0.703
(2)	*t+2*	0.436*	(1.822)	Yes	Firm	15,417	0.661
(3)	*t+3*	0.127	(0.504)	Yes	Firm	14,285	0.650
(4)	*t+4*	-0.095	(-0.407)	Yes	Firm	13,164	0.644
(5)	*t+5*	0.209	(0.790)	Yes	Firm	11,909	0.625
(6)	*t+6*	-0.272	(-0.841)	Yes	Firm	10,650	0.646
(7)	*t+7*	0.002	(0.005)	Yes	Firm	9,360	0.676
(8)	*t+8*	-0.245	(-0.865)	Yes	Firm	8,155	0.665
				Panel B: CAPEX / AT (High Capital Intensity)			
(1)	*t+1*	-2.063***	(-3.355)	Yes	Firm	4,529	0.761
(2)	*t+2*	1.104*	(1.739)	Yes	Firm	4,530	0.692
(3)	*t+3*	0.764	(1.162)	Yes	Firm	4,217	0.691
(4)	*t+4*	0.344	(0.613)	Yes	Firm	3,933	0.683
(5)	*t+5*	0.194	(0.258)	Yes	Firm	3,610	0.656
(6)	*t+6*	-0.251	(-0.345)	Yes	Firm	3,274	0.692
(7)	*t+7*	-0.381	(-0.680)	Yes	Firm	2,923	0.693
(8)	*t+8*	-0.422	(-0.646)	Yes	Firm	2,562	0.676
				Panel C: CAPEX / AT (Low Capital Intensity)			
(1)	*t+1*	-0.246	(-0.827)	Yes	Firm	4,454	0.724
(2)	*t+2*	-0.183	(-0.731)	Yes	Firm	4,376	0.782
(3)	*t+3*	-0.206	(-0.659)	Yes	Firm	4,037	0.732
(4)	*t+4*	0.277	(1.062)	Yes	Firm	3,686	0.734
(5)	*t+5*	0.212	(0.358)	Yes	Firm	3,275	0.650
(6)	*t+6*	-0.454	(-0.788)	Yes	Firm	2,892	0.718
(7)	*t+7*	-0.187	(-0.225)	Yes	Firm	2,520	0.739
(8)	*t+8*	-0.558	(-0.887)	Yes	Firm	2,182	0.710

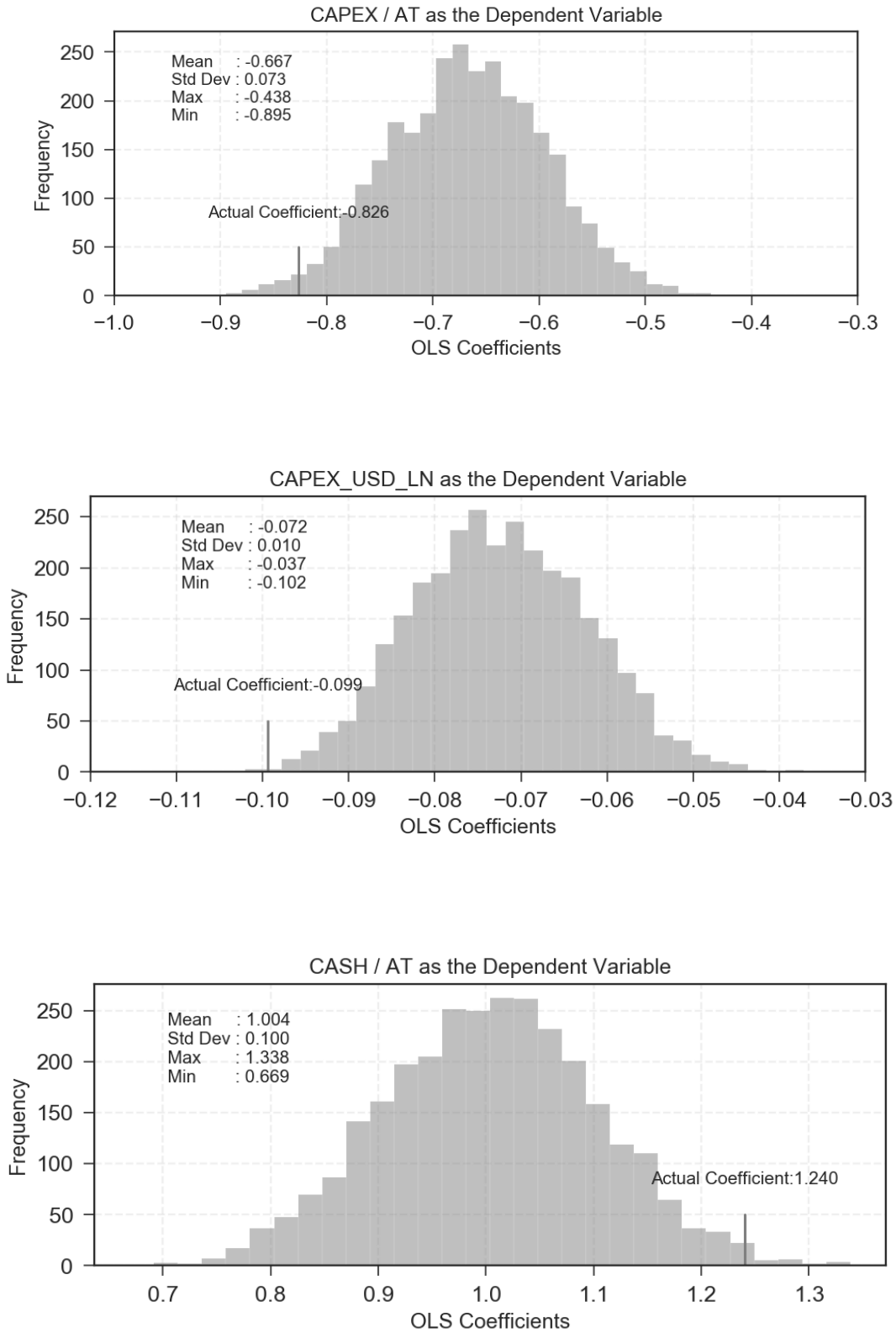
Notes: This table presents the long-term effects of firm-level unexpected exchange rate volatility on firms' investments. The sample is at the firm-year level. Panel A reports results for all firms. Panel B and Panel C report results for subsamples of high capital intensity (top 20%) and low capital intensity (bottom 20%) firms. The dependent variable is capital expenditure to total assets ratio (CAPEX_RATIO) in year t+1 to t+8. The independent variable of interest is firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL). The firm-level measure is calculated based on country-level measure then weighted by sales in a country divided by total foreign sales for the firm. We control for firm and country level control variables as in Table 2. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

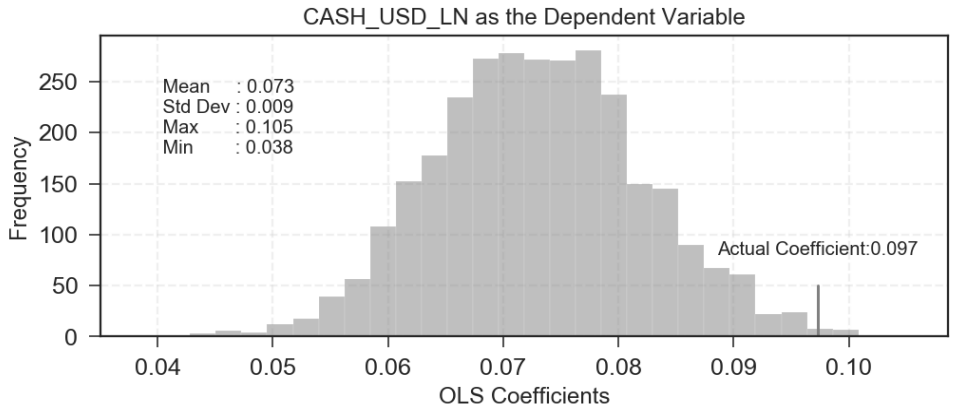
Table 10: Rise and Fall of FX Volatility

	(1) CAPEX / AT	(2) CAPEX_USD_LN	(3) CASH / AT	(4) CASH_USD_LN
UNEXP_GARCH_VOL (POSITIVE)	-0.938***	-0.0814*	1.546***	0.138***
	(-4.176)	(-1.652)	(2.828)	(3.720)
UNEXP_GARCH_VOL (NEGATIVE)	-0.518	-0.189	0.183	-0.0872
	(-0.846)	(-1.158)	(0.133)	(-0.927)
FX_USD_LN	1.369**	0.348**	0.736	-0.0126
	(2.309)	(2.318)	(0.516)	(-0.129)
GDP_LN	0.492	0.0277	19.49***	1.436***
	(0.200)	(0.0520)	(3.502)	(3.698)
GDP_CAP_LN	-0.219	-0.166	-18.08***	-1.372***
	(-0.0782)	(-0.282)	(-2.904)	(-3.104)
GDP_GROWTH	0.132***	0.0310***	-0.0341	-0.00295
	(5.308)	(5.052)	(-0.591)	(-0.687)
IMP_EXP_RATIO	-0.00644	-0.000187	-0.00824	-0.000744
	(-1.623)	(-0.189)	(-0.853)	(-1.024)
CAPITAL_RATIO	-0.000753	0.000463	0.00592	0.000265
	(-0.538)	(1.224)	(1.569)	(1.099)
STOCK_RATIO	0.00398***	6.03e-05	0.00169	0.000309
	(2.861)	(0.161)	(0.441)	(1.258)
TOBINQ	0.508***	0.139***	1.488***	0.0607***
	(5.022)	(3.398)	(4.479)	(5.293)
EBIDTA	4.165***	0.729**	3.546	0.523***
	(3.300)	(2.049)	(0.927)	(2.814)
EBIDTA_VOL	1.446	0.354	6.959**	0.354**
	(1.560)	(1.415)	(1.966)	(2.480)
LOSS	0.161	0.0527	0.155	0.0243
	(1.038)	(1.398)	(0.402)	(0.897)
LEVERAGE	-0.310	-0.0295	-3.642***	-0.263***
	(-0.602)	(-0.300)	(-3.249)	(-3.362)
PTBI	5.520***	1.229***	8.465***	0.596***
	(6.938)	(5.663)	(3.450)	(5.213)
PTBI_VOL	-0.356	-0.110	2.034	0.111
	(-0.661)	(-0.842)	(1.150)	(1.426)
SGA_DELTA	-1.311***	-0.344**	-4.842**	-0.193***
	(-3.075)	(-2.543)	(-2.518)	(-3.177)
SIZE	-1.712***	0.928***	-5.704***	0.657***
	(-9.463)	(15.42)	(-9.113)	(19.37)
FIRM_AGE	-0.761*	-0.340***	-0.660	-0.0318
	(-1.938)	(-3.762)	(-0.634)	(-0.402)
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	14,523	14,523	14,523	14,523
R-Squared	0.701	0.904	0.789	0.934

Notes: This table presents the effects of firm-level unexpected exchange rate volatility on firms' investments. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variable of interest is positive and negative unexpected exchange rate volatility, representing the unexpected rise or fall of volatility. Observations with unexpected GARCH volatility between -0.1% and 0.1% are excluded because they are too close to zero. In all regressions, we control for country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO as well as firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Figure 1: Placebo Tests





Notes: This figure presents placebo tests. For each country-year combination, we randomly assign a pseudo value generated by randomly picking unexpected exchange rate volatility (UNEXP_GARCH_VOL) from other firms in the same year. We re-estimate all regressions in Table 2 Panel A and save the coefficient estimates on the variable. We repeat this procedure 3,000 times and plot the histograms of these estimates.

APPENDIX: Variable Definition and Sample Distribution

Appendix: Table A1 Variable Definition

Variable Name	Definition	Source
Dependent Variables		
CAPEX / AT	Capital Expenditures (ITEM4601) * 100% / lagged Total Assets (ITEM2999).	*Worldscope*
CAPEX_USD_LN	Capital Expenditures (ITEM4601) in US$.	*Worldscope*
CASH / AT	Cash and Short-Term Investment (ITEM2001) * 100% / lagged Total Assets (ITEM2999).	*Worldscope*
CASH_USD_LN	Natural logarithm of Cash and Short-Term Investment (ITEM2001) in US$.	*Worldscope*
Independent Variables		
UNEXP_GARCH_VOL	Firm-level currency risk, calculated as : $\sum_{c=1}^{n} fx\_risk_c * exposure_c$ *fx_risk*: volatility shock based on annualized realized volatility and annualized conditional (predicted) volatility based on the GARCH model using the exchange rate of currency paris (country where firm headquarted / country$_c$) *exposure*: sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales.	*Worldscope, Datastream*
UNEXP_GARCH_VOL(POSITIVE)	Unexpected rise of exchange rate volatility (or negative volatility shock) is calculated as $\text{UNEXP\_GARCH\_VOL} * 1_{\text{UNEXP}_{\text{GARCH}_{\text{VOL}}}>0}$	*Worldscope, Datastream*
UNEXP_GARCH_VOL(NEGATIVE)	Unexpected fall of exchange rate volatility (or negative volatility shock) is calculated as $\text{UNEXP\_GARCH\_VOL} * 1_{\text{UNEXP\_GARCH\_VOL}<0}$	*Worldscope, Datastream*

UNEXP_VOL	Firm-level currency risk, calculated as: $\sum_{c=1}^{n} fx\_risk_c * exposure_c$ *fx_risk*: volatility shock based on annualized realized volatility change using the exchange rate of currency paris (country where firm headquarted / country$_c$) *exposure*: sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales.	*Worldscope, Datastream*
UNEXP_GARCH_VOL_FILL	Firm-level currency risk, calculated as: $\sum_{c=1}^{n} fx\_risk_c * exposure_c$ *fx_risk*: volatility shock based on annualized realized volatility and annualized conditional (predicted) volatility based on the GARCH model using the exchange rate of currency paris (country where firm headquarted / country$_c$) *exposure*: sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales. When the specific country of sales is not available, USD based exchange rate is used.	*Worldscope, Datastream*
UNEXP_VOL_FILL	Firm-level currency risk, calculated as : $\sum_{c=1}^{n} fx\_risk_c * exposure_c$ *fx_risk*: volatility shock based on annualized realized volatility change using the exchange rate of currency paris (country where firm headquarted / country$_c$) *exposure*: sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales. When the specific country of sales is not available, USD based exchange rate is used.	*Worldscope, Datastream*
FX_REGIME_CHANGE	$\sum_{c=1}^{n} fx\_regime\_change_c * exposure_c$	*Worldscope,* *Ilzetzki et al (2019)*

	fx_regime_change : dummy variable equals to one if country$_c$'s foreign exchange regime changes in the year *exposure* : sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales.	
SOV_DEBT_DOWNGRADE	$\sum_{c=1}^{n} sov\_debt\_downgrade_c * exposure_c$ *sov_debt_downgrade* : Dummy variable that equals one if the country$_c$'s sovereign debt downgrades in the year. *exposure* : sales in country$_c$ (ITEM19601 to ITEM19691) / total foreign sales.	*Worldscope, Michaelides et al (2018)*
FX_USD_LN	Annual change of the natural logarithm of US Dollar-based exchange rates.	*Worldscope*
FX_DERI	Dummy variable that equals one if the firm uses foreign exchange derivatives to hedge risk	*SEC 20-F*
EPU_INDEX	The annually-averaged Political Uncertainty Index from Baker, Bloom, and Davis (2016).	*Baker, Bloom, and Davis (2016)*
KZ_INDEX	Kaplan-Zingales Index = -1.001909 * ITEM1551$_{t-1}$ / ITEM2501$_{t-1}$ + 0.2826389 * (ITEM2999$_t$ + ITEM7210$_t$ - ITEM3501$_t$) / ITEM2999$_t$ + 3.139193 * (ITEM8221$_t$ / 100) -39.3678 * ITEM4052$_t$ / ITEM2501$_{t-1}$ - 1.314759 * ITEM2001$_t$ / ITEM2501$_{t-1}$	*Worldscope, Lamont, Polk, and Saá-Requejo (2001)*
PPENT/AT	Property, Plant and Equipment - Net (ITEM2501) / lagged Total Assets (ITEM2999).	*Worldscope*

Control Variables

Country-Level Controls		
FX_USD_LN	Annual change of the natural logarithm of US Dollar-based exchange rates.	*Datastream*
GDP_LN	Natural logarithm of GDP (current US$).	*World Bank*
GDP_CAP_LN	Natural logarithm of GDP per capita (current US$).	*World Bank*
GDP_GROWTH	GDP growth (annual %).	*World Bank*
IMP_EXP_RATIO	Imports and Exports of goods and services (% of GDP).	*World Bank*
CAPITAL_RATIO	Market capitalization of listed domestic companies (% of GDP).	*World Bank*
STOCK_RATIO	Stocks traded, total value (% of GDP).	*World Bank*

Firm-Level Controls		
TOBINQ	Tobin's Q, calculated as (Total Assets (ITEM2999) + Market Capitalization (ITEM7210) - Stockholders Equity (ITEM3501)) / Total Assets (ITEM2999).	*Worldscope*
EBIDTA	Mean value of (Earnings Before Interest (ITEM18198) / lagged Total Assets (ITEM2999)) over the last five fiscal years.	*Worldscope*
EBIDTA_VOL	Standard deviation of (Earnings Before Interest (ITEM18198) / lagged Total Assets (ITEM2999)) over the last five fiscal years.	*Worldscope*
LOSS	Dummy variable equals one if firm reports a loss (Income Before Extraordinary Items (ITEM1551) < 0) in any of the last three fiscal years.	*Worldscope*
LEVERAGE	Long-Term Debt (ITEM3251) / lagged Total Assets (ITEM2999).	*Worldscope*
PTBI	Pretax Income (ITEM1401) / lagged Total Assets (ITEM2999).	*Worldscope*
PTBI_VOL	Standard deviation of (Pretax Income (ITEM1401) / lagged Total Assets (ITEM2999)) over the last five years.	*Worldscope*
SGA_DELTA	The change in (Sales (ITEM1001) / Total Assets (ITEM2999)) over the prior fiscal year.	*Worldscope*
SIZE	Natural logarithm of Total Assets (ITEM7230) in US$.	*Worldscope*
FIRM_AGE	Natural logarithm of firm ages.	*Worldscope*

Appendix: Table A2 Sample Distribution

Country	Num Firm	Num Obs	Year Start	Year End	Country	Num Firm	Num Obs	Year Start	Year End
AUS	378	1,530	1989	2017	**ITA**	54	221	2001	2014
AUT	59	277	1995	2017	**JPN**	116	344	1998	2017
BEL	37	131	1995	2014	**KOR**	229	876	2000	2017
BRA	20	59	2006	2017	**LUX**	19	60	2001	2017
CAN	229	752	1990	2017	**MEX**	19	78	1995	2017
CHE	140	730	1987	2017	**MLT**	4	12	2013	2017
CYP	4	14	2007	2016	**MYS**	391	1,571	1995	2017
CZE	1	1	2005	2005	**NLD**	92	415	1990	2014
DEU	136	541	1988	2017	**NOR**	103	406	1990	2017
DNK	34	122	1990	2004	**NZL**	72	374	1990	2017
EGY	2	3	2009	2015	**PHL**	10	33	2000	2016
ESP	39	134	1995	2017	**POL**	88	339	1998	2017
FIN	29	96	1995	2004	**PRT**	16	84	1996	2014
FRA	153	552	1988	2014	**RUS**	14	39	2009	2017
GBR	595	1,829	1987	2008	**SAU**	9	18	2010	2016
GRC	44	159	2003	2017	**SGP**	433	2,060	1987	2017
HKG	76	274	1989	2017	**SVK**	2	5	2010	2013
HRV	8	25	2007	2017	**SVN**	7	26	2004	2017
HUN	13	64	2002	2017	**SWE**	100	351	1989	2003
IDN	59	209	1998	2017	**THA**	58	166	1999	2017
IND	56	154	2003	2017	**ZAF**	44	152	1997	2017
IRL	12	45	1997	2017					
ISR	78	329	1998	2017	**Total**	4,082	15,660	1987	2017

Internet Appendix

"The Real Effects of Exchange Rate Risk on Corporate Investment: International Evidence"

(not for publication)

This appendix presents supplementary results not included in the main paper.

Table IA1: Exchange Rate Risk and Corporate Investments

Alternative Volatility Measures

Panel A: Baseline Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN	
UNEXP_VOL	-0.890***			-0.124**			1.248**			0.093***		
	(-4.101)			(-2.355)			(2.553)			(2.786)		
UNEXP_GARCH_VOL_FILL		-0.323***			-0.056***			0.377**			0.039***	
		(-4.429)			(-2.913)			(2.022)			(3.210)	
UNEXP_VOL_FILL			-0.337***			-0.061***			0.329*			0.035***
			(-4.580)			(-3.105)			(1.745)			(2.850)
FX_USD_LN	1.325**	1.367**	1.371**	0.341**	0.345**	0.345**	0.534	0.461	0.446	-0.006	-0.010	-0.011
	(2.016)	(2.079)	(2.084)	(2.076)	(2.090)	(2.092)	(0.337)	(0.292)	(0.282)	(-0.058)	(-0.089)	(-0.101)
GDP_LN	1.250	1.016	1.007	0.418	0.379	0.376	20.097***	20.385***	20.358***	1.596***	1.623***	1.621***
	(0.456)	(0.369)	(0.366)	(0.673)	(0.610)	(0.606)	(3.172)	(3.212)	(3.207)	(3.539)	(3.597)	(3.591)
GDP_CAP_LN	-1.029	-0.802	-0.776	-0.597	-0.558	-0.552	-18.606***	-18.876***	-18.862***	-1.552***	-1.579***	-1.578***
	(-0.333)	(-0.259)	(-0.250)	(-0.874)	(-0.817)	(-0.808)	(-2.628)	(-2.662)	(-2.659)	(-3.066)	(-3.117)	(-3.115)
GDP_GROWTH	0.134***	0.136***	0.137***	0.030***	0.031***	0.031***	-0.024	-0.027	-0.028	-0.003	-0.003	-0.003
	(4.644)	(4.709)	(4.723)	(4.250)	(4.292)	(4.302)	(-0.374)	(-0.420)	(-0.426)	(-0.558)	(-0.602)	(-0.611)
IMP_EXP_RATIO	-0.006	-0.006	-0.006	-0.001	-0.001	-0.001	-0.006	-0.005	-0.005	-0.001	-0.001	-0.001
	(-1.243)	(-1.324)	(-1.326)	(-0.069)	(-0.124)	(-0.127)	(-0.514)	(-0.470)	(-0.473)	(-0.795)	(-0.742)	(-0.745)
CAPITAL_RATIO	-0.001	-0.001	-0.001	0.001	0.001	0.001	0.007*	0.007*	0.007*	0.001*	0.001	0.001
	(-0.706)	(-0.548)	(-0.534)	(0.113)	(0.216)	(0.230)	(1.786)	(1.706)	(1.716)	(1.647)	(1.520)	(1.530)
STOCK_RATIO	0.005***	0.004**	0.004**	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(2.642)	(2.480)	(2.470)	(0.763)	(0.654)	(0.640)	(-0.078)	(-0.004)	(-0.013)	(0.390)	(0.513)	(0.503)
TOBINQ	0.499***	0.496***	0.496***	0.126***	0.126***	0.126***	1.559***	1.563***	1.563***	0.068***	0.068***	0.068***
	(4.500)	(4.477)	(4.477)	(2.960)	(2.947)	(2.947)	(4.299)	(4.309)	(4.307)	(5.204)	(5.233)	(5.230)
EBIDTA	3.649**	3.589**	3.593**	0.796**	0.786**	0.787**	4.327	4.406	4.398	0.530***	0.537***	0.536***
	(2.364)	(2.329)	(2.331)	(2.081)	(2.059)	(2.060)	(1.067)	(1.086)	(1.084)	(2.627)	(2.654)	(2.652)
EBIDTA_VOL	1.388	1.359	1.364	0.440	0.435	0.436	6.223	6.258	6.249	0.333**	0.336**	0.335**
	(1.439)	(1.408)	(1.412)	(1.561)	(1.543)	(1.545)	(1.622)	(1.630)	(1.628)	(2.069)	(2.086)	(2.083)
LOSS	0.143	0.131	0.132	0.048	0.046	0.046	0.044	0.059	0.057	0.022	0.024	0.024
	(0.832)	(0.762)	(0.769)	(1.155)	(1.109)	(1.113)	(0.102)	(0.137)	(0.131)	(0.721)	(0.764)	(0.757)
LEVERAGE	-0.171	-0.148	-0.148	0.006	0.010	0.010	-3.834***	-3.860***	-3.855***	-0.235***	-0.237***	-0.237***
	(-0.295)	(-0.255)	(-0.254)	(0.057)	(0.093)	(0.095)	(-3.014)	(-3.026)	(-3.023)	(-2.693)	(-2.719)	(-2.715)
PTBI	5.421***	5.441***	5.437***	1.211***	1.213***	1.213***	8.596***	8.566***	8.569***	0.600***	0.598***	0.598***
	(7.290)	(7.318)	(7.309)	(5.396)	(5.414)	(5.408)	(3.336)	(3.323)	(3.325)	(4.650)	(4.635)	(4.640)
PTBI_VOL	-0.032	0.003	-0.003	0.007	0.012	0.011	1.942	1.895	1.902	0.124	0.120	0.121
	(-0.056)	(0.006)	(-0.005)	(0.043)	(0.075)	(0.069)	(0.921)	(0.899)	(0.903)	(1.355)	(1.314)	(1.322)
SGA_DELTA	-1.379***	-1.382***	-1.380***	-0.353**	-0.354**	-0.354**	-4.907**	-4.904**	-4.906**	-0.201***	-0.201***	-0.201***
	(-2.942)	(-2.957)	(-2.951)	(-2.402)	(-2.411)	(-2.407)	(-2.357)	(-2.352)	(-2.354)	(-2.888)	(-2.876)	(-2.883)
SIZE	-1.650***	-1.653***	-1.652***	0.924***	0.924***	0.924***	-5.869***	-5.868***	-5.871***	0.657***	0.658***	0.657***
	(-8.278)	(-8.285)	(-8.282)	(14.082)	(14.088)	(14.088)	(-8.382)	(-8.361)	(-8.367)	(17.402)	(17.421)	(17.414)
FIRM_AGE	-0.716	-0.715	-0.722	-0.343***	-0.343***	-0.344***	-0.301	-0.304	-0.297	-0.044	-0.044	-0.043
	(-1.598)	(-1.595)	(-1.612)	(-3.343)	(-3.341)	(-3.353)	(-0.255)	(-0.257)	(-0.251)	(-0.488)	(-0.490)	(-0.482)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660
R-Squared	0.703	0.703	0.703	0.905	0.905	0.905	0.785	0.785	0.785	0.932	0.932	0.932

Panel B: Control for EPU

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN	
UNEXP_VOL	-1.589***			-0.260***			2.418***			0.114**		
	(-4.285)			(-2.696)			(2.827)			(2.201)		
UNEXP_GARCH_VOL_FILL		-0.367***			-0.094***			0.541**			0.050***	
		(-3.427)			(-3.182)			(2.199)			(2.846)	
UNEXP_VOL_FILL			-0.369***			-0.096***			0.487*			0.047***
			(-3.432)			(-3.220)			(1.932)			(2.630)
FX_USD_LN	0.891	0.848	0.861	0.333	0.319	0.322	4.293*	4.354*	4.325*	0.181	0.189	0.186
	(0.859)	(0.817)	(0.829)	(1.398)	(1.337)	(1.351)	(1.877)	(1.904)	(1.891)	(1.124)	(1.169)	(1.155)
EPU_INDEX	-0.008***	-0.007**	-0.007**	-0.001	-0.001	-0.001	-0.003	-0.004	-0.004	-0.001	-0.001*	-0.001*
	(-2.680)	(-2.426)	(-2.425)	(-0.891)	(-0.648)	(-0.644)	(-0.361)	(-0.515)	(-0.505)	(-1.621)	(-1.783)	(-1.775)
GDP_LN	-0.161	-0.647	-0.646	0.356	0.213	0.210	21.829**	22.537**	22.429**	1.478**	1.558**	1.551**
	(-0.045)	(-0.180)	(-0.180)	(0.417)	(0.250)	(0.247)	(2.331)	(2.398)	(2.384)	(2.400)	(2.521)	(2.509)
GDP_CAP_LN	-0.113	0.366	0.373	-0.551	-0.401	-0.396	-19.406*	-20.098*	-19.986*	-1.338*	-1.423**	-1.417**
	(-0.028)	(0.090)	(0.091)	(-0.600)	(-0.437)	(-0.431)	(-1.852)	(-1.911)	(-1.898)	(-1.913)	(-2.027)	(-2.017)
GDP_GROWTH	0.086*	0.094**	0.095**	0.028**	0.030**	0.030**	0.022	0.011	0.008	-0.008	-0.009	-0.009
	(1.868)	(2.026)	(2.070)	(2.333)	(2.451)	(2.493)	(0.212)	(0.106)	(0.082)	(-1.147)	(-1.219)	(-1.253)
IMP_EXP_RATIO	-0.009	-0.011*	-0.011*	0.001	0.001	0.001	-0.004	-0.002	-0.002	-0.001	-0.001	-0.001
	(-1.569)	(-1.792)	(-1.802)	(0.390)	(0.222)	(0.209)	(-0.289)	(-0.147)	(-0.148)	(-0.203)	(-0.076)	(-0.073)
CAPITAL_RATIO	-0.001	0.001	0.001	-0.001	-0.001	0.001	0.004	0.003	0.003	0.001	0.001	0.001
	(-0.305)	(0.044)	(0.059)	(-0.338)	(-0.000)	(0.021)	(0.922)	(0.662)	(0.677)	(1.040)	(0.715)	(0.723)
STOCK_RATIO	0.003	0.003	0.003	0.001	0.001	0.001	0.003	0.004	0.004	0.001	0.001	0.001
	(1.230)	(0.974)	(0.950)	(0.771)	(0.505)	(0.471)	(0.612)	(0.813)	(0.809)	(0.808)	(1.095)	(1.103)
TOBINQ	0.435***	0.435***	0.435***	0.130**	0.130**	0.130**	1.342***	1.342***	1.341***	0.056***	0.056***	0.056***
	(3.423)	(3.423)	(3.423)	(2.386)	(2.382)	(2.382)	(3.241)	(3.236)	(3.236)	(3.841)	(3.850)	(3.848)
EBIDTA	3.244*	3.096	3.103	0.873*	0.848*	0.850*	7.676	7.901	7.891	0.765***	0.775***	0.774***
	(1.674)	(1.605)	(1.610)	(1.794)	(1.750)	(1.755)	(1.532)	(1.573)	(1.571)	(2.985)	(3.019)	(3.020)
EBIDTA_VOL	1.484	1.402	1.409	0.586	0.571	0.573	5.862	5.986	5.975	0.366*	0.372*	0.371*
	(1.274)	(1.204)	(1.210)	(1.621)	(1.581)	(1.586)	(1.243)	(1.268)	(1.266)	(1.783)	(1.811)	(1.809)
LOSS	0.161	0.146	0.147	0.088	0.084	0.084	-0.589	-0.568	-0.572	-0.018	-0.016	-0.016
	(0.665)	(0.606)	(0.609)	(1.346)	(1.290)	(1.291)	(-1.006)	(-0.971)	(-0.977)	(-0.422)	(-0.373)	(-0.379)
LEVERAGE	-0.676	-0.648	-0.650	-0.147	-0.141	-0.141	-2.744	-2.786	-2.782	-0.286**	-0.289**	-0.289**
	(-0.884)	(-0.843)	(-0.845)	(-1.000)	(-0.965)	(-0.967)	(-1.484)	(-1.501)	(-1.500)	(-2.359)	(-2.372)	(-2.370)
PTBI	4.729***	4.790***	4.784***	1.028***	1.035***	1.034***	6.217*	6.123*	6.126*	0.420***	0.418***	0.418***
	(5.330)	(5.430)	(5.421)	(3.926)	(3.987)	(3.978)	(1.910)	(1.882)	(1.883)	(2.695)	(2.680)	(2.686)
PTBI_VOL	0.275	0.359	0.354	0.052	0.067	0.065	1.430	1.302	1.309	0.006	-0.001	0.001
	(0.405)	(0.536)	(0.528)	(0.243)	(0.310)	(0.304)	(0.531)	(0.484)	(0.486)	(0.059)	(-0.000)	(0.006)
SGA_DELTA	-1.291**	-1.299**	-1.295**	-0.307*	-0.308*	-0.307*	-5.516**	-5.504**	-5.508**	-0.233***	-0.232***	-0.233***
	(-2.501)	(-2.536)	(-2.527)	(-1.663)	(-1.675)	(-1.669)	(-1.993)	(-1.986)	(-1.988)	(-2.666)	(-2.656)	(-2.665)
SIZE	-1.594***	-1.585***	-1.585***	0.879***	0.880***	0.880***	-6.410***	-6.423***	-6.424***	0.658***	0.657***	0.657***
	(-6.329)	(-6.287)	(-6.286)	(10.547)	(10.575)	(10.575)	(-5.902)	(-5.901)	(-5.903)	(14.600)	(14.603)	(14.600)
FIRM_AGE	-0.738	-0.803	-0.802	-0.429***	-0.442***	-0.442***	-1.210	-1.114	-1.121	-0.197	-0.190	-0.191
	(-1.116)	(-1.215)	(-1.214)	(-2.668)	(-2.742)	(-2.742)	(-0.704)	(-0.648)	(-0.652)	(-1.594)	(-1.539)	(-1.542)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857	8,857
R-Squared	0.746	0.745	0.745	0.910	0.910	0.910	0.798	0.798	0.798	0.936	0.936	0.936

Notes: This table presents the effects of unexpected exchange rate volatility at the firm level on firms' investments using alternative measures. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variables of interest include three alternative measures. We use firm-level realized volatility-computed FX volatility (UNEXP_VOL) , as well as GARCH (UNEXP_GARCH_VOL_FILL) and realized volatility (UNEXP_VOL_FILL)-computed measures by filling USD exchange rates when exact firm sales countries are not identified. The firm-level measure is calculated based on country-level measure then weighted by firm sales in a country divided by total foreign sales for the firm. In all regressions, we control for the mean change of the FX rate based on USD-based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. Panel A reports baseline regression results. In Panel B, we control for the Economic Policy Uncertainty Index (EPU_INDEX) constructed following Baker, Bloom, and Davis (2016). We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table IA2: Economic Openness
Alternative Volatility Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN		
UNEXP_VOL*IMP_EXP_RATIO	-0.005***			-0.002***			0.014***			0.001***		
	(-2.783)			(-2.700)			(2.823)			(3.690)		
UNEXP_VOL	-0.196			0.080			-0.558			-0.018		
	(-0.615)			(1.169)			(-0.759)			(-0.374)		
UNEXP_GARCH_VOL_FILL*IMP_EXP_RATIO		-0.004***			-0.001***			0.007***			0.001***	
		(-4.215)			(-3.957)			(3.193)			(3.607)	
UNEXP_GARCH_VOL_FILL		0.024			0.026			-0.267			-0.003	
		(0.239)			(1.025)			(-1.029)			(-0.180)	
UNEXP_VOL_FILL*IMP_EXP_RATIO			-0.004***			-0.001***			0.007***			0.001***
			(-4.359)			(-4.065)			(2.973)			(3.426)
UNEXP_VOL_FILL			0.025			0.027			-0.293			-0.005
			(0.247)			(1.039)			(-1.104)			(-0.298)
IMP_EXP_RATIO	-0.004	-0.002	-0.003	0.001	0.001	0.001	-0.009	-0.012	-0.011	-0.001	-0.001	-0.001
	(-0.918)	(-0.479)	(-0.576)	(0.294)	(0.628)	(0.560)	(-0.843)	(-1.062)	(-0.962)	(-1.053)	(-1.249)	(-1.164)
FX_USD_LN	1.238*	1.238*	1.240*	0.316*	0.314*	0.314*	0.760	0.701	0.669	0.007	0.006	0.003
	(1.883)	(1.874)	(1.877)	(1.914)	(1.907)	(1.903)	(0.479)	(0.443)	(0.422)	(0.068)	(0.054)	(0.031)
GDP_LN	1.595	1.704	1.772	0.519	0.542	0.561	19.201***	19.106***	19.047***	1.541***	1.540***	1.536***
	(0.586)	(0.619)	(0.645)	(0.842)	(0.880)	(0.914)	(3.042)	(3.022)	(3.012)	(3.414)	(3.412)	(3.396)
GDP_CAP_LN	-1.310	-1.329	-1.397	-0.679	-0.683	-0.702	-17.872**	-17.898**	-17.798**	-1.507***	-1.515***	-1.509***
	(-0.426)	(-0.428)	(-0.451)	(-1.001)	(-1.005)	(-1.037)	(-2.533)	(-2.534)	(-2.519)	(-2.981)	(-2.998)	(-2.981)
GDP_GROWTH	0.128***	0.127***	0.130***	0.029***	0.029***	0.029***	-0.009	-0.011	-0.017	-0.002	-0.002	-0.002
	(4.453)	(4.383)	(4.491)	(4.002)	(4.011)	(4.096)	(-0.145)	(-0.168)	(-0.258)	(-0.370)	(-0.383)	(-0.465)
CAPITAL_RATIO	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	0.008**	0.008*	0.008*	0.001*	0.001*	0.001*
	(-0.905)	(-0.834)	(-0.822)	(-0.103)	(-0.043)	(-0.035)	(1.990)	(1.935)	(1.926)	(1.840)	(1.745)	(1.740)
STOCK_RATIO	0.005***	0.005***	0.005***	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(2.781)	(2.646)	(2.626)	(0.927)	(0.842)	(0.818)	(-0.237)	(-0.164)	(-0.149)	(0.236)	(0.351)	(0.366)
TOBINQ	0.500***	0.496***	0.496***	0.126***	0.126***	0.126***	1.557***	1.563***	1.563***	0.068***	0.068***	0.068***
	(4.496)	(4.484)	(4.483)	(2.959)	(2.946)	(2.946)	(4.297)	(4.305)	(4.304)	(5.199)	(5.227)	(5.224)
EBIDTA	3.629**	3.539**	3.541**	0.790**	0.775**	0.774**	4.378	4.498	4.487	0.534***	0.543***	0.542***
	(2.356)	(2.309)	(2.310)	(2.073)	(2.039)	(2.038)	(1.081)	(1.112)	(1.108)	(2.638)	(2.682)	(2.679)
EBIDTA_VOL	1.373	1.368	1.373	0.436	0.438	0.438	6.261	6.241	6.234	0.335**	0.335**	0.334**
	(1.427)	(1.426)	(1.429)	(1.551)	(1.556)	(1.558)	(1.634)	(1.629)	(1.626)	(2.080)	(2.075)	(2.071)
LOSS	0.146	0.123	0.127	0.049	0.044	0.045	0.036	0.075	0.065	0.022	0.025	0.024
	(0.850)	(0.715)	(0.742)	(1.178)	(1.065)	(1.087)	(0.083)	(0.174)	(0.151)	(0.706)	(0.798)	(0.776)
LEVERAGE	-0.210	-0.160	-0.165	-0.005	0.007	0.006	-3.731***	-3.837***	-3.825***	-0.228***	-0.236***	-0.235***
	(-0.362)	(-0.277)	(-0.285)	(-0.048)	(0.067)	(0.057)	(-2.939)	(-3.012)	(-3.004)	(-2.620)	(-2.709)	(-2.699)
PTBI	5.434***	5.510***	5.505***	1.215***	1.230***	1.229***	8.563***	8.439***	8.453***	0.598***	0.590***	0.591***
	(7.328)	(7.433)	(7.425)	(5.434)	(5.509)	(5.507)	(3.324)	(3.278)	(3.282)	(4.627)	(4.561)	(4.571)
PTBI_VOL	-0.011	0.033	0.025	0.013	0.019	0.018	1.889	1.839	1.855	0.121	0.117	0.118
	(-0.020)	(0.057)	(0.042)	(0.081)	(0.118)	(0.109)	(0.898)	(0.878)	(0.884)	(1.321)	(1.287)	(1.299)
SGA_DELTA	-1.373***	-1.398***	-1.396***	-0.352**	-0.358**	-0.358**	-4.922**	-4.874**	-4.879**	-0.202***	-0.199***	-0.199***
	(-2.942)	(-3.003)	(-2.997)	(-2.402)	(-2.446)	(-2.443)	(-2.366)	(-2.341)	(-2.343)	(-2.892)	(-2.842)	(-2.850)
SIZE	-1.653***	-1.657***	-1.657***	0.924***	0.923***	0.923***	-5.862***	-5.859***	-5.862***	0.658***	0.658***	0.658***
	(-8.308)	(-8.296)	(-8.300)	(14.066)	(14.078)	(14.081)	(-8.376)	(-8.363)	(-8.369)	(17.414)	(17.456)	(17.447)
FIRM_AGE	-0.705	-0.677	-0.688	-0.340***	-0.334***	-0.336***	-0.330	-0.373	-0.356	-0.045	-0.048	-0.047
	(-1.575)	(-1.511)	(-1.535)	(-3.325)	(-3.274)	(-3.292)	(-0.280)	(-0.316)	(-0.301)	(-0.509)	(-0.541)	(-0.525)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660	15,660
R-Squared	0.704	0.704	0.704	0.905	0.905	0.905	0.785	0.785	0.785	0.932	0.932	0.932

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms in countries with different degrees of economic openness This table presents the effects of unexpected exchange rate volatility at the firm level on firms' investments using alternative measures. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variables of interest are 1) one of the three alternative firm-level exchange rate volatility measures as explained in Table A1, 2) the import-export to GDP ratio that measures the openness of an economy (IMP_EXP_RATIO), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table IA3: Investment Irreversibility
Alternative Volatilty Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN		
UNEXP_VOL*PPENT / AT	-4.678***			-0.644***			2.994*			0.470***		
	(-4.222)			(-3.397)			(1.785)			(3.779)		
UNEXP_VOL	0.826**			0.136*			0.032			-0.055		
	(2.262)			(1.797)			(0.036)			(-0.998)		
UNEXP_GARCH_VOL_FILL*PPENT / AT		-1.504***			-0.151***			1.312**			0.159***	
		(-4.638)			(-2.593)			(2.238)			(3.505)	
UNEXP_GARCH_VOL_FILL		0.209*			0.016			-0.200			-0.017	
		(1.673)			(0.557)			(-0.691)			(-0.855)	
UNEXP_VOL_FILL*PPENT / AT			-1.495***			-0.148**			1.363**			0.153***
			(-4.563)			(-2.511)			(2.277)			(3.281)
UNEXP_VOL_FILL			0.188			0.011			-0.269			-0.019
			(1.490)			(0.370)			(-0.909)			(-0.937)
PPENT / AT	2.346***	2.520***	2.402***	0.588***	0.601***	0.589***	-5.441***	-5.618***	-5.528***	-0.418***	-0.436***	-0.424***
	(3.466)	(3.602)	(3.479)	(5.159)	(5.180)	(5.107)	(-4.162)	(-4.302)	(-4.241)	(-4.505)	(-4.690)	(-4.571)
FX_USD_LN	1.332**	1.319**	1.330**	0.368***	0.366***	0.367***	1.087	1.045	1.027	0.030	0.029	0.026
	(2.000)	(1.986)	(2.003)	(2.607)	(2.592)	(2.598)	(0.703)	(0.678)	(0.666)	(0.271)	(0.264)	(0.243)
GDP_LN	2.187	2.050	2.045	0.447	0.426	0.424	17.948***	18.055***	18.013***	1.425***	1.444***	1.441***
	(0.802)	(0.745)	(0.743)	(0.792)	(0.754)	(0.750)	(2.853)	(2.868)	(2.859)	(3.161)	(3.200)	(3.192)
GDP_CAP_LN	-2.116	-1.973	-1.944	-0.596	-0.574	-0.568	-16.355**	-16.448**	-16.418**	-1.391***	-1.409***	-1.409***
	(-0.684)	(-0.634)	(-0.624)	(-0.967)	(-0.928)	(-0.920)	(-2.341)	(-2.353)	(-2.347)	(-2.753)	(-2.790)	(-2.787)
GDP_GROWTH	0.130***	0.132***	0.133***	0.031***	0.031***	0.031***	-0.016	-0.019	-0.019	-0.001	-0.001	-0.001
	(4.446)	(4.521)	(4.532)	(4.524)	(4.562)	(4.568)	(-0.254)	(-0.301)	(-0.306)	(-0.152)	(-0.217)	(-0.226)
IMP_EXP_RATIO	-0.005	-0.005	-0.005	0.001	0.001	0.001	-0.006	-0.006	-0.006	-0.001	-0.001	-0.001
	(-1.036)	(-1.051)	(-1.047)	(0.206)	(0.182)	(0.181)	(-0.547)	(-0.537)	(-0.544)	(-0.990)	(-0.965)	(-0.970)
CAPITAL_RATIO	-0.001	-0.001	-0.001	0.001	0.001	0.001	0.008*	0.008*	0.008*	0.001*	0.001*	0.001*
	(-0.646)	(-0.540)	(-0.530)	(0.013)	(0.064)	(0.074)	(1.833)	(1.802)	(1.817)	(1.738)	(1.652)	(1.667)
STOCK_RATIO	0.004**	0.004**	0.004**	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(2.464)	(2.354)	(2.352)	(0.981)	(0.930)	(0.923)	(-0.234)	(-0.200)	(-0.213)	(0.286)	(0.373)	(0.355)
TOBINQ	0.505***	0.506***	0.505***	0.106***	0.106***	0.105***	1.484***	1.484***	1.484***	0.065***	0.065***	0.065***
	(4.537)	(4.535)	(4.530)	(3.986)	(3.982)	(3.978)	(4.115)	(4.112)	(4.112)	(5.023)	(5.019)	(5.022)
EBIDTA	2.985*	2.960*	2.949*	0.560	0.557	0.556	3.655	3.690	3.697	0.495**	0.499***	0.500***
	(1.878)	(1.863)	(1.855)	(1.582)	(1.573)	(1.569)	(0.877)	(0.885)	(0.886)	(2.564)	(2.580)	(2.584)
EBIDTA_VOL	0.805	0.776	0.770	0.287	0.282	0.282	6.484*	6.506*	6.511*	0.321**	0.324**	0.325**
	(0.816)	(0.786)	(0.779)	(1.083)	(1.066)	(1.063)	(1.660)	(1.665)	(1.667)	(2.121)	(2.142)	(2.145)
LOSS	0.193	0.180	0.180	0.054	0.053	0.053	0.093	0.106	0.105	0.021	0.022	0.022
	(1.105)	(1.029)	(1.032)	(1.407)	(1.368)	(1.368)	(0.218)	(0.250)	(0.247)	(0.665)	(0.719)	(0.713)
LEVERAGE	-0.879	-0.858	-0.858	-0.164	-0.162	-0.161	-1.946	-1.962	-1.955	-0.089	-0.091	-0.091
	(-1.431)	(-1.393)	(-1.393)	(-1.515)	(-1.491)	(-1.488)	(-1.468)	(-1.478)	(-1.472)	(-0.969)	(-0.999)	(-0.990)
PTBI	5.227***	5.251***	5.253***	0.989***	0.992***	0.992***	10.939***	10.914***	10.911***	0.701***	0.698***	0.697***
	(6.887)	(6.907)	(6.907)	(5.139)	(5.149)	(5.149)	(4.400)	(4.390)	(4.390)	(5.638)	(5.632)	(5.629)
PTBI_VOL	0.154	0.157	0.156	0.087	0.086	0.086	0.853	0.832	0.832	0.097	0.095	0.096
	(0.263)	(0.270)	(0.268)	(0.523)	(0.516)	(0.514)	(0.397)	(0.387)	(0.387)	(1.058)	(1.041)	(1.044)
SGA_DELTA	-1.462***	-1.470***	-1.471***	-0.344**	-0.345**	-0.345**	-5.212**	-5.205**	-5.204**	-0.234***	-0.233***	-0.233***
	(-3.010)	(-3.042)	(-3.042)	(-2.321)	(-2.324)	(-2.324)	(-2.281)	(-2.279)	(-2.278)	(-3.325)	(-3.307)	(-3.308)
SIZE	-1.706***	-1.713***	-1.714***	0.804***	0.803***	0.803***	-5.739***	-5.736***	-5.737***	0.655***	0.656***	0.655***
	(-8.461)	(-8.504)	(-8.507)	(19.099)	(19.050)	(19.051)	(-7.956)	(-7.944)	(-7.946)	(17.379)	(17.407)	(17.399)
FIRM_AGE	-0.611	-0.606	-0.612	-0.255***	-0.255***	-0.256***	-0.585	-0.594	-0.592	-0.063	-0.064	-0.063
	(-1.392)	(-1.379)	(-1.392)	(-2.656)	(-2.650)	(-2.656)	(-0.498)	(-0.505)	(-0.503)	(-0.710)	(-0.718)	(-0.711)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	15,378	15,378	15,378	15,378	15,378	15,378	15,378	15,378	15,378	15,378	15,378	15,378
R-Squared	0.705	0.705	0.705	0.926	0.925	0.925	0.797	0.797	0.797	0.936	0.936	0.936

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms with different degrees of investment irreversibility using alternative volatility measures. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the net PPE to total assets ratio that measures investment irreversibility (PPENET_RATIO_INTER), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table IA4: Financial Constraints
Alternative Volatility Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	CAPEX / AT			CAPEX_USD_LN			CASH / AT			CASH_USD_LN		
UNEXP_VOL*KZ_INDEX	-0.177***			-0.046***			0.566***			0.027***		
	(-4.253)			(-3.148)			(3.364)			(4.054)		
UNEXP_VOL	-0.950***			-0.157***			0.907**			0.102***		
	(-4.248)			(-2.794)			(2.014)			(2.915)		
UNEXP_GARCH_VOL_FILL*KZ_INDEX		-0.058***			-0.010**			0.179***			0.004*	
		(-4.207)			(-2.004)			(2.901)			(1.820)	
UNEXP_GARCH_VOL_FILL		-0.384***			-0.054***			0.289			0.032***	
		(-5.065)			(-2.939)			(1.535)			(2.602)	
UNEXP_VOL_FILL*KZ_INDEX			-0.061***			-0.010*			0.189***			0.005*
			(-4.206)			(-1.951)			(2.840)			(1.835)
UNEXP_VOL_FILL			-0.400***			-0.059***			0.248			0.029**
			(-5.206)			(-3.133)			(1.302)			(2.282)
KZ_INDEX	0.038**	0.040**	0.036*	0.012*	0.012	0.011	-0.487***	-0.492***	-0.480***	-0.028***	-0.028***	-0.028***
	(2.034)	(2.157)	(1.940)	(1.672)	(1.568)	(1.493)	(-5.859)	(-5.759)	(-5.669)	(-7.157)	(-7.016)	(-6.981)
FX_USD_LN	1.448**	1.486**	1.495**	0.379**	0.386**	0.387**	0.511	0.458	0.427	-0.069	-0.073	-0.075
	(2.176)	(2.239)	(2.253)	(2.308)	(2.338)	(2.342)	(0.341)	(0.306)	(0.286)	(-0.629)	(-0.673)	(-0.688)
GDP_LN	0.930	0.652	0.660	0.163	0.121	0.121	16.837***	17.076***	17.003***	1.410***	1.436***	1.432***
	(0.332)	(0.232)	(0.235)	(0.278)	(0.207)	(0.207)	(2.832)	(2.869)	(2.859)	(3.131)	(3.185)	(3.177)
GDP_CAP_LN	-0.581	-0.324	-0.315	-0.364	-0.326	-0.323	-15.674**	-15.873**	-15.803**	-1.401***	-1.424***	-1.422***
	(-0.184)	(-0.102)	(-0.099)	(-0.555)	(-0.498)	(-0.494)	(-2.366)	(-2.392)	(-2.381)	(-2.772)	(-2.816)	(-2.811)
GDP_GROWTH	0.136***	0.139***	0.139***	0.030***	0.031***	0.031***	-0.051	-0.053	-0.052	-0.003	-0.004	-0.004
	(4.736)	(4.818)	(4.819)	(4.202)	(4.252)	(4.250)	(-0.791)	(-0.826)	(-0.816)	(-0.669)	(-0.715)	(-0.716)
IMP_EXP_RATIO	-0.005	-0.006	-0.006	-0.001	-0.001	-0.001	-0.007	-0.007	-0.007	-0.001	-0.001	-0.001
	(-1.170)	(-1.225)	(-1.232)	(-0.754)	(-0.780)	(-0.785)	(-0.623)	(-0.624)	(-0.620)	(-1.074)	(-1.055)	(-1.055)
CAPITAL_RATIO	-0.002	-0.001	-0.001	0.001	0.001	0.001	0.005	0.005	0.005	0.001	0.001	0.001
	(-0.968)	(-0.857)	(-0.831)	(0.308)	(0.361)	(0.384)	(1.158)	(1.189)	(1.182)	(1.210)	(1.160)	(1.163)
STOCK_RATIO	0.005***	0.005**	0.005**	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(2.626)	(2.469)	(2.447)	(1.279)	(1.190)	(1.166)	(-0.289)	(-0.271)	(-0.265)	(0.156)	(0.236)	(0.233)
TOBINQ	0.555***	0.555***	0.555***	0.129**	0.129**	0.129**	1.548***	1.539***	1.541***	0.073***	0.073***	0.073***
	(4.256)	(4.262)	(4.259)	(2.439)	(2.442)	(2.440)	(4.413)	(4.382)	(4.382)	(5.036)	(5.028)	(5.026)
EBIDTA	5.838***	5.836***	5.828***	1.082***	1.081***	1.079***	3.374	3.334	3.349	0.476**	0.477**	0.478**
	(3.957)	(3.942)	(3.937)	(3.150)	(3.128)	(3.123)	(0.717)	(0.705)	(0.708)	(2.066)	(2.067)	(2.068)
EBIDTA_VOL	2.630**	2.604**	2.606**	0.704**	0.698**	0.699**	4.043	4.120	4.119	0.249	0.253	0.252
	(2.229)	(2.201)	(2.202)	(2.396)	(2.376)	(2.376)	(1.066)	(1.084)	(1.083)	(1.437)	(1.453)	(1.451)
LOSS	0.198	0.188	0.190	0.030	0.029	0.029	0.120	0.122	0.119	0.031	0.032	0.032
	(1.104)	(1.050)	(1.061)	(0.764)	(0.735)	(0.741)	(0.293)	(0.298)	(0.289)	(0.990)	(1.012)	(1.005)
LEVERAGE	-0.653	-0.612	-0.612	-0.065	-0.058	-0.057	-3.078**	-3.140**	-3.134**	-0.208**	-0.213**	-0.212**
	(-1.090)	(-1.017)	(-1.018)	(-0.620)	(-0.549)	(-0.547)	(-2.263)	(-2.290)	(-2.284)	(-2.348)	(-2.395)	(-2.390)
PTBI	6.556***	6.535***	6.541***	1.396***	1.389***	1.390***	5.336*	5.420*	5.393*	0.432***	0.436***	0.436***
	(6.977)	(6.927)	(6.933)	(4.973)	(4.941)	(4.942)	(1.668)	(1.691)	(1.683)	(2.890)	(2.920)	(2.914)
PTBI_VOL	-0.886	-0.820	-0.824	-0.158	-0.143	-0.143	2.096	2.006	2.005	0.184**	0.175*	0.175*
	(-1.568)	(-1.446)	(-1.452)	(-0.950)	(-0.898)	(-0.897)	(1.020)	(0.977)	(0.975)	(1.964)	(1.807)	(1.813)
SGA_DELTA	-1.498**	-1.527**	-1.529**	-0.253*	-0.258*	-0.257*	-3.618	-3.527	-3.523	-0.211**	-0.209**	-0.209**
	(-2.490)	(-2.537)	(-2.540)	(-1.925)	(-1.950)	(-1.947)	(-1.406)	(-1.379)	(-1.378)	(-2.473)	(-2.449)	(-2.447)
SIZE	-1.787***	-1.787***	-1.788***	0.918***	0.918***	0.918***	-5.758***	-5.759***	-5.757***	0.640***	0.640***	0.640***
	(-8.356)	(-8.373)	(-8.377)	(13.853)	(13.861)	(13.858)	(-7.487)	(-7.493)	(-7.496)	(16.113)	(16.101)	(16.100)
FIRM_AGE	-0.612	-0.595	-0.601	-0.281***	-0.278***	-0.279***	0.119	0.074	0.072	-0.005	-0.006	-0.006
	(-1.380)	(-1.340)	(-1.354)	(-2.939)	(-2.912)	(-2.921)	(0.105)	(0.065)	(0.064)	(-0.058)	(-0.071)	(-0.066)
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Observations	14,724	14,724	14,724	14,724	14,724	14,724	14,724	14,724	14,724	14,724	14,724	14,724
R-Squared	0.716	0.716	0.716	0.910	0.910	0.910	0.792	0.792	0.792	0.936	0.935	0.935

Notes: This table presents the heterogeneous effects of unexpected currency volatility on the investments of firms with different degrees of financial constraints using alternative volatility measures. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The main independent variables are 1) firm-level GARCH-computed unexpected FX volatility (UNEXP_GARCH_VOL), 2) the KZ index that measures financial constraints (KZ_INDEX), and 3) the interaction of these two. In all regressions, we control for the mean change of the FX rate based on USD based exchange rates (FX_USD_LN); country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO; and firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.

Table IA5: Exchange Rate Regime Changes

Alternative Volatility Measures

	(1) CAPEX / AT	(4) CAPEX_USD_LN	(7) CASH / AT	(10) CASH_USD_LN
UNEXP_VOL	-17.805***	-3.310***	23.872***	1.643***
	(-2.801)	(-3.044)	(2.606)	(2.686)
Control	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Observations	15,660	15,660	15,660	15,660
Instrument		FX_REGIME_CHANGE		
F-Statistic	11.434	15.181	10.569	25.291

FX_REGIME_CHANGE	0.236***
	(4.267)
Control	Yes
Constant	Yes
Firm FE	Yes
Year FE	Yes
Cluster	Firm
Observations	15,660
R-Squared	0.403

Notes: This table presents the 2SLS regression results of firm-level unexpected exchange rate volatility on firms' investments using alternative volatility measure. The sample is at the firm-year level. The dependent variables listed in the table headers are the same as in Table 2. The independent variable in the second stage (Panel A) is firm-level realized volatility-computed unexpected FX volatility (UNEXP _VOL). The independent variable in the corresponding first stage (Panel B) is the firm-level FX regime change shock variable (FX_REGIME_CHANGE). The variable is calculated based on a country-level dummy variable that equals one if the country experiences the foreign exchange regime change in the year. Then similar to firm-level unexpected FX volatility, the firm-level measure is calculated based on country-level measure weighted by firm sales in a country divided by total foreign sales for the firm. In all regressions, we control for country-year characteristics including GDP_LN, GDP_CAP_LN, GDP_GROWTH, IMPORT_RATIO, EXPORT_RATIO, INTEREST_RATE, CAPITAL_RATIO, and STOCK_RATIO as well as firm-year characteristics including Tobin's Q, EBITDA, EBITDA_SIGMA, LOSS, LEVERAGE, PTBI, VOL_PTBI, DELTA_SGA, SIZE and FIRM_AGE, all of which are defined in Appendix Table A1. We also control for firm fixed effects and year fixed effects. Standard errors are clustered at the firm level. Robust t-statistics are in parentheses. ***, ** and * denote 1%, 5% and 10% statistical significance.