FX Transaction and Translation Risk

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Abstract

If a firm invoices a transaction in a foreign currency, a delay of payment between the transaction date and the settlement date exposes the firm to exchange rate risk. In their income statements, firms report such exchange rate gains and losses, signaling their exposure to currency risk. Using these publicly available accounting data, this paper revisits the exchange rate disconnect puzzle at the firm level. We focus on two countries, Japan and the United States, that exhibit a similar trade openness but two very different shares of foreign currency invoicing. We find that an appreciation of the yen significantly decreases the net income and investment of Japanese firms, but an appreciation of the dollar has no significant effect on the U.S. sample. Exchange rate risk appears linked to the value of Japanese firms: the higher the exposure to exchange rate risk according to their income statements, the higher the loadings of their equity returns on exchange rate returns.

Keywords: Exchange rates, net income, equity returns, investment, working capital.

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1 Introduction

At the macroeconomic level, exchange rates appear disconnected to real variables. A large literature, following Meese and Rogoff (1983), reports that macroeconomic variables —productivity shocks, GDP growth, or investment growth, for example — are not significantly related to changes in exchange rates in developed countries, a well-known empirical fact at odds with most models in international economics and known as the exchange rate disconnect puzzle.

In this paper, we revisit the impact of exchange rates on real variables, but we do so at the firm level and with a particular attention to exchange rate (FX) transaction risk. This specific risk arises as soon as a firm invoices a transaction in a foreign currency and a delay of payment exists between the transaction date and the settlement date. In their income statements, firms report these FX transaction gains and losses, signaling their exposure to currency risk more broadly. Using such accounting data as instruments, we focus on two countries, Japan and the United States, that exhibit a similar trade openness but two very different shares of foreign-currency invoicing. While we study these two countries in details, our approach can easily be extended to many other countries and firms as we only rely on publicly available data. We find that an appreciation of the yen significantly decreases the net income and investment of Japanese firms, but an appreciation of the dollar has no significant effect on the U.S. sample. Exchange rate risk appears linked to the value of Japanese firms: the higher the exposure to exchange rate risk according to their income statements, the higher the loadings of their equity returns on exchange rate returns.

We go beyond simple correlations and look for the causal impact of exchange rates on firms' net income and investment. This task would be very difficult with macroeconomic variables. Even if exchange rates were significantly correlated with GDP growth, for example, two identification issues would immediately arise: potential reverse causality and omitted variables. Is the GDP causing the exchange rate or the other way around? Is another variable affecting both the GDP and exchange rates? We exploit the power of the cross-section of firms to confront these issues. At the firm level, reverse causality concerns fade: no firm is large enough to affect a broad exchange rate index. But omitted variables remain possible, as the decision to hedge is endogenous. To

limit the role of omitted variables, we turn to a simple two-step procedure, using the firm-level FX transaction exposures as instruments for exchange rates. The first step estimates the firm-specific impact of the changes in exchange rates on the FX transaction exposure, firm by firm, controlling for both firm-level and country-level observables. The second step is a simple panel regression with firm, time, and industry $\times$ time fixed effects, along with firm-level controls. Intuitively, we compare firms with high vs low FX transaction exposure, in Japan vs the U.S. The impact of exchange rates on real variables survives all these controls. To account for our findings, an omitted variable would need to co-move with hedging decisions and profits, conditioning on the change in exchange rate, in Japan, but not in the U.S. We do not know of such mechanism.

The intuition behind our results is simple: Japanese firms do not fully hedge their exchange rate risk. Firms may hedge their currency risk partially or fully, through financial derivatives, foreign currency investments or foreign currency borrowing, or through multiple foreign operations. The FX transaction exposure we observe is net of direct financial hedging. If firms were hedging perfectly their currency risk with forward or option contracts, the FX transaction income would be zero.

Among all the Japanese public firm-year data, approximately one-fourth of the FX transaction observations imply a risk of more than 6% of the firm's net income. To the contrary, among all the U.S. public firm-year data, 90% of the observations imply a risk of less than 1.5% of the firm's net income. While the volatilities and persistence of the exchange rates are broadly similar in the two countries, currency risk clearly matters much more in Japan than in the U.S. It reaches large fractions of the after-tax profits for some firms. In Japan, among the firms reporting any FX transaction risk (including zero), one-fourth of the observations imply a risk of more than 17% of the firm's net income.

Unsurprisingly, the timing of FX transaction gains and losses is significantly linked to exchange rate changes. Overall, a 10% appreciation of the yen index implies a 0.12% FX transaction loss as a percentage of total sales for Japanese firms. The effect is ten times smaller in the U.S. The FX transaction loss is not negligible: a one-standard deviation appreciation of the yen corresponds to a 3.3% FX transaction loss as a percentage of net income. The absence of perfect financial hedging

may still be offset by indirect hedging through foreign currency assets and liabilities or multinational operations. Yet, the data suggest that Japanese firms do not hedge much overall. A ¥100 FX transaction loss leads to a ¥78 decrease in net income, suggesting that hedging is limited. If firms were hedging perfectly through foreign investments and borrowing or their foreign operations, then a ¥100 FX transaction loss would have no impact on net income. Partial hedging may be due to hedging costs (perhaps both monetary and informational) and financial frictions, unpredictable foreign currency flows, investment opportunities that are correlated with FX gains and losses, or the unwillingness to hedge a risk better left to investors or governments' FX interventions.

The impact of exchange rates extends beyond the firms' bottom line: in Japan, investment significantly decreases following an appreciation of the yen. A 10% appreciation of the yen means a 0.3% drop in the investment rate the following year. This is a large effect: for every ¥100 of FX transaction losses, the average Japanese firm reduces investment by ¥52. A yen appreciation decreases both the cash flows and the investment opportunities of Japanese firms, weakening hedging motives. U.S. firms do not exhibit a similar response to a U.S. dollar appreciation. The investment response suggests that some firms cannot smooth out the negative consequences of a yen appreciation, and thus postpone or cancel investment. The investment response suggests also that an exchange rate appreciation may be interpreted as permanent, in line with the random walk description of exchange rates: in this case, a cut in investment could be due to a decline in the profitability of the future imports or exports. The FX transaction exposure thus acts as a signal that a particular firm is exposed to exchange rates, beyond any working capital concern.

Consistent with our cash flow results, we find that the exposure to currency risk affects stock prices. At the aggregate level, equity returns appear uncorrelated with exchange rate changes in the U.S. and in half of the time in Japan. At the firm-level, FX equity betas are symmetric and rarely significant in the U.S. but they are often significantly negative in Japan. These equity FX betas increase significantly with the absolute values of the FX accounting exposures of Japanese firms. But no similar link exists for U.S. firms. We sort the Japanese firms that report any FX transaction exposure into four portfolios, from low to high exposure levels in absolute values (as a fraction of sales). The FX betas obtained from portfolio-level regressions that control for

aggregate market returns and size and value Fama-French factors increase monotonically across the four portfolios. Intuitively, highly exposed firms suffer — as is apparent in their cash flows — when the yen appreciates, at a time when the aggregate stock market tanks, suggesting that these highly exposed firms are indeed riskier.

Literature Review The paper builds on and contributes to three strands of the literature.

First, a very large literature studies the exchange rate disconnect puzzle. While earlier work, notably by Harberger (1950) and Laursen and Metzler (1950), describe the theoretical link between exchange rates and the rest of the economy, Meese and Rogoff (1983), in a seminal paper (probably the most cited paper in international economics), show that exchange rates appear disconnected from many real macroeconomic variables in developed countries. The puzzle remains to this day, although recent papers successfully link dollar exchange rates to capital flows (Lilley, Maggiori, Neiman and Schreger, forthcoming, Kalemli-Ozcan and Varela, 2019, Camanho, Hau, and Rey, 2021).

Exceptions to the exchange rate disconnect puzzle appear in emerging markets, where very large depreciations have a significant impact on the rest of the economy.[1] Our paper focuses instead on two developed countries, the U.S. and Japan, and their responses to usual exchange rate shocks. The choice of our sample is guided by recent work that shows the prevalence of the U.S. dollar as the invoicing currency (Goldberg and Tille, 2009, Gopinath, 2016, Boz, Gopinath and Plagborg-Moller, 2017, 2019, Gopinath and Stein, 2018, Ito et al., 2018, and Boz et al., 2020).[2] A U.S. firm invoicing in U.S. dollars does not report any FX transaction income, while a Japanese firm does, signaling its potential exposure to currency risk. Among developed economies, empirical evidence of the effect of exchange rates on real variables is scarce: Campa and Goldberg (1995) report the sectoral

[1] A growing literature, from Forbes (2002), Aguiar (2005), Desai, Fritz, and Forbes (2008) to Ranciere, Tornell, and Vamvakidis (2014), Kim, Tesar, and Zhang (2015), Alfaro, Asis, Chari, and Panizza (2017), Ahnert, Forbes, Friedrich, and Reinhardt (2018), Niepmann and Schmidt-Eisenlohr (2019), Kohn, Leibovici, and Szkup (2020), Verner and Gyongyosi (2020), Salomao and Varela (2021), Kalemli-Ozcan, Liu, and Shim (2021) and Keller (2021) study the impact of exchange rates on firms and households. Verner and Gyongyosi (2020) establish a causal impact of exchange rates on Hungarian agents.

[2] Our comparison between Japan and the U.S. echoes the exchange rate pass-through literature that compares the impact of exchange rates on prices across countries, depending notably on the shares of domestic currency invoicing (Gopinath, Itskhoki, and Rigobon, 2010, Devereux, Tomlin and Dong, 2015, and Forbes, Hjortsoe, and Nenova, 2017).

response of investment to exchange rate shocks in four developed countries over the 1970–1990 period, especially in low mark-up sectors; Goldberg (1997) study the investment response in Latin America; Nucci and Pozzolo (2001) report similar results on a sample of Italian manufacturing firms. More recently, Barbiero (2020) uses very detailed data on foreign transactions of French firms to build firm-specific exchange rate shocks and report a small causal impact of exchange rates on investment. We share the same objective, but only rely on publicly available data.

Second, a theoretical and empirical literature studies how firms manage currency risk and respond to its unhedged component. In a frictionless world without taxes, the Modigliani-Miller theorem implies that hedging does not affect the firm's value: in essence, hedging can be left out to investors. In the presence of market imperfections, however, volatility can be costly, and firms may want to hedge their currency risk in the presence of (i) managerial risk aversion (Stulz, 1984) or asymmetric information about managers (Breeden and Viswanathan, 1990); (ii) convex taxes (Smith and Stulz, 1985),; (iii); financial distress costs and debt overhang (Myers, 1977; Smith and Stulz, 1985); and (iv) costly external financing (Froot, Scharfstein, and Stein, 1993, and Rampini and Viswanathan, 2010).

On the empirical front, however, our knowledge of nonfinancial firms' hedging decisions and its impact on investment, profits and production is severely limited by data availability. Nonfinancial firms do not have to report the precise amounts and values of FX derivatives in their balance sheet or income statements. The empirical literature is thus limited and scattered across specific and often hand-collected datasets.[3] Alfaro, Calani, and Varela (2021) is an exception: using Chilean data on trade credit, exports, and FX derivatives, they show that Chilean firms' FX hedging is

[3]Guay and Kothari (2003) hand-collect the notional amounts of each firm's derivatives positions as of December 1997 from their Form 10-K SEC filings (more precisely, the "Footnotes to Financial Statements") and found that, under some assumptions, the estimated amounts of interest rate, currency, and commodity price risks hedged by large firms are modest relative to their sizes. Kim, Mathur and Nam (2006) find evidence of substitutability between operational and financial hedging using a textual analysis of annual reports. Allayannis and Ofek (2001) suggest that operational hedging is not as effective as the use of financial derivatives in mitigating FX risk. Allayannis and Weston (2015) also use the footnotes to the 10-K reports and find that hedging is linked to higher market-to-book ratios. Lyonnet, Martin and Mejean (2016), using survey data on a sample of European exporting firms, find that larger firms are more likely to both invoice exports in a foreign currency and use financial derivatives. Hoberg and Moon (2017), using text-based measures of 10-K filings, find that firms prefer using financial derivatives to hedge when these instruments are more liquid and available. Rampini, Viswanathan, and Vuillemey (2019) focus on financial institutions and the role of financial constraints.

limited, increasing with firm sizes and decreasing with the illiquidity of FX forward contracts. Such a wealth of data is unfortunately not available in many countries. We attempt to circumvent this data barrier by using accounting variables that measure the impact of exchange rates net of financial hedging. Our methodology is easily replicable and can be extended to many countries. All firms following the generally accepted accounting principles (GAAP) report their FX translation risk and FX effect on cash, while all firms following the international financial reporting standards (IFRS) report their FX transaction risk as well.

The part of currency risk that is unhedged may affect corporate investment, labor, and production decisions. Again, data availability constrain the previous literature. While firm-level exports and foreign currency bond issuances are available in some countries, imports and foreign currency investments usually are not available, making the net currency exposure difficult to assess. Most papers thus focus on multinational firms, which are the most likely exposed to currency risk.[4] Instead, we consider both domestic and international firms, and our accounting variables capture the net direct effect of exchange rates. They offer a novel way to focus on firms directly exposed to currency risk and build firm-level exchange rates as instruments.[5]

Third, the paper links the public firms' currency exposure to their equity prices. Inspired by the model of Adler and Dumas (1984), a large literature reports the challenges of measuring currency risk in stock returns.[6] Dominguez and Tesar (2006) find some currency risk in equity returns in a larger sample of eight developed countries. He and Ng (1998) report exchange rate risk in Japanese

[4]Goldberg and Kolstad (1994) investigate the effect of exchange rate variability on the location choices of multinational firms. They find that the share of production overseas correlates positively with exchange rate volatility. Bernard, Jensen and Schott (2009) show that multinational firms and exporters tend to be larger and more productive, employ more workers, and sell more products than firms that sell only domestically. Taylor, Wang and Xu (2020), using fixed to floating exchange rate regime change and downgrades of sovereign debts, find that greater volatility in currency markets reduces firms' capital expenditures.

[5]Firm-level exchange rates, built from trade data, are used as instruments in the international trade literature. Maurin, Thesmar, and Thoenig (2003), using French exports, builds firm-level exchange rates to study the demand for skill labor. Our instruments are obtained from accounting instead of trade data.

[6]See, among others, Jorion (1990), Bodnar and Gentry (1993), Amihud (1994), Bartov and Bodnar (1994), Sercu and Uppal (1995), He and Ng (1998), Bodnar and Wong (2000), Griffin and Stulz (2001), Williamson (2001), Bodnar, Dumas, and Marston (2002), Doukas (2003), and Bartram, Brown, and Minton (2010). Most of these papers focus on the U.S. stock market. Dominguez (1998) reports exchange rate risk in Japanese firm's equity returns in the energy and utilities sector and among medium and large industrial firms. But other papers study multinational firms, notably Denis, Denis, and Yost (2002), Desai, Foley, and Hines (2008), Baker, Foley, and Wurgler (2009), and Fillat and Garetto (2015).

firm's stock returns and link it to their exports. None of these papers use the accounting variables that we focus on. A few papers in the accounting literature discuss the economic interpretation of these variables (notably Soo and Soo, 1994, White, Sondi, and Fried, 2001, and Louis, 2003). Bartov and Bodnar (1994) is, to our knowledge, the only paper that uses these accounting variables to study exchange rate risk in equity returns; their sample, however, focuses on the U.S., where currency risk appears very limited. By contrasting the U.S. with Japan, we show that the FX transaction and translation adjustments significantly signal currency risk in equity returns.

The rest of this paper is organized as follows. Section 2 presents a toy model to frame our empirical work and highlight the endogenous aspect of currency hedging and thus currency exposure. Section 3 describes the impact of exchange rates in accounting statements, both in theory and in our data. Section 4 shows that exchange rates affect firms' FX accounting exposures, net income, and investment. Section 5 focuses on the cost of capital as measured through stock returns. Section 6 concludes. A separate Appendix describes the data sources, some accounting examples, and multiple robustness checks.

2 Toy Model

This section describes a partial-equilibrium, static model that illustrates our empirical work. In the model, exchange rates, wages, and interest rates are exogenous. There is no capital, only labor.

Every period, the firm exports a net quantity $Y_t = AL_t^{\alpha}$, at a unit price p_t (in domestic currency), produced with labor L_t, hired at the exogenous rate w_t. The firm sells at date t in foreign currency and receives the payment in foreign currency at date $t+1$. Let S_t denote the spot exchange rate that is expressed in foreign currency per unit of domestic currency: if S_t increases, the domestic currency appreciates. Since the exports are invoiced in foreign currency, the firm sells its output for $p_t S_t A L_t^{\alpha}$ units of foreign currency. At date $t+1$, the firm receives $p_t S_t Y_t / S_{t+1}$ units of domestic currency. If the foreign currency appreciates between date t and $t+1$, the firm's revenue in domestic currency appreciates.[7]

[7] Trade financing takes three main forms: (i) cash in advance terms require the importer to pay before goods are

Every period, the firm chooses how much labor to hire and how much exchange rate risk to hedge with forward contracts. We assume that the firm is risk-averse, with parameter η. The risk aversion may come from financial constraints (see Froot, Scharfstein, and Stein, 1993) or bankruptcy deadweight costs. These deeper motivations are left unspecified in this reduced-form model where the firm simply maximizes its expected profit and minimizes the variance of its profit due to exchange rate changes.

Many strategic choices and frictions are left out of the model, notably the choice between domestic vs. foreign sales, the organization of the firm (as a multinational vs. a domestic firm), its production function (import of intermediate inputs), the length of the payment delays, and some potential menu costs that prevent the unit price to adjust. All these additional choices and frictions are relevant, but we focus on the most simple framework possible for exchange rate transaction risk.

Let λ_t denote the share of exports in foreign currency that the firm choses to hedge at the forward rate F_t (also expressed in foreign currency per unit of domestic currency). The covered interest rate parity (CIP) implies $S_t/F_t = (1+i)/(1+i^\star)$, where i denotes the risk-free domestic interest rate, and $i^\star$ the foreign one. The maximization problem of the firm is thus:

$$\text{Max}_{\lambda_t, L_t} \ (1-\lambda_t) E_t \left(\frac{p_t S_t A L_t^\alpha}{S_{t+1}} \right) + \lambda_t \frac{p_t S_t A L_t^\alpha}{F_t} - \frac{\eta}{2} p_t A L_t^\alpha Var_t \left[(1-\lambda_t) \frac{S_t}{S_{t+1}} \right] - w_t L_t \qquad (1)$$

shipped and the title is transferred, (ii) open-account terms allow a customer to delay payment after the receipt of the goods, and (iii) letters of credit where banks commits to paying on behalf of the importers, most often following the receipt of the goods. Except with cash in advance terms, currency risk exists in all these transactions because exchange rates may move between the decision to import or export and the corresponding payment. In a study of a U.S.-based firm that exports frozen and refrigerated food products, primarily poultry, **?** find that cash in advance and open account terms dominate, representing respectively 42 percent and 41 percent of the transaction values. A few recent papers, however, using detailed data on payment terms that cover all transactions of individual countries, report that open account (or trade credit) is by far the most prominent payment form, typically representing 80-90 percent of trade. Niepmann and Schmidt-Eisenlohr (2017) report that about 15 percent of world trade use letters of credit or document collections. Cash in advance in contrast is now used much less frequently — e.g. only 9 percent of Chilean exports use cash in advance (Garcia Marin et. al, 2020). Demir and Javorcik (2018) document that about 80 percent of Turkish exports use open account, while Ahn (2020) reports similar numbers for Chile and Colombia.

The first-order conditions are then:

$$[(1-\lambda_t^\star)E_t\left(S_t/S_{t+1}\right)+\lambda_t^\star S_t/F_t] \quad \alpha \quad Y_t^\star/L_t^\star-\eta\alpha(1-\lambda_t^\star)^2 Var_t(S_t/S_{t+1})Y_t^\star/L_t^\star=w_t/p_t \tag{2}$$

$$1-\lambda_t^\star = \frac{E_t\left(S_t/S_{t+1}\right)-S_t/F_t}{\eta Var_t(S_t/S_{t+1})} \tag{3}$$

As noted, the firm's problem is clearly static. For simplicity, let us assume that the wage w, domestic and foreign risk-free rates are constant (thus the ratio S/F is also constant if the covered interest rate parity holds). We can the drop the t subscript everywhere and denote S and S' the exchange rate in the present and next period. The optimal labor $L^\star$ and hedging share hedging $\lambda^\star$ are:

$$\frac{S}{F}\frac{\alpha Y^\star}{L^\star} = \frac{w}{p} \tag{4}$$

$$1-\lambda^\star = \frac{E(S/S')-S/F}{\eta\sigma^2} \tag{5}$$

The optimal labor choice is governed by the real wage and a wedge driven by the domestic and foreign interest rates. The optimal hedging choice is governed by the expected currency excess return, the managers' risk-aversion and the expected variance of the exchange rate, σ^2. The firm hedges less (lower $\lambda^\star$) if (i) it foresees an appreciation of the foreign currency (S' decreases); (ii) it is less risk-averse (lower η); (iii) the exchange rate is less volatile (lower σ^2). If, for example, the exchange rate is a random walk, $E(S')=S$, and the domestic and foreign interest rates are equal, $F=S$, then $\lambda^\star=1$: the firm fully hedges and the next period exchange rate S' does not affect its profits.

After choosing its optimal production and hedging policy, the firm is exposed to exchange rate risk on the part of its sales that it does not hedge. Let $FX_{t,t+1}^{exposure}/p_tY_t$ denote the firm's ex-post exposure to exchange rate fluctuations, as a percentage of its sales:

$$FX_{t,t+1}^{exposure}/p_tY_t=(1-\lambda^\star)\underbrace{\frac{S_t-S_{t+1}}{S_{t+1}}}_{\text{without hedging}}+\lambda^\star\underbrace{\frac{S_t-F_t}{F_t}}_{\text{with hedging}} \tag{6}$$

The firm invoices for $p_t S_t Y_t$ units of foreign currency. On the share of its sales that are not hedged, the firm actually receives $p_t S_t Y_t / S_{t+1}$ units of domestic currency. On the rest, the firm receives receives $p_t S_t Y_t / F_t$ units of the domestic currency. These two settlements need to be compared to the initial invoice to obtain the exchange rate transaction gain or loss. If the firm hedges two-thirds of its sales ($\lambda = 2/3$), a 10% appreciation of the foreign currency leads to a 3.3% exchange rate transaction gain.

This toy model focuses on the exchange rate transaction risk that occurs as soon as (i) the firm invoices in foreign currency, and (ii) there is a delay of payment between the invoice and settlement dates. This is not the only source of exchange rate risk for firms. Exchange rate shocks may impact firms' profits, even in the absence of payment delays. In the presence of price stickiness, if a Japanese firm, with production costs in yen, invoices its exports in U.S. dollars, a depreciation of the U.S. dollar imply lower revenues in yen for the Japanese firm. If prices are flexible, that firm may choose to increase its prices in U.S. dollars but at the cost of a potentially lower demand. The accounting measure of transaction risk is a signal that exchange rates may matter for the firm.

This signal, however, is not perfect and misses potential exchange rate effects. If a firm invoices its international trade in its own functional currency, no exchange rate transaction risk exists. Yet, the same firm may suffer or benefit from currency fluctuations. In fact, exchange rates may affect purely domestic firms that do not trade internationally, because the exchange rate shocks impact their foreign competitors. An appreciation of the U.S. dollar, for example, makes Japanese goods invoiced in yen cheaper for U.S. buyers, thus potentially weakening the demand for a U.S. firm producing the same good as a Japanese firm. The utility producer that sells electricity to the U.S. firm may then suffer from a lower demand following an appreciation of the U.S. dollar, even if that utility's production costs are all in U.S. dollars. This paper does not bring any new evidence on these channels; we focus instead of firms directly affected by currency fluctuations in their income, balance sheet, and cash flow statements.

3 Exchange Rate Effects in Accounting Statements

Exchange rates affect accounting statements because firms need to report their activity in a single currency. To do so, every firm must first determine its functional currency: it is the currency of the primary economic environment in which the firm operates. All the firm's activities need then to be reported in that functional currency. Yet, firms sometimes transact in a different currency or own subsidiaries that report in a different currency. When the proceeds of such transactions or investments cannot be immediately converted in the firm's functional currency, some accounting adjustments are necessary. We review below these adjustments, starting with the transaction risk in the income statement.

3.1 FX transaction risk

As already noted, FX transaction risk arises from variations in the exchange rate between the time a transaction denominated in a foreign currency is recorded and the time it is settled. Such a delay may occur when a firm buys or sells goods (impacting the accounts payables or accounts receivables), but also when it borrows or lends in a foreign currency.

Let us consider the simple example of a Japanese firms that sells in U.S. dollars.[8] The firm sells on May 1st its product for \$1M (at a time when \$1 is worth ¥105) and receives the payment three months later on August 1st (at a time when \$1 is worth ¥95). At the end of June, when \$1 is worth ¥100, the firm publishes its quarterly accounting report. At that point, the firm records an FX transaction exposure of $(100 - 105) \times \$1M = -¥5M$. On August 1st, at the time of settlement, the FX transaction exposure is an additional $-¥5M$. The annual FX transaction exposure is thus $(95 - 105) \times \$1M = -¥10M$. In this example, the firm invoices in U.S. dollars but functions in yen; when the U.S. dollar is worth less yen at the settlement date than at the time of the sale (i.e., the U.S. dollar depreciated and the yen appreciated), the firm books a loss. As this example shows, both realized and unrealized exchange rate gains and losses are reported in the income statement.

The firm may decide to hedge partially or completely its exchange rate exposure, and the

[8] Appendix (A) provides a thorough description of the accounting treatment of this example.

income statement only reports the impact of exchange rates after hedging. Let us pursue the example above and assume that the firm signs on May 1st a three-month FX forward contract: according to this contract, the firm will be able to convert its U.S. dollars into yen three months later, on August 1st, at the forward rate of ¥103 per U.S. dollar. On June 31st, the firm needs to report its exchange rate exposure in its quarterly report. At that point the forward contract that expires on August 1st trades at a forward rate of ¥98 per U.S. dollar. Assuming a 6% discount rate to account for the time value of money between June 31st and August 1st (i.e., one moth), the firm the books a gain of $(103 - 98) \times \$1,000,000 \times (1.06)^{-\frac{1}{12}} = ¥4,976M$. The total FX transaction exposure is then only $-5M + 4,976M = -¥0,024M$ — a small loss compared to the $¥5M$ loss in the absence of hedging. On August 1st, when the forward rate is then ¥95 per U.S. dollar, the firm books a second hedging gain of $(103 - 95) \times \$1M - 4,976M = ¥3,024M$ and a total FX transaction exposure of $-5M + 3,024M = -¥1.976M$. Overall, the economic loss corresponds to the difference between the spot rate (that the firm used to invoice) and the forward rate that it actually receives. The loss is thus only $(103 - 105) \times \$1M = -¥2M$. One can easily check that it is the sum of the two FX transaction exposures recorded ($¥0,024M + ¥1.976M = ¥2M$).

The transaction risk is not about the level of exchange rate per se, but how much exchange rates change between the transaction and payment dates. It only exists if transactions are in a foreign currency and not settled immediately or if a firm invests or borrows in a foreign currency, and if the resulting currency risk is not perfectly hedged. Let us turn now to an exchange rate valuation effect.

3.2 FX translation risk

Translation risk arises from the need of a parent company to report consolidated financial accounts in a single currency for the whole group, including its subsidiaries. To do so, the foreign subsidiaries' accounts must be translated into the parent's functional currency. During the consolidation process, the equity component of the balance sheet is always translated at the historical rate, i.e., the spot rate at the time equity capital was injected (excluding retained earnings). But other accounts,

including assets and liabilities, are translated either at the historical or at the current exchange rate, i.e., the spot rate at the time the balance sheet is consolidated. Revenue and expense accounts should be translated using the spot rate at the time each transaction took place; in practice, firms tend to use the average exchange rate over the reporting period. The foreign currency translation adjustment then results from the need to balance all the accounts on the consolidated statements after they have been translated using different exchange rates. This is a complex accounting process and we leave a detailed quantitative example for the Appendix (B).

Instead, let us summarize it through a simple formula, for example in the case of a U.S. firm with a European subsidiary. Denote K the capital stock, NI the net income, Div the total dividends paid, and S the exchange rate. In this case, the translation adjustment is equal to

$$\begin{aligned} \text{Translation Adj.} &= K_{€} \times \left(S_{\text{at the reporting date}} - S_{\text{at stock issuance}} \right) \\ &+ NI_{€} \times \left(S_{\text{at the reporting date}} - S_{\text{average exchange rate over the reporting period}} \right) \\ &+ Div_{€} \times \left(S_{\text{at the dividends declaration date}} - S_{\text{at the reporting date}} \right) \end{aligned} \tag{7}$$

Three effects appear in Equation (7) on capital stock, net income, and dividends:

1. The first effect pertains to the capital stock of the subsidiary and potentially long-term exchange rate changes. There is a positive translation adjustment if the exchange rate at the reporting date is above the exchange rate at stock issuance. In other words, if the euro has appreciated since the European subsidiary was created, the translation adjustment measures a potential investment gain: the U.S. firm invested in euros, and those euros appreciated. This first term could thus capture long-term changes in exchange rates.

2. The second and third terms pertain to flow variables, net income and dividends, and to short-run variations in exchange rates. Let us start with net income. The average exchange rate is used to convert in U.S. dollars the net income of the subsidiary. Yet, intuitively, the wealth created by the subsidiary is only captured in the parent company's accounts at the end of the reporting period, and should thus be converted in U.S. dollars using the end of

period exchange rate. If the euro appreciated against the U.S. dollar (with its value at the end of the year above its average that year), the enterprise's value receives an additional boost.

3. Let us now focus on dividends. If they were actually paid to the parent firm before the reporting date and if the exchange rate changed since that time, an adjustment is necessary. Assume again for example that the euro appreciated since the dividend payments, then the U.S. firm would have rather received those payments at the reporting date instead of earlier. But because the U.S. firm actually received the payments before that, it has to log a loss. This effect comes from the difference between the exchange rate when dividends are declared and the exchange rate at the reporting date.

Translation risk is thus specific to firms that own subsidiaries or other associate companies that operate in a foreign currency.[9] In our analysis, we use both the within period flow of translation adjustment (recorded in "other comprehensive income"), as well as the cumulative balance of past translated adjustments (recorded in the shareholders' equity section of the balance sheet). We turn now to the cash flow statements.

3.3 FX effect on cash

The cash flow statement includes two exchange rate entries. The first one keeps track of the FX transaction adjustments that induce actual cash flows. The second one reports the FX effect on cash, an adjustment needed to consolidate the statements of cash flows of foreign subsidiaries. We describe briefly this second entry, leaving the accounting presentation in Appendix (C).

The FX effect on cash exists because the consolidated cash flows must be reported in the parent firm's functional currency and various cash flows are reported at different exchange rates. The FX

[9]Translation risk may or may not be large in multinationals. It is inexistent if subsidiaries use the same functional currency as the parent company. Many multinationals avoided to repatriate their earnings before the recent tax law (to avoid paying taxes on U.S. dividends). In the absence of drift in exchange rates, no translation adjustment comes from the value of the subsidiary's equity. But if the current spot exchange rate is above the average that year and the subsidiary has positive retained earnings, then translation effect is positive: the parent company enjoys the fact that its subsidiary is keeping some money in foreign currency whose value in dollars increases.

effect on cash ensures that the sum of all cash flows corresponds to the change in the consolidated cash balances at the beginning and end of the period, which are translated at their respective reporting dates in the balance sheet.

Let us continue our example of a U.S. firm with a European subsidiary. We denote C the cash amount of the subsidiary, NI its net income, Dep its depreciation, $CFFin$ and $CFInv$ its cash flows from financing and investing, and S the exchange rate. The FX Effect on Cash is then

$$\begin{aligned}
\text{FX Effect} \quad \text{on} \quad & \text{Cash}_{t+1} = \text{Cash}_{€,t} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the reporting date},t}) \\
+ \quad & (\text{NI}_{€,t+1} + \text{Dep}_{€,t+1}) \times (S_{\text{at the reporting date},t+1} - S_{\text{average over the reporting period},t+1}) \\
+ \quad & \text{CFFin}_{€,t+1} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the financing date},t+1}) \\
+ \quad & \text{CFInv}_{€,t+1} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the investment date},t+1}). \qquad (8)
\end{aligned}$$

Three effects drive the FX Effect on Cash: (i) a re-evaluation of the beginning-of-period cash, (ii) a valuation effect on net income and depreciation, and (iii) a valuation effect on cash flows from financing and investment activities.

In this paper, we use the three different FX exposure measures review above in the U.S. and in Japan as conditioning variables to study the impact of exchange rates on firm profits, investment, and stock prices. Using annual reports of a Japanese company, Nintendo Co., Figure (1) presents an example of the FX transaction, FX translation and FX effects on cash, along with the change in exchange rates. An increase of the exchange rate corresponds to an appreciation of the yen (the domestic currency for a Japanese firm).

Clearly, when the yen appreciates, Nintendo records some large FX transaction losses. For example, in 2016, its FX transaction risk (as a fraction of sales) is $-\$162m/\$4,664m = -3.4\%$, and $-162/146 = -110.1\%$ as a fraction of net income. In the same year, its FX translation adjustment as fraction of sales is $-136/4,664 = -2.9\%$, the FX effect on Cash, also as a fraction of sales is $-34/4,664 = -0.7\%$. To go beyond a simple example, we turn to a large dataset.

3.4 Data

Corporate finance data come from Compustat for the U.S. and Toyo Keizai for Japan. Stock returns come from CRSP and Datastream. The samples contain only publicly listed firms for which we have both stock returns and financial statements. Appendix (D) describes the data and the sample selection in details. It also reports summary statistics, including the percentiles of the distribution of all the variables used in the paper.

Summary statistics immediately highlight the contrast between the U.S. and Japan. Among the firms reporting any FX transaction risk (including 0), half of the Japanese FX transaction observations imply a risk of more than 6% of the firm's net income. And one-fourth of the same observations imply a risk of more than 17% of the firm's net income. Among all the Japanese public firm-year data, approximately one-fourth of the FX transaction observations imply a risk of more than 6% of the firm's net income. The U.S. counterparts suggest a much smaller role for currency risk. Among the U.S. firms reporting any FX transaction risk (including 0), three-quarters of the observations imply a risk of less than 6% of the firm's net income. And only 1/10 of the same observations imply a risk of more than 15.7% of the firm's net income. Among all the U.S. public firm-year data, 90% of the observations imply a risk of less than 1.5% of the firm's net income. Clearly, exchange rates matter for Japanese firms, but much less for U.S. firms.

By definition, FX translation risk appears only for multinationals and is absent from domestic firms. FX transaction risk appears more likely in multinationals than in domestic firms, and increases with firm sizes and exports. FX transaction risk is also present among U.S. and Japanese firms that do *not* have exports: the exchange rate exposure must then come from investing and borrowing in a foreign currency, or imports invoiced in a foreign currency. While Compustat offers a measure of exports at the firm level, it does not report imports at the firm level. The FX exposure measure thus highlights a set of firms that is usually ignored.

The three FX exposures, scaled by sales, appear persistent over time, especially in absolute values. In panel regressions with time and firm fixed effects, the persistence coefficient is around 0.1 for the three measures.

To study the response of U.S. firms to currency shocks, our exchange rate index is the major dollar index published by the Federal Reserve Board. The exchange rate index is expressed in foreign currency per U.S. dollar: an increase in the index thus corresponds to an appreciation of the U.S. dollar. To study the response of Japanese firms to currency shocks, we use the daily effective exchange rate for Japan published by the Bank of International Settlements (BIS), expressed in foreign currency per yen. An increase in the index corresponds to an appreciation of the yen. We now turn to the empirical link between exchange rates and the FX exposure variables.

4 Exchange Rate Risk and Firms' Profits and Investment

We first report the correlations between changes in exchange rates and firm-level foreign currency exposures, and then turn to the causal impact of exchange rate changes on net income and investment.

4.1 The Determinants of FX Exposure

Table (1) presents the results of the following regressions:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction risk (scaled by sales or by net income), Δs_t denotes the yearly change of the yen index (a positive change indicates a yen appreciation) in columns (1) to (4) or the yearly change in the U.S. dollar index in columns (5) to (8), where a positive change indicates a dollar appreciation. All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well

as the contemporaneous growth rates of GDP, net exports and investment, and the exchange rate volatility (obtained as the yearly standard deviation of daily percentage returns). All variables are expressed in percentages except the change in exchange rate, which is in basis points to improve the readability of the slope coefficient. The data are annual and the estimation period is 1990–2017 for both countries. Figure 2 presents the estimation results of these regressions through bin scatter plots of firm-year observations sorted by exposure for Japan (upper panel) and the U.S (lower panel). In both cases, an appreciation of the home currency corresponds to FX transaction losses, but the slope is much steeper for Japan than the U.S.

In Japan, the FX transaction amounts appear significantly related to the changes in exchange rates: a 10% appreciation of the yen (close to the annual standard deviation) corresponds to a 0.1% loss of FX transaction income expressed as a fraction of total sales. As a fraction of net income, a 10% appreciation of the yen corresponds to a 3.6% loss of FX transaction income. We consider that a firm is exposed to currency risk as soon as it reports some non-zero FX transaction exposure; once a firm enters the sample of exposed firms, it remains there for the reminder of the time period, irrespective of whether it reports some non-zero exposure or not. Focusing on the sample of exposed firms, we find — unsurprisingly — an even stronger link between FX transaction exposures and exchange rate changes: in that sample, a 10% appreciation of the yen corresponds to a 0.2% (5.6%) loss of FX transaction income expressed as a fraction of total sales (net income). On average, Japanese firms are adversely affected by an appreciation in the Yen relative to currencies of its major trading partners.

In the U.S., a 10% appreciation of the U.S. corresponds to a 0.01% loss of FX transaction income expressed as a fraction of total sales: the effect is ten times smaller than in Japan. This difference between Japan and the U.S. can be due to U.S. firms hedging more than Japanese firms, or being less exposed to currency risk as they invoice more in their functional currency (**?**, **?**).

4.2 The Effects of FX Exposure on Profits and Investment

To estimate the impact of exchange rate changes on net income and investment, we use the accounting FX exposures as instruments. We thus implement the following two stages. The first stage is a set of firm-level regressions:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction, translation, or FX effect on cash (all scaled by sales), Δs_t denotes the change in the yen or U.S. dollar index. The firm-level ($\Lambda_{i,t}$) and country-level (Γ_t) controls are the same as in the previous section. But the regression is now run firm by firm, in order to recover a firm-specific loading ($\delta_{2,i}$) on the exchange rate. The second stage uses the projection of exchange rates on the FX exposure, $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, as an independent variable:

$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + Ind_{i,t} + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2 \Lambda_{i,t} + \epsilon_{i,t},$$

where $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the net income (defined as after tax profits, scaled by assets or sales), or the net cash flows (scaled by assets), or next period's investment (defined as the change in the stock of PPE plus the depreciation, scaled by lagged PPE). Since the impact of exchange rates is now firm-specific, the second stage includes time (σ_t) and firm (ν_i) fixed effects, as well as time $\times$ industry fixed effects ($Ind_{i,t}$). Intuitively, we compare firms with high vs low FX exposure, in the U.S. vs Japan. Table 2 reports the results.

The Appendix presents the distribution of the first-stage slope coefficients and their t-statistics. Among Japanese firms, the distribution of the firm-specific first-stage loadings ($\delta_{1,i}$) is skewed to the left and a majority of the $\delta_{1,i}$s are negative, indicating that an appreciation of the yen on average correlates with FX transaction losses. A similar pattern emerges with the other measures of FX exposure, based on the balance sheet and cash flow statement. Among U.S. firms, the distribution of first-stage loadings $\delta_{1,i}$ is roughly centered around zero. — This is consistent with the evidence presented in Table 1 and Figure 2 that report a larger effect of exchange rates on

firms' income in Japan than in the U.S.

We find that exchange rates significantly affect net income (either scaled by assets or sales) in Japan, but not in the U.S. The pass-through in Japan is large: for every ¥100 of FX transaction loss, the net income is reduced by ¥78. The equivalent metric is 23 cents per dollar in the U.S., but this pass-through is not statistically significant. The impact on investment is also large and significant in Japan, but inexistent in the U.S. In Japan, for every ¥100 of FX transaction loss, the investment drops by ¥88. This investment repose is larger than the one reported by Rauh (2016), who finds that investment decreases by 60 to 70 cents for every $1 shock. The investment response that we measure goes beyond a simple cash flow sensitivity effect, thus making causal inference challenging.

We like to interpret the above evidence as causal, but let us discuss the potential identification issues. Again, when the yen appreciates, the average Japanese firm incurs large FX transaction losses and a decrease of its profit margin and investment. These results pertain to the whole universe of firms, thus alleviating the concerns on external validity. At the firm level, reverse causality does not seem an issue: all firms take the exchange rates as given, and no single firm is large enough to affect it. But could something else be decreasing the profit margin at the same time? As the toy model illustrated, the decision to sell in foreign currency and not hedge (or partially) is endogenous. In the toy model, it depends on the managers risk-aversion, interest rates, exchange rate's expectations and variance. In a richer model, it would depend on productivity, elasticity of demand, etc. If any of these drivers of the hedging decision also drives profits and investment and is not captured by our large set of firm-level and country-level controls, then a potential omitted variable exists. For example, if a manager is always less risk-averse than its peers, she hedges less: the firm records large FX exposures and shows up as a high $\delta_{1,i}$-firm. Although we have no precise mechanism in mind, the same low risk-aversion may lead to low profits. As long as the managers' characteristic is not time-varying, the firm fixed effects in the regressions should capture that potential omitted characteristic. A danger for our identification would be a manager that is less risk-averse than others in a particular year (thus hedging less and recording less profits), and (for some reasons) the yen appreciates that year. To completely fool

our estimation, this mechanism should be present in Japan but not in the U.S. We are not aware of any model that would deliver that behavior, but we do not rule it out. Our identification relies on the presence of firm-specific exchange rate shocks, obtained after controlling for country-level variables. These firm-specific exchange rate shocks allow us to control for both time and firm fixed effects. Placebo experiments (focusing on the investment response one year before the shocks, or using a random variable instead of exchange rate changes) do not produce any significant results.

Although at odds with the exchange rate disconnect literature, the impact of exchange rates on firms' profits is intuitive: it simply means that firms do not fully hedge their exchange rate risk. Partial hedging may be due to the hedging costs, the difficulty to hedge unpredictable cash flows, or the pursuit of currency carry trade returns. It may also be that it is optimal to let investors hedge currency risk, especially if such risk does not affect the investment policy of the firm.

The impact of exchange rates on investment suggests that exchange rates matter beyond the simple payment delays. Assuming that the exchange rate shock is temporary, when the FX transaction loss occurs, an unconstrained firm may just smooth it out by borrowing. A financially-constrained firm, however, may need to reduce its expenses, and thus postpone investment. An exchange rate shock may also be seen as permanent (in line with a random walk assumption on exchange rate, $E_t(s_{t+1}) = s_t$). This permanent shock might lead to a cut in investment because the profitability of exports or imports has been impaired. If export prices are set in U.S. dollars and cannot be adjusted (because of competition pressures), then an appreciation of the yen (i.e., a dollar depreciation) may render the business less profitable, leading to an investment reduction. In this case, the impact of exchange rates on the firm's activities is no longer limited to its working capital channel.

This section shows that exchange rates significantly impact the firm's net income and investment in Japan but not in the U.S. An appreciation of the yen significantly decrease the firms' after-tax profits and investment. Since an appreciation of the yen clearly constitutes bad news for Japanese firms, we now test whether this effect is priced in equity markets.

5 FX Exposure and Firms' Values

This section starts with the study of U.S. and Japanese aggregate equity returns before turning to firm-level returns.

5.1 Aggregate Currency Betas

We consider weekly returns, as often done in the financial management industry, to minimize the timing mismatch between equity and currency time stamps.[10] The U.S. aggregate equity returns summarize the AMEX, NASDAQ, NYSE, and ARCA markets.

Figure 3 presents yearly exchange rate betas for the U.S. aggregate equity market obtained from the following regressions:

$$R^M_{t+h} = \alpha_t + \beta^{FX}_t \Delta s_{t+h} + \epsilon_{t+h}, \tag{9}$$

where $h = 1, \ldots, 52$, R^M_{t+h} is the weekly aggregate stock market return and $Deltas_{t+h}$ is the weekly return on the U.S. dollar foreign exchange index, both in year t and week h. The exchange rate betas, β^{FX}_t, are estimated year by year. A positive beta in year t means that the U.S. aggregate equity index tends to increase when the U.S. dollar appreciates that year. Likewise, we obtain currency betas for the Japanese aggregate stock market by regressing weekly return on the Japanese MSCI equity index on weekly changes in the BIS trade-weighted yen index. A positive beta in year t means that the Japanese aggregate equity index tends to increase when the yen appreciates that year against a basket of foreign currencies. The sample period runs from 1/1/1975 to 12/31/2019 for the U.S. and from 1/1/1983 to 12/31/2019 for Japan. The standard errors are estimated by bootstrapping with replacement 1,000 times under the assumption that returns are *i.i.d.* The gray areas around the point estimates correspond to the 95% confidence intervals. We

[10] The U.S. exchange rate series are provided by the Federal Reserve Bank of New York and correspond to buying rates at noon (local time) each day. Stock market returns are measured from close to close each day (usually 4pm local time in the U.S. and 3pm local time in Japan). The yen index is provided by the Bank of International Settlements (BIS) and built for the recent period from the bilateral exchange rates measured by the European Central Bank (ECB) at 1:15pm GMT (10:15pm in Japan).

obtain similar standard errors when considering the heteroskedasticity and autocorrelation of the residuals, following **?**, with the optimal number of lags described in **?**.

Over most of the 1975–2019 sample, with the exception of the 2007–2013 period, the U.S. exchange rate betas are not significantly different from zero. In the first half of the Japanese sample period, from 1983 to 2005, Japanese aggregate exchange rate betas are not significantly different from zero either. After 2006 though, the Japanese aggregate exchange rate betas turn and remain significantly negative, showing that the value of the Japanese aggregate stock market tends to decrease when the yen appreciates.

Overall, the aggregate stock indices suggest that exchange rates have little impact on aggregate returns in the U.S. This could be because (i) U.S. firms are not exposed to currency risk, (ii) they hedge their currency exposure, (iii) positive and negative exposures cancel out, or (iv) exchange rate risk is not priced in equity returns. The Japanese evidence suggests that, at least since 2006, exchange rate risk is priced in Japanese equity markets, Japanese firms are exposed to that risk, and positive and negative exposures do not cancel out at the aggregate level. To better understand the price of currency risk, we turn now to firm-level betas.

5.2 Firm-level Currency Betas

At the firm level, currency betas are obtained as:

$$R_{i,t+h} = \alpha_{i,t} + \beta_{i,t}^{FX} \Delta s_{t+h} + \beta_{i,t}^{M} R_{t+h}^{M} + \beta_{i,t}^{SMB} SMB_{t+h} + \beta_{i,t}^{HML} HML_{t+h} + \epsilon_{i,t+h}, \tag{10}$$

where $h = 1, \ldots, 52$, $R_{i,t+h}$ is the weekly stock return on firm i in year t and week h, Δs_{t+h} is the weekly change in exchange rate, and SMB_{t+h} and HML_{t+h} are the size and value return factors of **?**. Firm-level stock returns come from CRSP for the U.S. and Datastream for Japan. To later match the currency betas to financial characteristics of the firms, the currency betas are estimated over the same reporting period as the financial variables, using the end of the fiscal year for each firm. The initial sample contains 26,996 unique firms, as identified by their PERMCO number, over the 1976–2019 period. Currency betas for Japanese firms are obtained similarly, replacing the U.S.

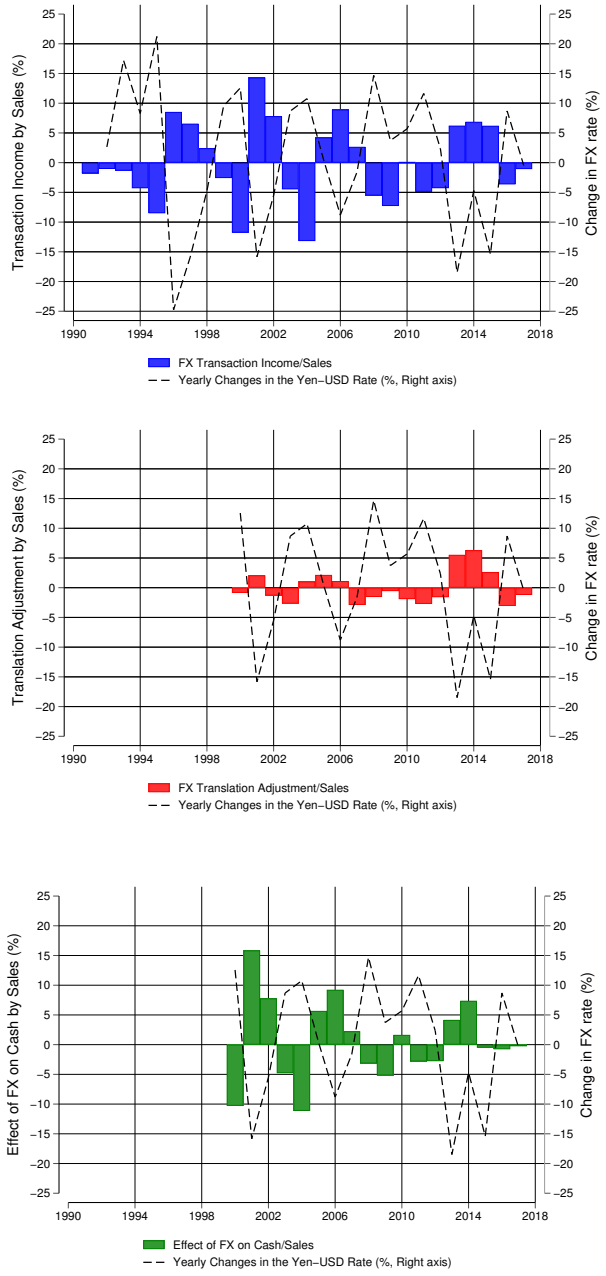
dollar index with the yen index, and expressing all control variables in yen. Japanese stock returns come from Datastream. Figure 4 reports the histograms of the currency betas and t-statistics. The vertical dotted lines for t-statistics denote the -1.96 and 1.96 cutoffs values corresponding to 95% confidence intervals.

U.S. firm-level betas exhibit two clear features: (i) most of them are small and insignificant, (ii) the distribution of betas appear broadly symmetric with positive exposures balancing negative ones. These two features are consistent with the absence of aggregate exposure noted on Figure 3. Japanese firm-level betas appear different: (i) a large fraction of the betas is statistically significant, and (ii) their distribution is clearly asymmetric: the vast majority of Japanese firms exhibit negative betas and a large proportion of the betas are significantly negative, i.e. their stock prices decline when the yen appreciates against foreign currencies. Tables 4 and 5 show that the firm-level betas of Japanese firms increase significantly with their FX exposures, while the firm-level betas of U.S. firms do not. Figure 5 shows that, in Japan, high FX-exposure firms exhibit high FX betas.

6 Conclusion

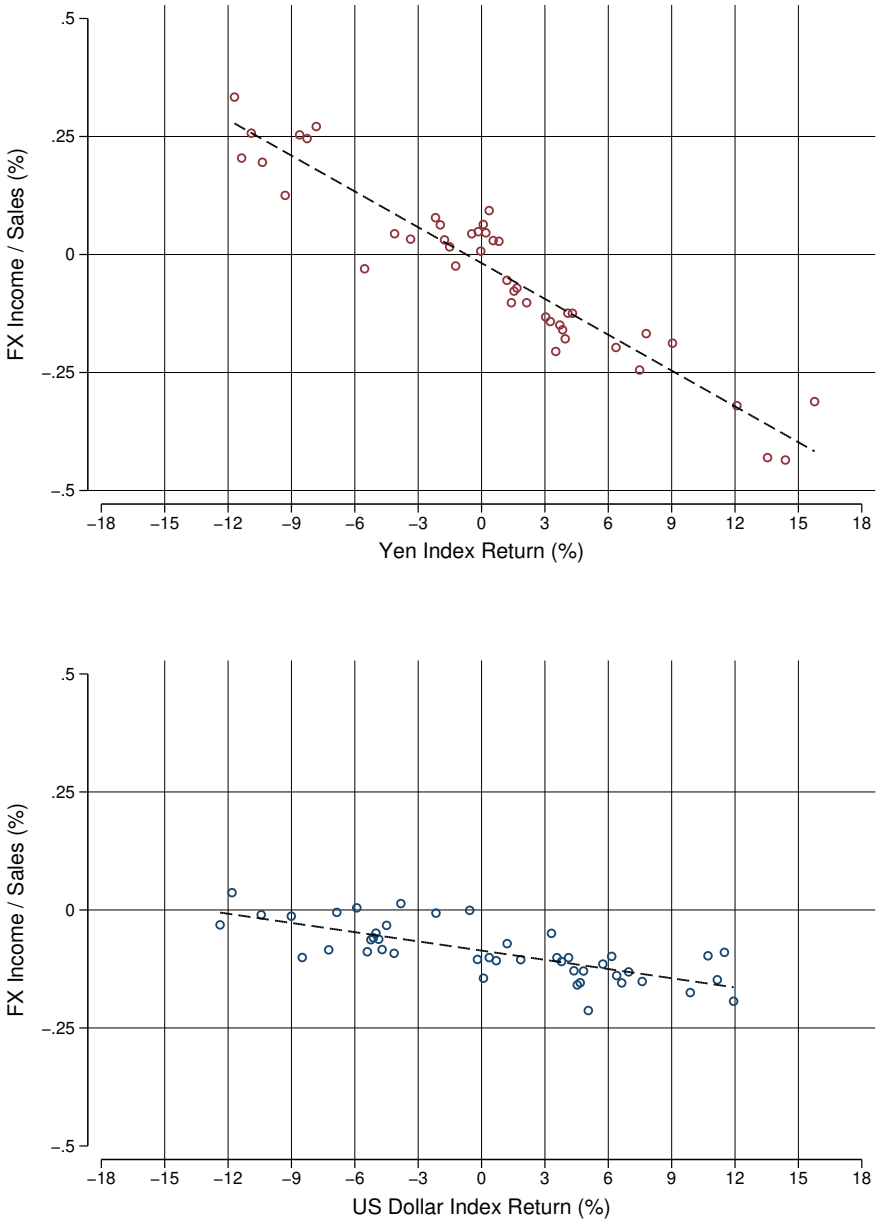
Firms have to report the direct impact of exchange rates on their balance sheet, income, and cash flow statements. Since FX transaction exposure is recorded net of exchange rate derivatives that hedge it, accounting data immediately indicate that firms do not fully hedge the direct impact of exchange rates with FX derivatives. Using these accounting variables as signals of currency exposures, we show that an appreciation of the yen has a large and significant impact on the bottom line of Japanese firms. A similar appreciation of the U.S. dollar has no significant impact on average on U.S. firms. Our results imply that firms do not fully hedge their currency risk through foreign currency investments and debt, or through international operations. Using the accounting variables to build firm-level exchange rates, we show that a yen appreciation causes a decline of corporate investment. Finally, currency exposure is linked to the cost of capital: highly exposed firms tend to exhibit higher currency betas.

Figure 1. Foreign Currency Effects: the Example of Nintendo Co.



This figure presents the FX transaction, FX translation, and FX effect on cash (all scaled by total sales) reported in Nintendo's consolidated statements of income, balance sheet, and cash flows. The dashed line represents the yearly change in the exchange rate defined in U.S. dollars per Yen, such that a positive change corresponds to an appreciation of the yen. The source is Nintendo's 10K reports.

Figure 2. Foreign Exchange Transaction Income and Exchange Rates

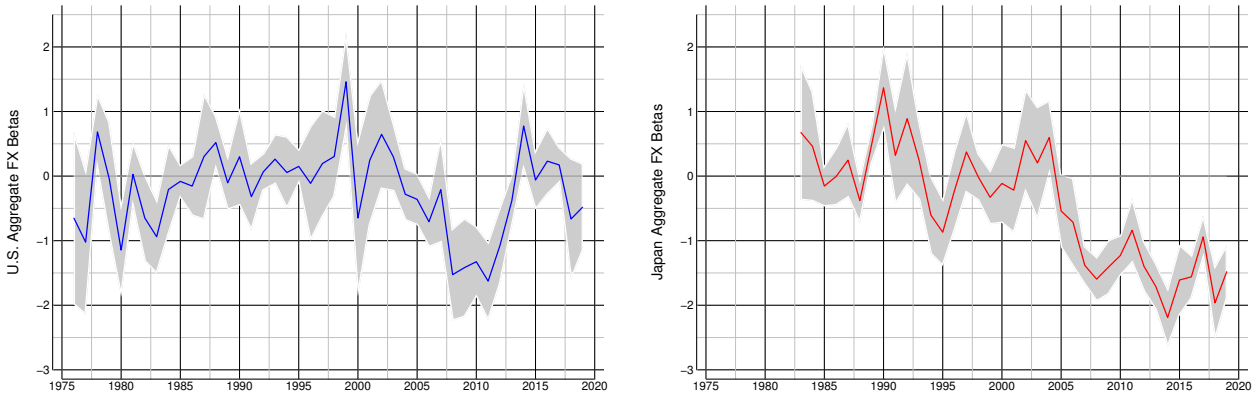


This figure presents bin scatter plots of the correlation between FX exposure and the exchange rate index return for Japan (top panel), and the US (bottom panel). The regressions follow the specification below:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction risk (scaled by sales), Δs_t denotes the yearly change of the yen index or dollar index (a positive change indicates a yen or a dollar appreciation). All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), the lagged payout ratio (defined as dividends divided by net income), and Tobin's Q. The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment, and the exchange rate volatility (computed as the yearly standard deviation of daily percentage returns). The figures present 45 bins of firm-year observations sorted by exposure. The data are annual and the estimation period is 1990–2017.

Figure 3. Exchange Rate Betas on U.S. and Japanese Aggregate Equity Returns

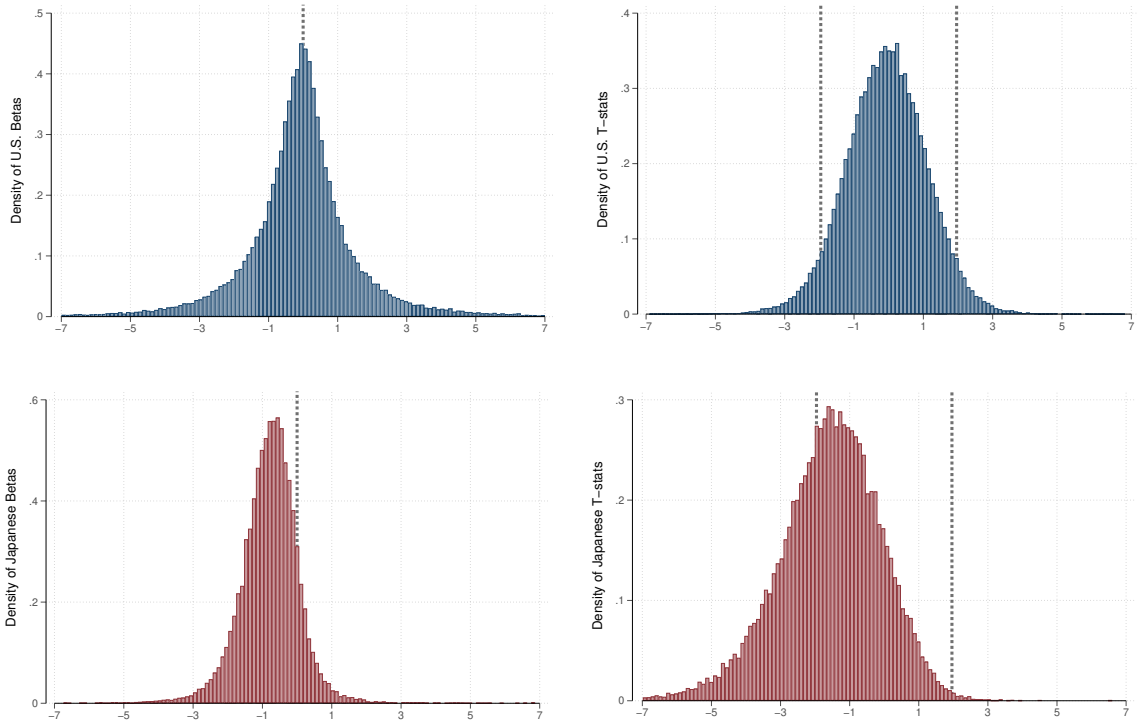


This figure presents yearly exchange rate betas for the U.S. (left panel) and Japanese (right panel) aggregate equity market returns obtained from the following regressions:

$$R^M_{t+h} = \alpha_t + \beta^{FX}_t \Delta s_{t+h} + \epsilon_{t+h}, \tag{11}$$

where $h = 1, \ldots, 52$, R^M_{t+h} is the weekly aggregate stock return and Δs_{t+h} is the weekly return on the U.S. dollar (or yen) index, both in year t and week h. The exchange rate betas, β^{FX}_t, are estimated year by year. For U.S. betas, the dollar exchange rate index is expressed in foreign currency per U.S. dollar: an increase in the index corresponds to an appreciation of the U.S. dollar. A positive beta means that the U.S. aggregate equity index increases when the U.S. dollar appreciates. The equity index (covering the AMEX, NASDAQ, NYSE, and ARCA stock markets) comes from Compustat and the exchange rate index from the U.S. Federal Reserve. For Japanese betas, the exchange rate index is expressed in foreign currency per yen: an increase in the index corresponds to an appreciation of the yen. A positive beta means that the Japanese aggregate equity index increases when the yen appreciates. The equity index (Nikkei) comes from Datastream and the exchange rate index from the BIS. The standard errors are estimated by bootstrapping with replacement 1,000 times under the assumption that returns are *i.i.d.* The gray areas around the point estimates correspond to the 95% confidence intervals. Data are weekly, and the sample period is 1/1/1975 to 12/31/2019 for the U.S. and 1/1/1983 to 12/31/2019 for Japan.

Figure 4. Exchange Rate Betas on U.S. and Japanese Firm-Level Equity Returns

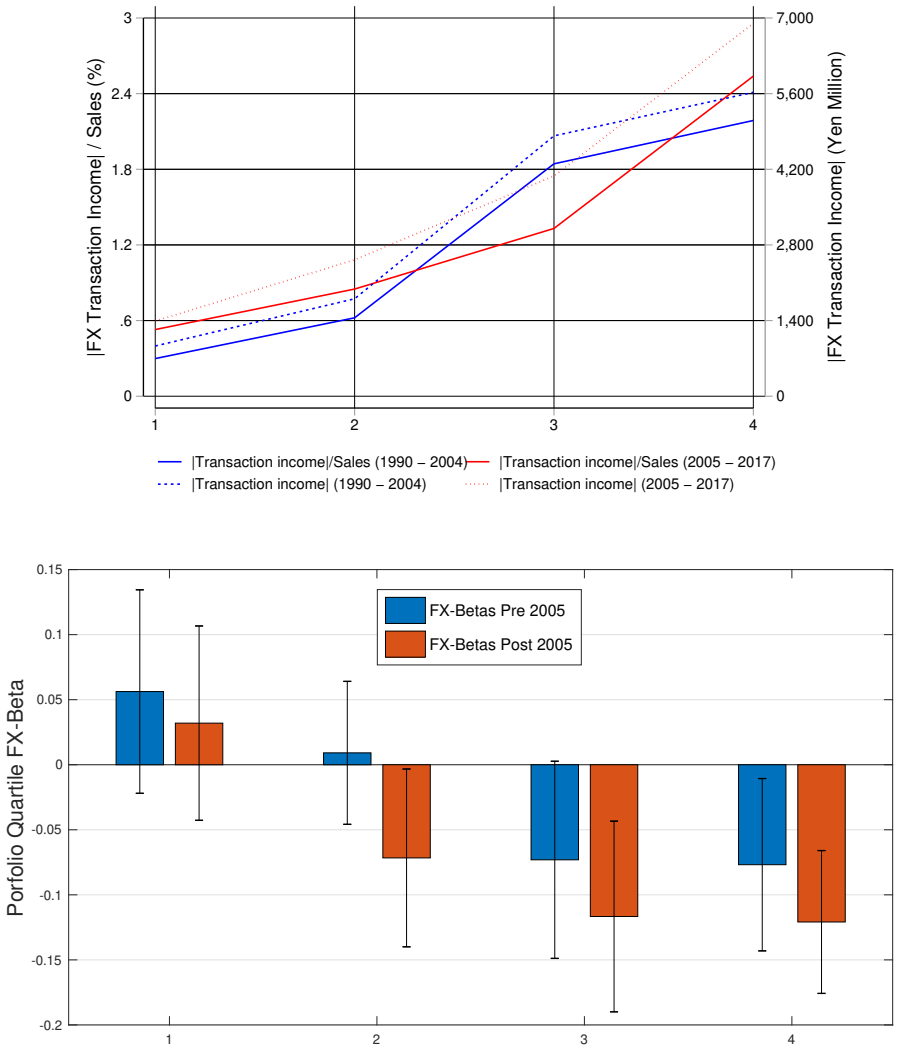


These figures report the distribution of the firm-level currency betas (left panel) and t-statistics (right panel) for U.S. firms (top panel, in blue) and Japanese firms (bottom panel, in red). The currency betas are obtained as:

$$R_{i,t+h} = \alpha_{i,t} + \beta_{i,t}^{FX} \Delta s_{t+h} + \beta_{i,t}^{M} R_{t+h}^{M} + \beta_{i,t}^{SMB} SMB_{t+h} + \beta_{i,t}^{HML} HML_{t+h} + \epsilon_{i,t+h}, \tag{12}$$

where $h = 1, \ldots, 52$, $R_{i,t+h}$ is the weekly stock return on firm i in year t and week h, R_{t+h}^{FX} is the weekly change in the dollar or yen index, and SMB_{t+h} and HML_{t+h} are the size and value Fama-French return factors (expressed in U.S. dollars or in yen). The graphs were truncated to the $[-7, 7]$ interval on the horizontal axis. The densities on the vertical axis are reported in percentages. The standard errors are obtained by a heteroskedasticity and autocorrelation consistent estimation. The vertical dotted lines for t-statistics denote the -1.96 and 1.96 cutoffs values corresponding to 95% confidence intervals. Data are weekly, and the sample period is 1/1/1975 to 12/31/2019 for the U.S. and 1/1/1989 to 11/1/2019 for Japan. There are 65,334 firm-year $\beta_{i,t}^{FX}$ in the U.S. sample and 33,102 firm-year $\beta_{i,t}^{FX}$ in the Japanese sample.

Figure 5. Exchange Rate Betas on Portfolios of Firms Sorted by their FX Transaction Income



This figure focuses on Japanese firms with non-zero foreign currency transaction income (absolute values, scaled by total firm net sales). The FX betas are obtained from portfolio-level regressions that control for aggregate market returns and the size and value Fama-French factors.

Table 1. FX Transaction Income and Exchange Rates

	FX Transaction in Japan, scaled by				FX Transaction in U.S., scaled by			
	Sales		Net Income		Sales		Net Income	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FX Index Return (/100)	-1.17***	-1.20***	-30.92***	-35.67***	-0.12***	-0.12***	-0.12	-0.08
	(-9.17)	(-6.65)	(-7.21)	(-6.25)	(-4.00)	(-5.63)	(-0.27)	(-0.17)
Sales Growth		-0.01		-1.55		0.00		-0.00
		(-0.22)		(-1.67)		(0.50)		(-0.87)
Log Assets (Lag)		-0.00		1.64**		-0.00**		-0.03
		(-0.13)		(2.20)		(-2.13)		(-0.81)
Leverage (Lag)		0.10		1.67		-0.00		-0.00
		(1.59)		(0.80)		(-0.31)		(-1.24)
Payout Ratio (Lag)		-0.13		-8.04		-0.01		-1.56
		(-1.48)		(-1.53)		(-0.23)		(-0.95)
Tobin's Q		-0.00		0.06		0.07*		-0.60
		(-1.03)		(1.36)		(1.91)		(-1.35)
FX Volatility		-0.00		2.00		-0.01		-0.16
		(-0.05)		(0.86)		(-0.58)		(-0.58)
Market Return		-0.00		0.02		0.00*		-0.00
		(-0.08)		(0.85)		(1.96)		(-0.64)
SMB		0.00		0.00		0.00		-0.01**
		(0.20)		(0.06)		(0.56)		(-2.59)
HML		-0.00		0.00		0.00**		-0.00
		(-0.37)		(0.01)		(2.35)		(-0.29)
GDP Growth		0.00		0.31		0.00***		0.00
		(0.21)		(1.66)		(2.98)		(1.26)
Net Exports Growth		-0.00		-0.00		-0.00*		-0.00**
		(-1.35)		(-1.65)		(-1.87)		(-2.59)
Investment Growth		-0.00		-0.27		-0.00**		-0.01
		(-0.07)		(-1.58)		(-2.21)		(-1.28)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	26,698	26,698	26,698	26,698	48,864	48,864	48,864	48,864
R-squared	0.16	0.16	0.09	0.09	0.17	0.17	0.15	0.15

This table reports the results of the following regressions:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction risk (scaled by sales in the left panel — columns (1), (2), and (3), and by net income in the right panel — columns (4), (5), and (6)), Δs_t denotes the yearly change of the yen index or dollar index (a positive change indicates a yen or a dollar appreciation). All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points to improve the readability of the slope coefficient. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the year level. t-statistics are reported in parentheses.

Table 2. Impact of Exchange Rates on the Firms' Bottom Line

	Japan				US			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Return on Assets		Profit Margin		Return on Assets		Profit Margin	
FX Income / Sales	0.59***	0.59***	0.78***	0.78***	0.36	0.27	0.23*	0.23*
	(2.99)	(3.06)	(4.17)	(4.23)	(0.37)	(0.29)	(1.69)	(1.69)
Sales Growth		3.85***		3.44***	0.61		0.62***	
		(3.91)		(7.45)		(1.37)		(7.10)
Assets (Log, Lag)		-1.43***		-1.07***		7.04***		0.20***
		(-6.28)		(-6.71)		(22.24)		(4.86)
Leverage (Lag)		-1.36*		-1.90***		-7.63***		0.33***
		(-1.75)		(-3.77)		(-6.64)		(3.12)
Payout Ratio (Lag)		-5.61***		-5.84***		-1.59		-0.03
		(-4.95)		(-5.04)		(-0.97)		(-0.30)
Tobin's Q		-0.05**		-0.05***		-0.06		-0.07***
		(-2.42)		(-3.20)		(-0.42)		(-3.59)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,883	27,883	28,329	28,329	45,977	45,977	46,837	46,837
R-Squared	0.45	0.47	0.42	0.44	0.66	0.68	0.57	0.57

This table presents the results of the two-stage estimation:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$
$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + Ind_{i,t} + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2 \Lambda_{i,t} + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the return on assets (defined as the net income, i.e. after-tax profits, scaled by assets), or the profit margin (defined net income scaled by sales). All regressions control for firm fixed effects ($\delta_{0,i}$ and ν_i) and the second stage controls for time fixed-effects (σ_t) and industry × time fixed effects ($Ind_{i,t}$). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table 3. Impact of Exchange Rates on the Firms' Investment

	Investment in Japan, scaled by			Investment in U.S., scaled by		
	PPE	Assets	Sales	PPE	Assets	Sales
	(1)	(2)	(3)	(4)	(5)	(6)
FX Income / Sales	1.24**	0.43***	0.52***	0.04	0.14	1.11
	(2.40)	(3.85)	(3.38)	(0.18)	(0.45)	(0.56)
Sales Growth	5.88***	0.88***	1.13***	-0.08	0.25**	-3.91***
	(4.98)	(5.52)	(5.29)	(-0.26)	(2.11)	(-3.69)
Assets (Log, Lag)	-3.82***	-1.05***	-1.33***	-0.65***	-2.47***	-8.44***
	(-7.57)	(-10.87)	(-10.19)	(-3.05)	(-23.36)	(-11.62)
Leverage (Lag)	-12.80***	-3.00***	-4.30***	-0.03	-0.17	-4.37***
	(-8.79)	(-9.71)	(-10.67)	(-0.19)	(-0.52)	(-2.86)
Payout Ratio (Lag)	-2.39	0.09	0.52	0.14	-2.70	-2.17
	(-0.82)	(0.14)	(0.48)	(0.86)	(-1.21)	(-0.29)
Tobin's Q	0.10**	0.01*	0.02*	0.02	0.15***	0.35**
	(2.54)	(1.93)	(1.80)	(0.98)	(4.12)	(2.09)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,902	25,849	25,825	37,686	37,346	37,275
R-Squared	0.32	0.34	0.33	0.35	0.49	0.50

This table presents the results of the two-stage estimation:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$
$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + Ind_{i,t} + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2 \Lambda_{i,t} + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the firm's capital expenditures defined as the change in the stock of property, plant, and equipment (PPE) + depreciation, scaled by last year's PPE stock in columns (1) and (4), scaled by total assets in columns (2) and (5), and scaled by total sales in columns (3) and (6). All regressions control for firm fixed effects ($\delta_{0,i}$ and ν_i) and the second stage controls for time fixed-effects (σ_t) and industry × time fixed effects ($Ind_{i,t}$). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table 4. Japanese Firm-level FX Betas and FX Exposures

	Firm FX-beta (absolute value)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FX Transaction	3.88***	3.80***					3.52***		3.52***
	(3.35)	(3.22)					(3.01)		(2.96)
FX Transaction (Lag)		0.38						0.69	-0.11
		(0.33)						(0.60)	(-0.09)
FX Effect on Cash			1.36*	1.18			0.39		-1.36
			(1.79)	(1.64)			(0.56)		(-1.59)
FX Effect on Cash (Lag)				1.95***				1.49**	1.54**
				(3.32)				(2.25)	(2.27)
FX Translation					1.60***	1.14*	1.46***		1.30**
					(2.63)	(1.68)	(2.63)		(2.36)
FX Translation (Lag)						1.32***		1.45***	1.50***
						(2.66)		(2.71)	(2.79)
Log assets	3.79***	3.79***	3.75***	3.51**	3.37**	3.06**	3.23**	3.21**	2.80**
	(2.74)	(2.73)	(2.70)	(2.53)	(2.42)	(2.18)	(2.31)	(2.30)	(2.00)
Leverage	8.85*	8.82*	9.29**	9.28**	9.57**	9.52**	9.42**	9.11**	9.19**
	(1.95)	(1.95)	(2.05)	(2.05)	(2.11)	(2.10)	(2.08)	(2.01)	(2.03)
Payout Ratio	-8.34	-8.33	-7.93	-7.90	-7.57	-7.93	-7.91	-8.22	-8.28
	(-0.88)	(-0.88)	(-0.84)	(-0.84)	(-0.80)	(-0.83)	(-0.83)	(-0.86)	(-0.86)
Net Trade Credit	3.03	3.00	3.00	2.73	2.76	2.46	2.56	2.46	2.18
	(1.58)	(1.56)	(1.56)	(1.42)	(1.44)	(1.28)	(1.34)	(1.28)	(1.13)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	28,776	28,776	28,776	28,776	28,776	28,776	28,776	28,776	28,776
R-squared	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

Table 5. U.S. Firm-level FX Betas and FX Exposures

	Firm FX-beta (absolute value)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FX Transaction	1.75	1.88					1.69		1.80
	(0.63)	(0.64)					(0.61)		(0.62)
FX Transaction (Lag)		-1.00						-0.76	-1.03
		(-0.39)						(-0.32)	(-0.40)
FX Effect on Cash			-7.14	-8.05			-6.92		-8.01
			(-0.82)	(-0.89)			(-0.80)		(-0.88)
FX Effect on Cash (Lag)				5.13				2.25	5.44
				(0.45)				(0.16)	(0.47)
FX Translation					-0.02	-0.02	-0.02		-0.01
					(-0.33)	(-0.32)	(-0.22)		(-0.18)
FX Translation (Lag)						-0.08		-0.09	-0.09
						(-1.18)		(-1.21)	(-1.24)
Log assets	-20.55***	-20.55***	-20.53***	-20.53***	-20.54***	-20.54***	-20.54***	-20.54***	-20.54***
	(-11.95)	(-11.95)	(-11.94)	(-11.93)	(-11.94)	(-11.94)	(-11.95)	(-11.94)	(-11.94)
Leverage	0.43	0.39	0.43	0.43	0.39	0.38	0.46	0.36	0.43
	(0.16)	(0.14)	(0.16)	(0.16)	(0.14)	(0.14)	(0.17)	(0.13)	(0.16)
Payout Ratio	-19.97**	-19.98**	-19.96**	-19.96**	-19.96**	-19.95**	-19.97**	-19.96**	-19.97**
	(-2.11)	(-2.11)	(-2.10)	(-2.10)	(-2.10)	(-2.10)	(-2.11)	(-2.10)	(-2.11)
Net Trade Credit	0.23	0.24	0.19	0.19	0.23	0.24	0.19	0.24	0.18
	(0.36)	(0.37)	(0.31)	(0.30)	(0.37)	(0.37)	(0.30)	(0.38)	(0.30)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	56,756	56,756	56,756	56,756	56,756	56,756	56,756	56,756	56,756
R-squared	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43

A Appendix: Transaction Risk

Foreign currency transaction risk arises at the company level when an entity takes part in a transaction that (i) is denominated in a currency other than its functional currency and (ii) creates a monetary balance sheet account. The firm's transactions need to be measured and reported in its functional currency. Therefore, if the transaction gives rise to a liability or asset account, for example an accounts receivable following export sales or accounts payable from import purchases, then changes in the expected functional currency cash flows caused by changes in exchange rates affect the company's net income through foreign exchange gains or losses, under both the IFRS and GAAP accounting rules.

If a foreign currency transaction is initiated and settled within a reporting period, it creates a realized gain or loss that flows to the income statement. If the company has a foreign currency transaction that is initiated and settled between reporting periods (i.e., if the reporting date falls in between initiation and settlement), then at the time of reporting, the company has an unrealized translation gain or loss. This unrealized gain or loss appears on the same line of the income statement. These amounts therefore affect the company's reported profits and are net of any hedging on the underlying assets or liabilities.

The effect on net income caused by fluctuations in foreign exchange rates can arise from many types of transactions: when the company buys or sells on credit goods or services denominated in a foreign currency, borrows or invests funds in a foreign currency denominated security, acquires or disposes of assets whose prices are denominated in a foreign currency, or if for any other reason incurs or settles liabilities denominated in foreign currency. The FX transaction effect can also include gains and losses on inter-company foreign currency transactions that are not considered a long-term investment. Common examples of foreign currency transactions include accounts receivables from export sales, accounts payable from the purchase of imported goods, foreign currency denominated loans, investment in foreign bonds, or deferred tax balances in a foreign jurisdiction.

An important characteristic that distinguishes the FX transaction effect from FX translation

adjustments (presented in the next section) is that transaction gains and losses relate to the company's own operations and investments that are denominated in foreign currency, whereas translation adjustments arise from the need to consolidate the financial accounts of foreign subsidiaries operating in different currencies into a single reporting currency. Therefore, while translation risk can only arise at the parent level at consolidation of financial statements of the group, transaction risk can individually affect both the parent (reporting) and foreign entities.

Below we present a detailed example of a foreign currency transaction effect on a company's financial statements, and the top panel of Figure (1) presents an example of how the foreign transaction income of a Japanese company, Nintendo Co., evolves with the exchange rate.

A.1 Foreign currency transaction income - Case without hedging

Suppose that USCo is a company operating and reporting in U.S. dollars. It purchases inventory for 1,000,000 Euros on February 1, 20X0 on a 90-day trade credit. Assume that the exchange rate on February 1, 20X0 is USD 1.25 = 1 EUR. The US company must then report the transaction and accounts payable in its functional currency, and the effect on its balance is as follows:

Table A1. Foreign Currency Transaction - Entries on February 1, 20X0

Account	Type	Decrease	Increase
Inventory	Assets		1,250,000
Accounts payables	Liabilities		1,250,000

The foreign currency liability account is then settled at a later date, in our example on May 1, 20X0. Assume that the next reporting date is March 31, 20X0 and that the spot rate on that day is USD 1.30 = 1 EUR. While the transaction has not settled yet, the company still needs to report the full extent of the impact of the exchange rate change from 1.25 to 1.30 on its net income, as if it was already realized. In doing so, the company will make the following entry to update its account payables on the reporting date:

Table A2. Foreign Currency Transaction - Entries on March 31, 20X0

Account	Type	Decrease	Increase
Accounts payables	Liabilities		50,000
Foreign currency transaction loss	Income Statement		50,000

The $50,000 amount is recorded as a foreign currency loss on the income statement for the period. Suppose that on settlement day, May 1, 20X0, the foreign exchange rate on that day is USD 1.35 = 1 EUR. The company first records an entry to recognize the difference between the US dollar balance on settlement day (1,350,000 US dollars) and the balance as of the previous reporting date on March 31, 20X0 (1,300,000 US dollars). The offsetting entry is then the foreign currency transaction loss that will be reported in the income statement of the following period, on June 31, 20X0. These entries are presented in Table (A3).

Table A3. Foreign Currency Transaction - Entries on May 1, 20X0

Account	Type	Decrease	Increase
Accounts payable	Liabilities		50,000
Foreign currency transaction loss	Income Statement		50,000

Finally, the company also records the payment of the account payables in cash. The total entries on settlement day are then as in Table (A4) :

Table A4. Foreign Currency Transaction - Entries on March 1, 20X0

Account	Type	Decrease	Increase
Accounts payable	Liabilities	1,350,000	
Cash	Assets	1,350,000	

Unrealized gains and losses occur when the reporting date is between the transaction date and the settlement date. Both realized and unrealized gains and losses due to foreign exchange transactions are reported in the income statement.[11] In the example above, the company incurred an unrealized loss of $50,000 reported on March 31, 20X0 on the income statement, as well as a realized loss of $50,000 that reported on June 31, 20X0. Both realized and unrealized impact the income statement in the same way.

[11] Exceptions to this rule are gains and losses to net investment hedges and long-term inter-company transactions that are not expected to be settled in the foreseeable future. Foreign currency gains and losses on these two exceptions are recorded in the cumulative translation adjustment account.

A.2 Foreign currency transaction income - Case with hedging

What happens if the firm hedges its foreign currency position? Suppose now that the same company USCo, which operates and reports in U.S. dollars and purchases inventory for 1,000,000 Euros on February 1, 20X0 on a 90-days trade credit, decides to hedge its currency risk. Assume that the spot rate on February 1^{st} is USD 1.25 = 1 EUR, and that the company entered a forward contract to buy 1,000,000 Euros at USD 1.27 = 1 EUR in 90 days. Suppose also that the next reporting date is on March 31^{st}. Table (A5) below summarizes the exchange rates and corresponding gains and losses recorded over the three month period of the hedging contract.

Table A5. Spot, Forward Rates, and Contract Valuations

Date	Spot rate	Forward rate	Contract value	Contract gain/loss
02/01/20X0	1.25	1.27	0	0
03/31/20X0	1.30	1.31	39,806	39,806
05/01/20X0	1.35	1.35	80,000	40,194

At any point in time, the current forward contract's fair value is computed as the difference between the current and the previous forward rates multiplied by the notional currency amount, discounted back from the settlement date. In the example above, using an annual discount rate of 6%, the current forward contract's fair value is $\$39,806 = (1.31 - 1.27) \times 1,000,000 \times (1.06)^{-\frac{1}{12}}$. The discount period is one month (from the end of March to the start of May). The gains or losses on the contract are then computed as the difference between the current and previous forward contract's fair values.[12]

The gains or losses on the forward hedging contract are entered in the same accounting line as the gains or losses on the underlying foreign currency liability. The table below compares the net reporting of the foreign exchange gains and loss in the cases with and without the forward hedging contract. On March 31st, the firm reports the sum of the forward contract's fair value and the FX transaction loss: $-50,000 + 39,806 = -\$10,194$. On May 1st, the forward contract's fair value

[12]The example described here is exactly relevant for the case where the forward contract is designated as a fair value hedge. Other possible designations of forward hedging contracts are cash flow hedge with hedge effectiveness based on changes in spot rates, and cash flow hedge with hedge effectiveness based on changes in forward rates.

becomes $(1.35 - 1.27) \times$ €$1M$, and the firm keeps track of its difference with its previous value: $(1.35 - 1.27) \times$ €$1M - 39,806 = \$40,194$. The firm then reports a FX transaction exposure equal to the FX transaction loss and the hedging component: $-50,000 + 40,194 = -\$9,806$. The total FX transaction loss corresponds to the difference between the spot and forward rate, multiplied by the notional: $(1.25 - 1.27) \times$ €$1M = -\$20k$. It is also equal, by construction, to the sum of the two FX transaction exposures reported: $-\$10,194 - \$9,806 = -\$20k$.

Table A6. Foreign Currency Transaction - FX Rates and Valuations

Date	Spot rate	Forward rate	Payable	FX gain/loss	FX gain/loss with Hedging
02/01/20X0	1.25	1.27	1,250,000	0	0
03/31/20X0	1.30	1.31	1,300,000	(50,000)	(10,194)
05/01/20X0	1.35	1.35	1,350,000	(50,000)	(9,806)

The FX gains/loss column of Table (A6) reports the net effect of foreign exchange transaction income in the case where no hedging is used (see section A.1 above). These amounts correspond to the reported entries on the income statements as of March $31^{st}, 20X0$ (second row), and as of June $31^{st}, 20X0$ (third row). The "FX gains/loss with Hedging" column reports the net effect considering both the foreign exchange gain/loss and the forward contract gain/loss. In the case where the company uses a hedging contract, this net foreign exchange transaction income is what the company ultimately reports on its income statements as of March $31^{st}, 20X0$ (second row), and as of June $31^{st}, 20X0$ (third row).

B Appendix: Translation Risk

A firm that owns at least 50% of the shares of another firm (or when the ownership stake is between 20% and 50% and the parent owns significant voting shares) must report consolidated financial statements. The firm that owns the controlling stake is the parent firm, the other one is its subsidiary. The consolidated statements are reported in the parent company's functional currency and require the translation of all financial accounts of foreign entities into this single currency before they can be consolidated. This translation must occur at period-end spot exchange rates for assets and liabilities.[13] But the income statement accounts are translated at the period average exchange rate, whereas equity accounts are converted at historical exchange rates, except the retained earnings, since dividends are translated at the spot rate as of their declaration date. Gains and losses that arise due to the exchange rate differences, and which are needed for the consolidated accounts to balance, are denoted foreign currency translation adjustments, and are reported in other comprehensive income. The cumulative translation adjustment (CTA) account, which is a separate component of accumulated other comprehensive income (OCI) in shareholder's equity, records the accumulated balance of all previous periods' foreign currency translation adjustments. Let us go through a detailed example on how translation adjustments affect a company's financial accounts.

Suppose USCo is a U.S.-located parent company reporting in U.S. dollars, and SpainCo is a distinct operation that is a wholly owned subsidiary located in Spain and operating and reporting financial statements in Euros. We assume that SpainCo is capitalized on Jan 1, 20X0 (the date of injection of equity capital) and that USCo starts the reporting year 20X0 with no accumulated translation adjustments. We examine below the effect of the foreign currency translation of the accounts of SpainCo when they are consolidated by the parent company. The foreign entity's balance sheet and income statement for the period from Jan 1, 20X0 to Dec 31, 20X0 as reported in Euros are presented in Tables (B1) and (B2). The spot exchange rate between the U.S. dollar and euro at the relevant dates is in Table (B3).

[13] When a foreign entity's reports are not in its functional currency, the reporting entity must first remeasure the statements in its functional currency before the translation step.

Table B1. Foreign entity's income statement for the period ending Dec 31, 20X0

Account	€
Sales	15,000,000
COGS	(11,250,000)
Selling expense	(900,000)
Depreciation	(375,000)
Interest	(350,000)
Income Tax	(625,000)
Net Income	1,500,000
Less: Dividends on June 1, 20X0	(400,000)
Retained earnings on Dec 31, 20X0	1,100,000

Table B2. Foreign entity's balance sheet for the period ending Dec 31, 20X0

Assets	€	Liabilities and Equity	€
Cash	1,225,000	Accounts payable	450,000
Accounts receivable	1,125,000	Total current liabilities	450,000
Inventory	1,500,000	Long-term notes payable	3,750,000
Total current assets	3,850,000	Total liabilities	4,200,000
PP&E	3,750,000	Capital stock	1,975,000
Less: Accumulated depreciation	(375,000)	Retained earnings	1,100,000
Total	7,225,000	Total	7,225,000

The first step of the translation process is to translate the income statement. Since the foreign entity operates in a currency (€) other than the parent's functional currency ($), most of the income statement accounts are translated using the average foreign exchange rate over the reporting period, except for dividends which are translated at the spot exchange rate as of the date of their declaration. The translation is shown in Table (B4).

Table B3. Euro Dollar exchange rates over the period ending Dec 31, 20X0

Date	Description	Rate in USD / EUR
Jan 1, 20X0	Historical at foreign entity's common stock issuance	1.20 (H)
Dec 31, 20X0	Current at reporting date	1.30 (C)
	Weighted average when inventory acquired	1.24 (WA)
	Average, 20X0	1.25 (A)
June 1, 20X0	Dividends declaration	1.27 (D)

Table B4. Translation of the Foreign Entity's Income Statement

Account	in EUR (€)	FX Rate	in USD ($)
Sales	15,000,000	1.25 (A)	18,750,000
COGS	(11,250,000)	1.25 (A)	(14,062,500)
Selling expense	(900,000)	1.25 (A)	(1,125,000)
Depreciation	(375,000)	1.25 (A)	(468,750)
Interest	(350,000)	1.25 (A)	(437,500)
Income Tax	(625,000)	1.25 (A)	(781,250)
Net Income	1,500,000	1.25 (A)	1,875,000
Less: Dividends on June 1, 20X0	(400,000)	1.27 (D)	(508,000)
Retained earnings on Dec 31, 20X0	1,100,000		**1,367,000**

Let us detail the conversion of the retained earnings. The starting point is the definition of the retained earnings for the period in euros:

$$\text{Retained earnings in €} = \text{Net income in €} - \text{Dividend in €} \tag{13}$$

The retained earnings in U.S. dollars are obtained after converting the net income and the dividends at two different exchange rates:

$$\begin{aligned} \text{Retained earnings in \$} &= \text{Net income in €} \times \text{Average exchange rate (A)} \\ &- \text{Dividend in €} \times \text{Exchange rate when dividends declared (D)} \end{aligned} \tag{14}$$

To simplify the exposition, let us assume that the firm declares its dividend at the end of the reporting period, i.e. the end of the year in this example. In this case, the exchange rate rate C is the same as D. Even in this simplified case, the retained earnings in U.S. dollars are not the retained earnings in euros times the exchange rate at the end of the reporting period (denoted C) if that spot rate is different from the average exchange rate over the reporting period.

Once this step is completed, we obtain the retained earnings in the currency of the parent company. The next step is to translate the balance sheet accounts. The foreign exchange rates used are the current spot rate as of the reporting date for all assets, liabilities, and the historical rate as of the date of capitalization for the capital stock. The retained earnings obtained from translation of the income statement are then plugged in, and the amount required to balance total liabilities and equities with total assets is then the foreign currency translation adjustment for the period. This account flows to the "other comprehensive income" and does not directly affect the net income. This step is summarized in Table (B5) below.

Let us build the translation adjustment step by step. The starting poing is the usual accounting

Table B5. Foreign Currency Translation Adjustment Amount

Account	in EUR	FX Rate	in USD
Assets			
Cash	1,225,000	1.30 (C)	1,592,500
Accounts receivable	1,125,000	1.30 (C)	1,462,500
Inventory	1,500,000	1.30 (C)	1,950,000
Total current assets	3,850,000	1.30 (C)	5,005,000
PP&E	3,750,000	1.30 (C)	4,875,000
Less: accumulated depreciation	(375,000)	1.30 (C)	(487,500)
Total assets	7,225,000	1.30 (C)	9,392,500
Liabilities and Equity			
Accounts payable	450,000	1.30 (C)	585,000
Total current liabilities	450,000	1.30 (C)	585,000
Long-term notes payable	3,750,000	1.30 (C)	4,875,000
Total liabilities	4,200,000	1.30 (C)	5,460,000
Capital stock	1,975,000	1.20 (H)	2,370,000
Retained earnings	1,100,000	From the I/S	1,367,000
Translation adjustment	N/A	**To balance**	**195,500**
Total liabilities and equity	7,225,000		9,392,500

equation applied to the subsidiary:

$$\text{Assets in } € = \text{Liabilities in } € + \text{Equity in } € \tag{15}$$

Since equity is converted in U.S. dollars at a different rate than the assets and liabilities, a translation adjustment is necessary for the accounting equation to hold in U.S. dollars too:

$$\text{Assets in } \$ = \text{Liabilities in } \$ + \text{Equity in } \$ + \text{Translation Adjustment} \tag{16}$$

Let us convert each element of the subsidiary's balance sheet. The assets and liabilities are simply converted using the exchange rate at the reporting date:

$$\begin{aligned} \text{Assets in } \$ &= \text{Assets in } € \times \text{Exchange rate at the reporting date (C)} \\ \text{Liabilities in } \$ &= \text{Liabilities in } € \times \text{Exchange rate at the reporting date (C)} \end{aligned}$$

To convert the equity component, we need to disentangle the previous capital stock from the new retained earnings. For the subsidiary, the equity is the sum of these two components:

$$\text{Equity in €} = \text{Capital stock in €} + \text{Retained earnings in €} \tag{17}$$

The previous equity stock is converted using the exchange rate existing when the stock was issued, while retained earnings in U.S. dollars are obtained from the income statement (see Equation (14) and Table (B4)):

$$\begin{aligned}
\text{Equity in \$} &= \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} + \text{Retained earnings in \$}, \\
&= \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} \\
&+ \text{Net income in €} \times \text{Average exchange rate (A)} \\
&- \text{Dividend in €} \times \text{Exchange rate when dividends declared (D)}.
\end{aligned}$$

We can now define the translation adjustment precisely, starting from its definition in Equation (23):

$$\begin{aligned}
\text{Translation Adj.} &= \text{Assets in €} \times \text{Exchange rate at reporting date (C)} \\
&- \text{Liabilities in €} \times \text{Exchange rate at reporting date (C)} \\
&- \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} \\
&- \text{Net income in €} \times \text{Average exchange rate (A)} \\
&+ \text{Dividend in €} \times \text{Exchange rate when dividends declared (D)}
\end{aligned}$$

Using Equation (15), this simplifies to:

$$\begin{aligned}\text{Translation Adj.} &= \text{Equity in €} \times \text{Exchange rate at reporting date (C)} \\ &- \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} \\ &- \text{Net income in €} \times \text{Average exchange rate (A)} \\ &+ \text{Dividend in €} \times \text{Exchange rate when dividends declared (D).}\end{aligned}$$

Using Equations (13) and (17) leads to:

$$\begin{aligned}\text{Translation Adj.} &= \text{Capital stock in €} \times \text{Exchange rate at reporting date (C)} \\ &+ \text{(Net income - Dividends) in €} \times \text{Exchange rate at the end of the year (C)} \\ &- \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} \\ &- \text{Net income in €} \times \text{Average exchange rate (A)} \\ &+ \text{Dividend in €} \times \text{Exchange rate when dividends declared (D)}\end{aligned}$$

The final expression is thus:

$$\begin{aligned}\text{Translation Adj.} &= \text{Capital stock in €} \times \text{Exchange rate between reporting date (C)} \\ &- \text{Capital stock in €} \times \text{Exchange rate at stock issuance (H)} \\ &+ \text{Net income in €} \times \text{Exchange rate at the end of the year (C)} \\ &- \text{Net income in €} \times \text{Average exchange rate (A)} \\ &+ \text{Dividend in €} \times \text{Exchange rate when dividends declared (D)} \\ &- \text{Dividend in €} \times \text{Exchange rate at reporting date (C).} \qquad (18)\end{aligned}$$

What are the drivers of the translation adjustment? There are three effects apparent in Equation (18) on capital stock, net income, and dividends:

1. The first effect pertains to the capital stock of the subsidiary. There is a positive translation

adjustment if the exchange rate at the reporting date (C) is above the exchange rate at stock issuance (H). In other words, if the euro has appreciated since the European subsidiary was created, the translation adjustment measures a potential investment gain: the U.S. firm invested in euros, and those euros appreciated. In our example, we assume that the stock was created at the beginning of the year, but stock issuance may date back years before the current reporting date. This first term could thus capture long-term changes in exchange rates. If exchange rates follow a random walk with drift, this first term would capture the drift in exchange rates.

2. The second and third terms pertain to flow variables, net income and dividends, and to short-run variations in exchange rates. To focus on net income, assume that dividends are paid at the end of the year (so that C = D), and thus no valuation effect exists for dividends. There is, however, a positive valuation effect on net income if the exchange rate at the reporting date (C) is above the average exchange rate (A) over the reporting period. Recall that this average exchange rate was used to convert in U.S. dollars the net income of the subsidiary. Yet, intuitively, the wealth created by the subsidiary is only captured in the parent company's accounts at the end of the reporting period, and should thus be converted in U.S. dollars using the end of period exchange rate. In our example, the euro appreciated against the U.S. dollar (with its value at the end of the year above its average that year), thus the enterprise's value, i.e. the assets' value, gets an additional boost: the net income transferred from the subsidiary to the parent company should be measured at the end-of-year exchange rate, not at the average exchange rate used to convert the income statements. This valuation effect on net income depends on short-term changes in exchange rates.

3. Let us now focus on dividends. They were actually paid before the end of the year to the parent firm. Since the euro appreciated since that time (C is above D), the U.S. firm would have rather received those payments at the end of the year. But because they actually received the payments before that, they have to log a loss. This effect comes from the difference between the exchange rate when dividends are declared (D) and the exchange rate

at the reporting date (C).

To build intuition on the second and third terms above, consider the case where the exchange rate when dividends are declared (D) is equal to the average exchange rate (A) over the reporting period, i.e. D = A. Then the second and third terms capture the product of the retained earnings in euros times the difference between the exchange rate at the end of the year (C) and the average exchange rate (A). Again, this effect is about a flow variable and a short-term change in exchange rates. The intuition is like in case (2) above: if the wealth transfer from the subsidiary to the parent company occurs at the end of the year, then retained earnings should be converted using the exchange rate at that date and not the average exchange rate over the year.

In the example above, the foreign entity's functional currency is different from the parent's: in this case, the translation method is called "current." Under the current method, all assets and liabilities are translated at the current spot rate. If the foreign entity's functional currency is the same as the parent's, the translation method is "temporal." Under the temporal method, only monetary assets and liabilities (cash, loans, etc.) are translated at the spot exchange rate, while non-monetary assets and liabilities (such as inventory) are translated at the historical exchange rate. Expenses related to non-monetary assets are translated at the same exchange rate used to translate the assets (for example, COGS or inventory). Most companies use the current method described in the example above.

When the current method is used, all assets and liabilities are considered when measuring the translation adjustment. The translation adjustment is only realized if the entire foreign subsidiary is sold. Therefore, the translation adjustment flows to the "Other Comprehensive Income" and the cumulative translation adjustment is a component of shareholders' equity on the balance sheet.

C Appendix: Effect of FX on Cash Flow Statements

When consolidating the statements of cash flows of its foreign subsidiaries, the parent company reports, in its functional currency, the foreign currency cash flows using the exchange rates in effect at the time of the different cash flows.[14] The FX effect on cash is the adjustment needed so that the reported consolidated cash flows then correspond to the change in the consolidated cash balances at the beginning and end of the period, which are translated at their respective reporting dates. The FX effect on cash is reported as a separate item of the consolidated cash flow statement.

We build on our translation example in the previous section to illustrate the FX effect on cash. Recall that the exchange rate at the beginning of the second period (or end of the first period) of SpainCo is 1.30 USD/EUR (as of Dec 31, 20X0). Suppose now for simplicity that SpainCo realized the same operating performance (in euros) in year 20X1 as in year 20X0, and that they did not pay out dividends during this second period. Assume also that SpainCo purchased fixed assets for 1,500,000 euros and issued long-term debt with proceeds of 600,000 euros, both on March 1, 20X1. Finally, assume the following exchange rates between the euro and the U.S. dollar apply over the second period ending Dec 31, 20X1:

Table D1. Euro vs. U.S. Dollar exchange rates over the period ending Dec 31, 20X1

Date	Description	Rate in USD / EUR
Jan 1, 20X1	Beginning of the period rate	1.30
Dec 31, 20X1	Current at reporting date	1.40 (C)
	Weighted average when inventory acquired	1.34 (WA)
	Average, 20X1	1.35 (A)
March 1, 20X1	Rate at fixed assets acquisition	1.33 (RA)
March 1, 20X1	Rate at debt issuance	1.33 (RD)

We describe now how to obtain the effect of exchange rate on cash. We start with the translation of SpainCo's income statement, and then build the consolidated statement of cash flows of the parent company, USCo. These steps are presented in Tables (D2) and (D3) below.

[14] An appropriately weighted exchange rate may be used if the result is the same as when using individual exchange rates for each cash flow.

Table D2. Translation of the Foreign Income Statement for the period ending Dec 31, 20X1

Account	in EUR (€)	FX Rate	in USD ($)
Sales	15,000,000	1.35 (A)	20,250,000
COGS	(11,250,000)	1.35 (A)	(15,187,500)
Selling expense	(900,000)	1.35 (A)	(1,215,000)
Depreciation	(375,000)	1.35 (A)	(506,250)
Interest	(350,000)	1.35 (A)	(472,500)
Income Tax	(625,000)	1.35 (A)	(843,750)
Net Income	1,500,000	1.35 (A)	2,025,000
Retained earnings on Dec 31, 20X1	1,500,000		**2,025,000**

When translating SpainCo's statement of cash flows into its consolidated reports, USCo will translate cash flows from operating activities at the average rate during the period (1.35) — this is the same rate used in the translation of the income statement. Cash flows from investing and financing activities, however, are translated using the spot exchange rates in effect when each cash flow occurred, in this example March 1, 20X1. Once translated to the parent company's functional currency, the sum of these cash flows gives a first measure of the net increase in cash, in this example $\$1,334,250$ — it is calculated as the sum of the cash flows in the U.S. dollars in the last column of Table (D3). This number must then be reconciled with the net increase in cash that comes from the difference between the stock of cash at the beginning and at the end of the year, each one being translated at their respective balance sheet current rates. In this example, the cash at the beginning of year is translated at 1.30 (the current rate as of Dec 31,20X0), and the cash at the end of the year is translated at 1.40 (the current rate as of Dec 31, 20X1). This gives a net increase in cash of $\$1,487,500$. The final step is to reconcile $\$1,334,250$ with $\$1,487,500$, which implies the reported FX effect on cash of \$1,487,500 -\$1,334,250= \$ 153,250.

We can generalize this example and derive a simple expressions for the FX effect on cash. The starting poing is the flow accounting equation applied to the subsidiary:

$$\text{Cash in } €_{t+1} = \text{Cash in } €_t + \text{Change in Cash in } €, \tag{19}$$

Table D3. Translation of the Statement of cash flows for the period ending Dec 31, 20X1

Account	in EUR (€)	FX Rate	in USD ($)
Cash flows from operating activities:			
Net income	1,500,000	1.35 (A)	2,025,000
Depreciation	375,000	1.35 (A)	506,250
Cash flows from investing activities:			
Purchase of fixed assets	(1,500,000)	1.33 (RA)	(1,995,000)
Cash flows from financing activities:			
Proceeds from issuance of long-term debt	600,000	1.33 (RA)	798,000
Effect of exchange rate changes on cash			**153,250**
Net increase in cash	975,000		1,487,500
Cash at beginning of year	1,225,000	1.30	1,592,500
Cash at end of year	2,200,000	1.40 (C)	3,080,000

where the last term describes the sources of additional cash:

$$\begin{aligned} \text{Change in Cash in } €_{t+1} &= \text{Net Income in } €_{t+1} + \text{Depreciation in } €_{t+1} && (20) \\ &+ \text{Cash Flow from Investing in } €_{t+1} && (21) \\ &+ \text{Cash Flow from Financing in } €_{t+1} && (22) \end{aligned}$$

Since all the components of the change in cash are converted in U.S. dollars at different rates (and rates that differ from those used to convert the cash levels at the recording dates), a translation adjustment is again necessary for the accounting equation to hold in U.S. dollars too. This translation adjustment is the FX effect on Cash:

$$\text{Cash in } \$_{t+1} = \text{Cash in } \$_t + \text{Change in Cash in } \$_{t+1} + \text{FX effect on cash}_{t+1}. \quad (23)$$

Let us convert each element of the subsidiary's cashflow statement. The cash levels are simply

converted using the exchange rate at the reporting dates:

$$\text{Cash in } \$_{t+1} = \text{Cash in } €_{t+1} \times S_{\text{at the reporting date},t+1} \tag{24}$$

$$\text{Cash in } \$_{t} = \text{Cash in } €_{t+1} \times S_{\text{at the reporting date},t} \tag{25}$$

The different components of the change in cash are converted either at the average exchange rate over the reporting period (for the net income and depreciation amounts), or at the exchange rate of the dates the financing and investment operations occurred. The second term in Equation (23) (denoted "Change in Cash in \$") is thus:

$$\begin{aligned}\text{Change in Cash in } \$_{t+1} &= (\text{Net Income} + \text{Depreciation}) \text{ in } €_{t+1} \times S_{\text{average over the reporting period},t+1} \\ &+ \text{Cash Flow from Financing in } € \times S_{\text{at the financing date},t+1} \\ &+ \text{Cash Flow from Investing in } € \times S_{\text{at the investment date},t+1}.\end{aligned}$$

Our example assumes that the financing and investment dates are the same, but they could differ. Using Equations (23), (24) and (24), the FX effect on cash is:

$$\begin{aligned}\text{FX effect on } \text{Cash}_{t+1} &= \text{Cash}_{€,t} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the reporting date},t}) \\ &+ (\text{NI}_{€,t+1} + \text{Dep}_{€,t+1}) \times (S_{\text{at the reporting date},t+1} - S_{\text{average over the reporting period},t+1}) \\ &+ \text{CFFin}_{€,t+1} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the financing date},t+1}) \\ &+ \text{CFInv}_{€,t+1} \times (S_{\text{at the reporting date},t+1} - S_{\text{at the investment date},t+1}).\end{aligned}$$

1. The first term is a pure valuation effect: if the euro appreciates, the cash held in euros by the subsidiary becomes more valuable to the parent firm, even if the amount of cash in euros does not change;

2. The second term is a translation effect on the cash flows from operations: if the euro is more valuable at the reporting date than on average over the previous year, the parent company enjoys an additional gain;

3. The last two terms capture the translation effects of the financing ressources and investments: the logic is the same as for the previous terms, but the adjustment effect is positive if the foreign currency is worth more at the reporting date than at the dates the financing and investment transactions occurred.

D Appendix: Data Sources

D.1 Foreign Exchange Indices

To study the response of U.S. firms to currency shocks, our exchange rate index is the major dollar index published by the Federal Reserve Board. It is a weighted average of values of the U.S. dollar against the currencies of a large group of major U.S. trading partners. The index weights, which change over time, are derived from U.S. export shares and from U.S. and foreign import shares. The data are at the daily frequency, from 1/2/973 to 12/31/2019.

To study the response of Japanese firms to currency shocks, we use the daily effective exchange rate for Japan published by the Bank of International Settlements (BIS). The data are the daily frequency, from 10/03/1983 to 10/29/2019. We use the narrow index over the 1983–1996 period and the broad index thereafter. The yen index weights, which change over time, are derived from Japanese import and export shares with a large group of trading partners.

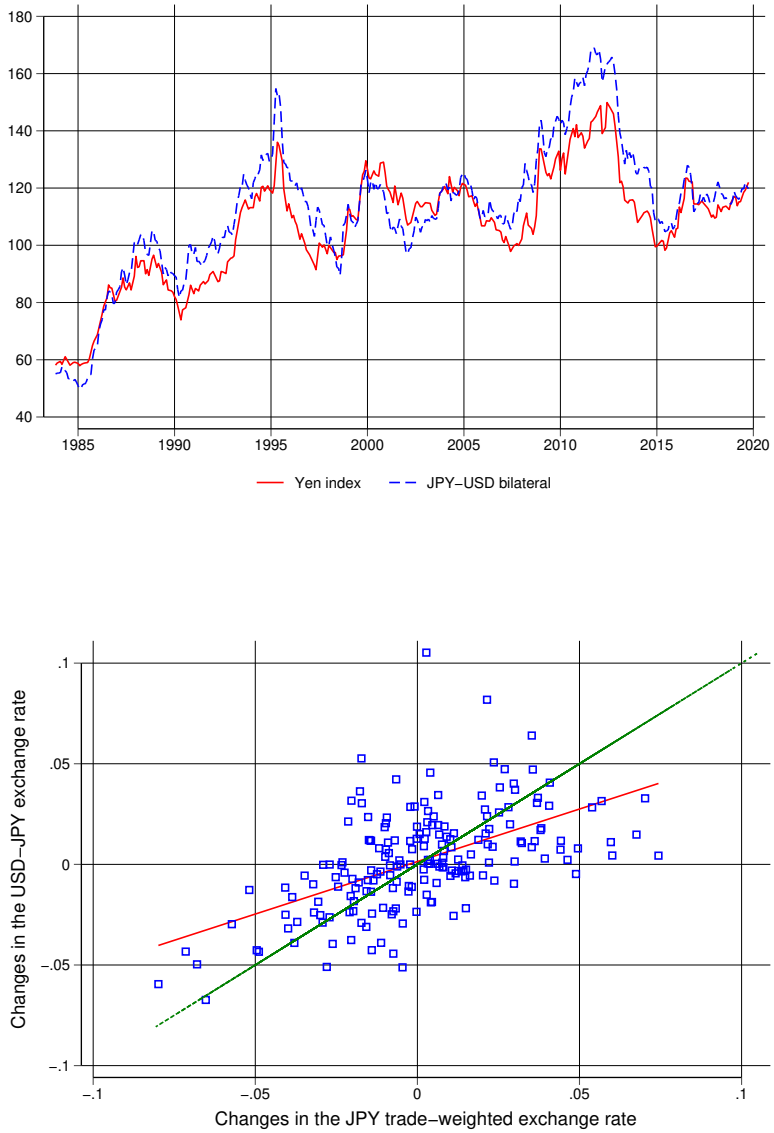
Figure 6 compares the trade-weighted exchange rate index used in the analysis with the yen-U.S. dollar bilateral exchange rate. Figure 7 presents the level and volatility of the trade-weighted yen and U.S. dollar indices. Table D1 reports the summary statistics of the two changes in exchange rates.

To smooth out the potential effect of intra-day timing differences between stock returns and exchange rate changes, we use weekly returns to compute exchange rate equity betas.

D.2 U.S. Data Sources and Sample Selection

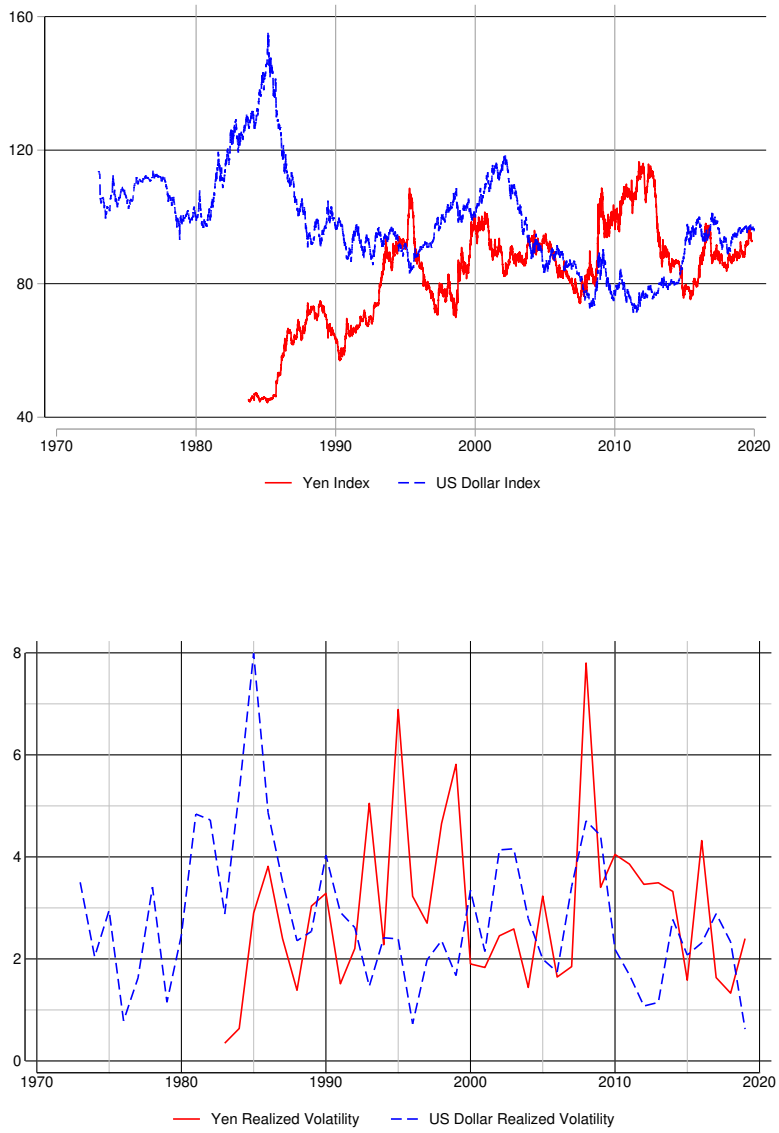
Firm-level data for the U.S. sample come from the Compustat Fundamentals, the Compustat Segment files, and CRSP. Table D2 reports the list of variables, along with their codes. Compustat Fundamentals files report balance sheet, cash flow, and income statements. Compustat's Segments files present the geographical breakdown of each firm's non-U.S. sales and exports. We merge the Compustat and CRSP datasets using the CRSP-Compustat merging tool and keep only the firm-year observations that have both exchange rate betas and financials information.

Figure 6. Yen Trade-Weighted Index and the Yen-U.S. Dollar Exchange Rate



This figure compares the trade-weighted exchange rate index used in the analysis with the yen-U.S. dollar bilateral exchange rate. The rates are presented in levels in the top panel and in changes in the bottom panel. The yen-US dollar bilateral exchange rate is in U.S. dollars per yen, such that an increase corresponds to a yen appreciation, as was the case for example during and immediately following the last global financial crisis. The data used for the graphs is at the monthly frequency. Both the bilateral rate and the trade-weighted yen index were scaled to equal 100 on 01/01/1998. In the scatter plot, the red solid line plots the line of best fit, while the reference 45 degree line is plotted in green. The bilateral exchange rate is from the U.S. Federal Reserve, the data is at the monthly frequency and covers the period from January 1971 to October 2020. The trade-weighted yen index is from the BIS, the original data is at the daily frequency from October 1983 to October 2019.

Figure 7. Level and Volatility of the Yen and U.S. Dollar Trade-Weighted Indices



This figure reports the trade-weighted yen and U.S. dollar indices. The top panel presents the exchange rates in levels scaled to 100 on January 3, 2000, and the bottom panel presents the realized annual volatility computed as the yearly standard deviation of the daily index values. The exchange rates are presented in foreign currency per yen/U.S. dollar, such that an increase corresponds to a yen/dollar appreciation. The data used for the graphs is at the daily frequency. The U.S. dollar exchange rate is from the U.S. Federal Reserve, the data is at the daily frequency and covers the period from January 1973 to December 2019. The trade-weighted yen index is from the BIS, the data is at the daily frequency from October 1983 to October 2019.

Table D1. U.S. Dollar & Yen Index Return Summary Statistics

Index	Obs	Mean	St Deviation	Min	Max	Skew.	Kurt.	AR(1) Coeff	AR(1) Std. Err.
				Yen — Weekly Frequency					
1990-2004	783	0.06	1.44	-5.69	12.53	1.13	11.20	-0.0056	0.0359
2005-2017	678	0.00	1.49	-5.25	11.10	0.91	8.31	-0.0999	0.0385
1990-2017	1,461	0.03	1.46	-5.69	12.53	1.02	9.76	-0.0569	0.0262
				Yen — Annual Frequency					
1990-2004	15	2.86	12.84	-17.97	18.82	-0.55	1.80	0.191	0.2723
2005-2017	13	-0.25	8.28	-12.61	11.98	0.10	1.60	0.270	0.2796
1990-2017	28	1.42	10.89	-17.97	18.82	-0.27	1.83	0.224	0.1906
				Dollar — Weekly Frequency					
1990-2004	783	-0.01	0.89	-3.64	2.87	0.11	3.64	-0.0012	0.0358
2005-2017	678	0.02	1.00	-3.78	4.44	0.30	4.46	0.0310	0.0385
1990-2017	1,461	0.00	0.94	-3.78	4.44	0.22	4.19	0.0159	0.0262
				Dollar — Annual Frequency					
1990-2004	15	-0.72	7.45	-15.33	10.74	-0.16	2.20	0.284	0.270
2005-2017	13	0.98	7.32	-9.97	11.72	0.01	1.77	-0.032	0.311
1990-2017	28	0.07	7.31	-15.33	11.72	-0.09	2.08	0.1523	0.199

To select our final sample of firm-year observations, we follow **?**. Starting from the sample of firms for which we can match financial information in Compustat with stock returns data from CRSP, we drop firms in the finance, insurance and real estate sectors, which we identify from SIC codes between 6,000 and 6,799. Next, we only keep firms that are headquartered and incorporated in the U.S., using the variables LOC (current ISO country code - headquarters), and FIC (foreign incorporation code). We also delete firms whose native currency is not the U.S. dollar, using variable CURNCD. Furthermore, we remove from the sample all firms involved in a major acquisition, that we identify using the Compustat variable ACQMETH. For consistency, we only keep firms whose reporting periods (fiscal year) end in December of the calendar year. Finally, we require at least three years minimum for a firm to be included in the data sample. The data sample contains 8,395 unique firms.

To double-check the transaction, translation, and effect on cash values in the Compustat database, we compare them to the annual reports of a randomly selected sample of U.S. listed firms: the information available in Compustat perfectly matches the annual reports. We recover the stock amount of accumulated translation adjustments in the variable "Retained Earnings Cumulative Translation Adjustment" (*recta*). We find the flow of translation adjustment per period in the variable "Currency Translation Adjustment" (*cicurr*). When the FX translation value is missing but two subsequent cumulative translation adjustment (CTA) values are present (and non-zero), we compute the missing FX translation value as the time-difference in CTAs. We recover the FX effect on cash using the variable *exre*.

D.3 Japan Data Sources and Sample Selection

The sources of firm-level data for Japan are the Toyo Keizai general dataset and Datastream. Table D3 lists all variables along with their exact codes. We use a similar sample selection as for the U.S. data. In particular, we only use firms from the general module, excluding firms in the brokerage, banking, and insurance industries. We keep firms headquartered in Japan and using the yen as their functional currency. Finally, we require at least three years minimum of data for a firm to be

Table D2. Main Variables — U.S.

Variable	Code (Item No.)	Description
Sales	sale (No. 12)	Net Sales
Net income	ni (No. 172)	Net Income (Loss)
Total assets	at (No. 6)	Identifiable/Total Assets
Equity	ceq (No. 60)	Common/Ordinary Equity - Total
Capx	capx (No. 128)	Capital Expenditures
Ordinary income	ib (No. 18)	Before extraordinary items
Depreciation and Amortization	dp (No. 14)	Income statement
Property, plant and equipment	ppegt (No. 8)	Book value
Common shares outstanding	csho (No. 25)	Number of shares
Share price	prcc (No. 24)	Closing price
Deferred taxes	txdb (No. 74)	Balance sheet - Liabilities
Debt issuance	dltis (No. 111)	Long-term debt issuance
Debt repayment	dltr (No. 114)	Long-term debt reduction
Changes in current debt	dlcch (No. 301)	Net change in short-term borrowings
Dividends per share	dvpsp (No. 201)	Cash dividends
Earnings per share	epsfx (No. 57)	Common shares - diluted
Receivables	rect (No. 2)	Accounts receivable
Accounts payable	ap (No. 70)	trade obligations due within one year
COGS	cogs (No. 41)	Cost of goods sold
Inventories	invt (No. 3)	Inventories
FX transaction income	fca (No. 150)	Foreign Exchange Income (Loss)
FX translation adjustment	cicurr	Comprehensive Income - Currency Translation Adj
FX effect on cash	exre (No. 314)	Statement of Cash Flow
Cumulative trans adjustment	recta (No. 230)	Accumulated OCI Cumulative Translation Adj
Foreign sales	sales	Segments file - Sum of sales if geotp=3
Export sales	salexg (export)	Segments file
Stock return	ret	CRSP Holding Period Return

included in the sample. The data sample contains 3,095 unique firms. As a consistency check on our measures of exposure, we match the data with annual reports of a randomly selected sample of Japanese firms. The FX transaction income is obtained as the net effect of the foreign exchange gains and losses — there is no additional information in these two subcategories as firms either report one or the other.

Table D3. Main Variables — Japan

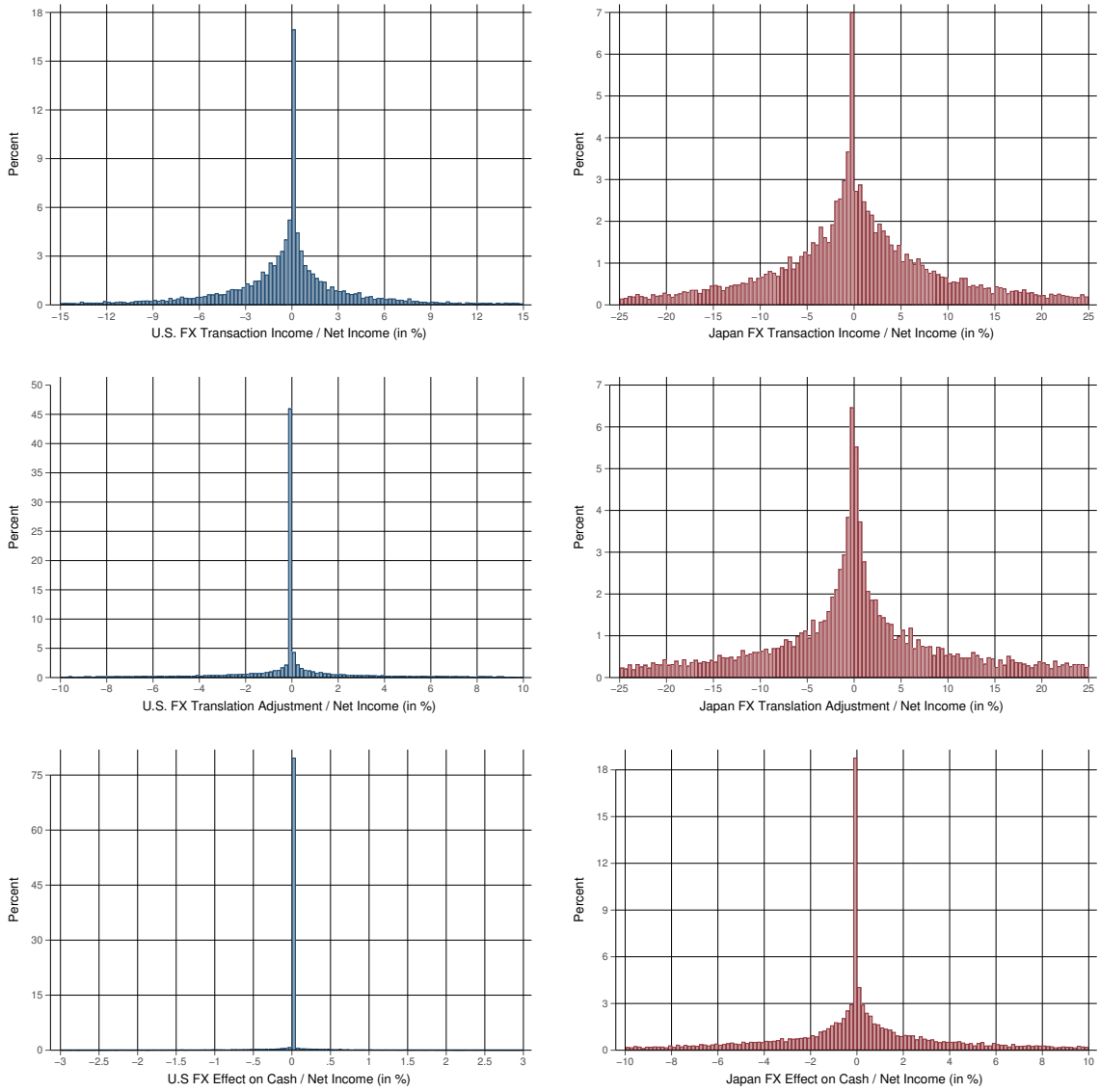
Variable	Itemid No.	Description
Sales	No. 6	Net Sales
Net income	No. 12	Net Income (Loss)
Total assets	No. 60	Total Assets
Equity	No. 64	Shareholders Equity
Capital expenditures	No. 1140	Investments in fixed assets
Cash	No. 1179	Cash and cash equivalents
Common shares Outstanding	No. 253	Number of shares
Deferred taxes	No. 747	Balance sheet - Liabilities
Dividends per share	No. 1170	Cash dividends
Receivables	No. 464	Accounts receivable
Accounts payable	No. 704	trade obligations due within one year
COGS	No. 912	Cost of goods sold
Inventories	No. 489	Inventories
Foreign exchange gains	No. 1008	FX gains - Net income
Foreign exchange losses	No. 1034	FX losses - Net income
FX translation adjustment	No. 3394	Foreign Currency Translation Adjustment OCI
FX effect on cash	No. 1175	Effect of foreign exchange on the statement of cash flows
Cumulative trans adjustment	No. 109	Cumulative Translation Adjustment
Export sales	No. 457	Sales abroad
Stock return	RET	Datastream international stock return files

D.4 Raw data on FX transaction, translation, and effect on cash

Figure (8)reports the distribution of the FX transaction, translation, and effect on cash, all scaled by net income. All variables are in absolute values, at the firm and year level. The left panel focuses on U.S. firms (blue bars) while the right panel focuses on Japanese firms (red bars). The ratios are reported in percentages. Close to 15% of the U.S. observations exhibit no currency transaction

risk, against only 6% in Japan. Figure (9) presents the distribution of the same variables scaled by total net sales to address the potential concern of very small net income values. A similar picture emerges.

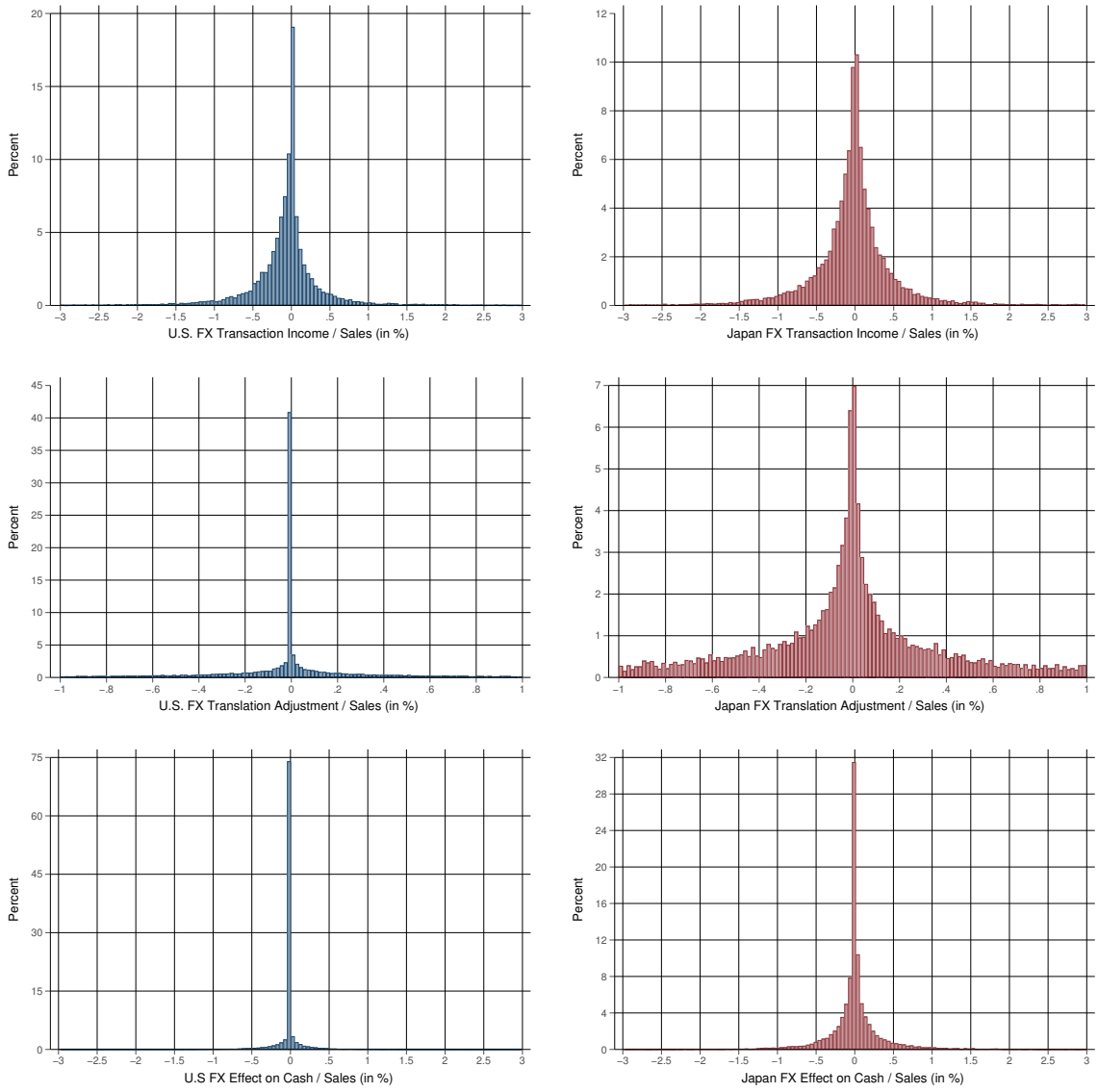
Figure 8. Distribution of FX Transaction, Translation, Effect on Cash (Scaled by Net Income)



This figure reports the distribution of the FX transaction, translation, and effect on cash, all scaled by net income. The left panel focuses on U.S. firms (blue bars) while the right panel focuses on Japanese firms (red bars). The ratios are reported in percentages. The data are annual. For the U.S, the source is Compustat and the sample period is 1976–2019 for the transaction risk and 2001–2018 for the translation adjustment. For Japan, the source is Toyo Keizai and the sample period is 1990–2018 for transaction risk and 2010–2018 for translation adjustment.

Figure (10) presents the firm-year level distribution of the FX transaction, translation, and effect on cash for both the U.S. and Japanese samples. All variables are scaled by net income and reported

Figure 9. Distribution of FX Transaction, Translation, and Effect on Cash (Scaled by Total Sales)

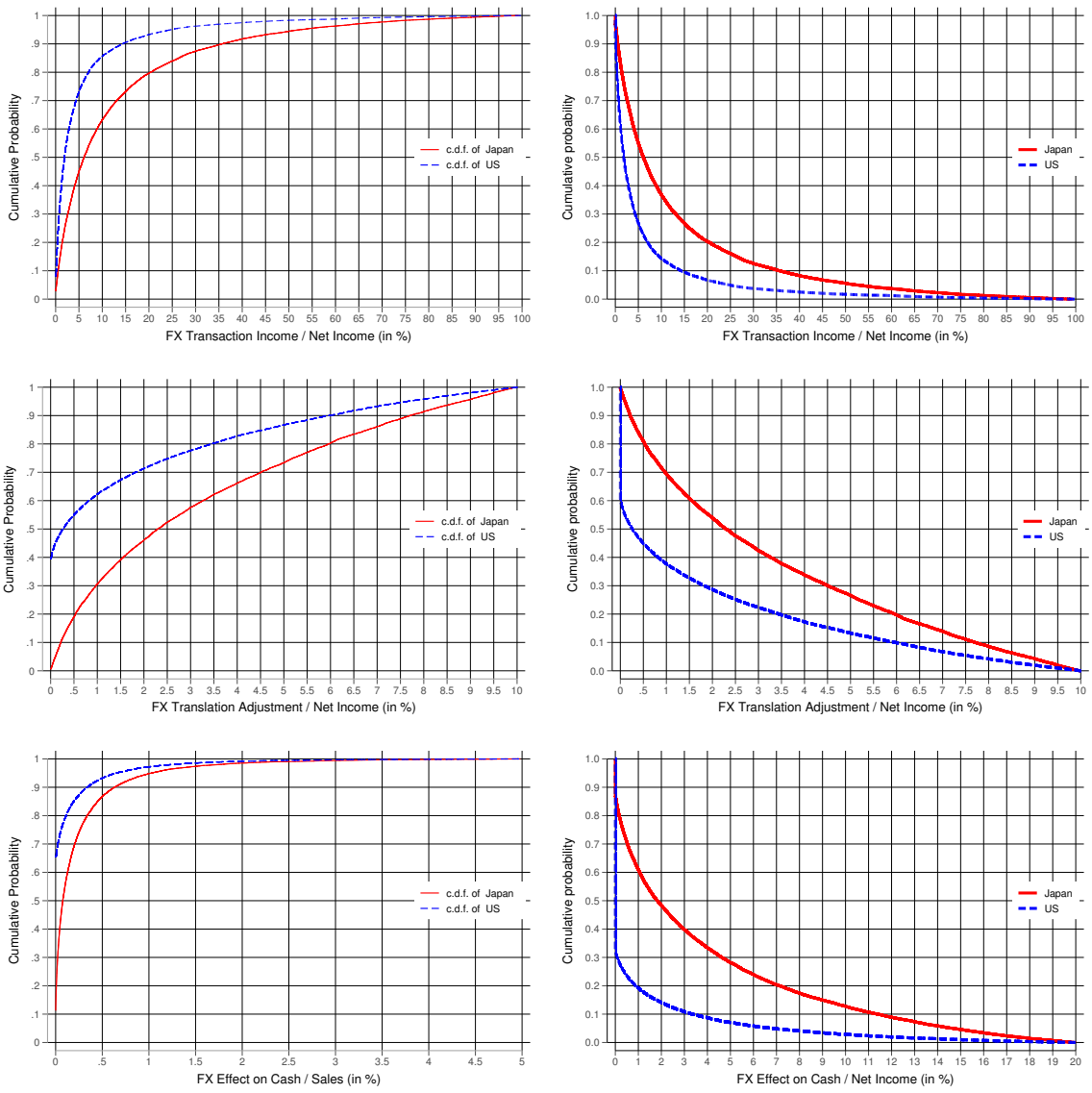


This figure reports the distribution of the FX transaction, translation, and effect on cash, all scaled by total sales. The left panel focuses on U.S. firms (blue bars) while the right panel focuses on Japanese firms (red bars). The ratios are reported in percentages. The data are annual. For the U.S, the source is Compustat and the sample period is 1976–2019 for the transaction risk and 2001–2018 for the translation adjustment. For Japan, the source is Toyo Keizai and the sample period is 1990–2018 for transaction risk and 2001–2018 for translation adjustments.

in absolute values. On the left-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure less than x percent in absolute value. On the right-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure of at most x percent in absolute value. The difference between the U.S. and Japan is clear: 20% percent of the Japanese firms exhibit an exchange transaction risk of more than 20% of their net income; 10% have a risk of more than 50% of their income. In the U.S., 20% of the U.S. firms exhibit an exchange transaction risk of more than 2% of their net income, and only 5% have an exchange transaction risk of more than 50% of their net income. Exchange rate transaction risk is much more important in Japan than in the U.S. Figure (11) presents the same distributions scaled by total net sales.

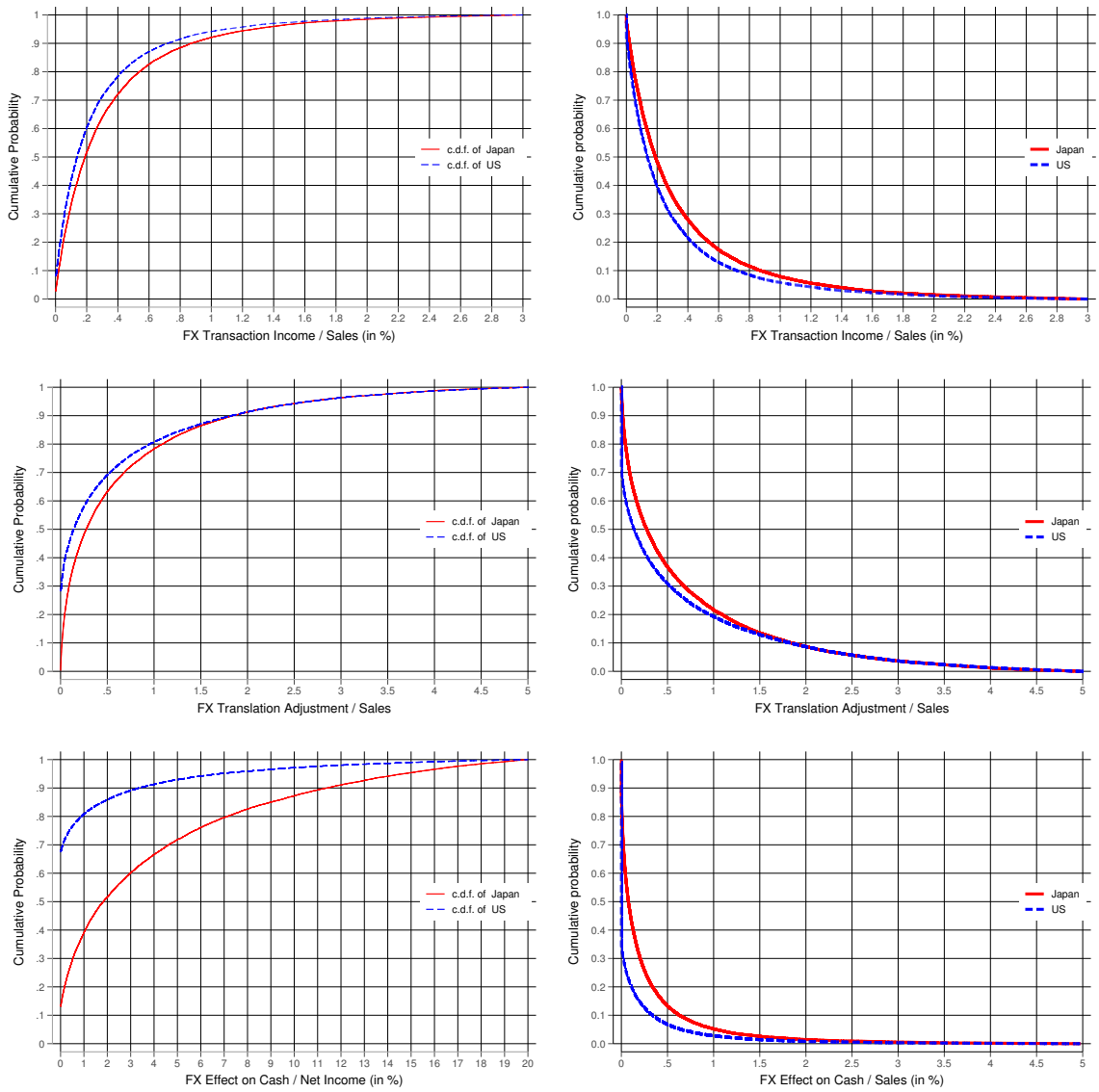
We breakdown firms by type. Table (D4) reports the number of observations, the average and the standard deviation (of the FX transaction and FX translation measures for multinational vs domestic firms

Figure 10. Cumulative Distribution of FX Transaction and Translation Risks (Scaled by Net Income)



This figure presents the firm-year level the distribution of the FX transaction, translation, and effect on cash, all scaled by net income, for both the U.S. and Japanese samples. All variables are reported in absolute values. On the left-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure less than x percent in absolute value. On the right-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure of at most x percent in absolute value. The data are annual. For the U.S, the source is Compustat and the sample period is 1976–2019 for the transaction risk, 2001–2018 for the translation adjustment, and 1982–2018 for the cumulative translation effect. For Japan, the source is Toyo Keizai and the sample period is 1990–2018 for transaction risk, and 2000–2018 for the translation adjustment and cumulative translation variables.

Figure 11. Cumulative Distribution of FX Transaction and Translation Risks (Scaled by Sales)



This figure presents the firm-year level the distribution of the FX transaction, translation, and effect on cash, all scaled by sales, for both the U.S. and Japanese samples. All variables are reported in absolute values. On the left-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure less than x percent in absolute value. On the right-hand side, for each value x on the horizontal axis, the vertical axis denotes the share of firm-year observations that have a transaction/translation exposure of at most x percent in absolute value. The data are annual. For the U.S, the source is Compustat and the sample period is 1976–2019 for the transaction risk and 2001–2018 for the translation adjustment. For Japan, the source is Toyo Keizai and the sample period is 1990–2018 for transaction risk and 2001–2018 for translation adjustments.

D.5 Summary Statistics

Tables (D5) and (D6) present the summary statistics of the firm-level variables in the U.S. sample. Tables (D7) and (D8) are the counterparts for the Japanese sample.

Table D4. FX Transaction and Translation Effects: Domestic vs Multinational Firms

Status	Transaction	Translation	Effect on Cash	Transaction	Translation	Effect on Cash
		U.S.			Japan	
			Panel A: Number of Observations			
Multinational & Exporter	2,723	4,885	7,354	6,626	8,351	8,177
Multinational & Non-exporter	12,336	26,101	38,878	9,524	14,592	13,848
Domestic & Exporter	26	0		2,840	0	
Domestic & Non-exporter	632	0		2,959	0	
Total	15,713	30,167	65,010	21,949	22,581	25,112
			Panel B: Averages			
Multinational & Exporter	0.32	0.88	0.99	0.41	0.99	0.35
Multinational & Non-exporter	0.40	0.97	0.13	0.34	0.76	0.28
Domestic & Exporter	0.11			0.46		
Domestic & Non-exporter	0.55			0.24		
Total	0.39	2.97	0.09	0.36	0.84	0.22
			Panel C: Standard Deviations			
Multinational & Exporter	0.58	1.71	0.26	0.49	2.72	1.59
Multinational & Non-exporter	0.92	1.69	0.30	0.48	1.63	0.65
Domestic & Exporter	0.14			0.52		
Domestic & Non-exporter	1.59			0.39		
Total	0.93	7.35	0.26	0.48	2.10	0.36

This table reports the number of non-zero observations (Panel A), the average (Panel B) and the standard deviation (Panel C) of the FX transaction, translation, and effect on cash for multinational vs domestic firms. Multinationals are the firm-year observations with non-zero foreign subsidiary sales abroad or non-zero FX translation adjustment. Once a firm reports a translation adjustment, it is classified as a multinational thereafter. All the other observations pertain to domestic firms. FX transaction, translation, and effect on cash are in absolute values and scaled by total sales. For the U.S, the source is Compustat and the sample period is 1976–2019 for the transaction risk, 1988-2018 for the FX effect on cash, and 2001–2018 for the translation adjustment. For Japan, the source is Toyo Keizai and the sample period is 2000–2018 for transaction risk, 2000-2017 for FX effect on cash, and 1990–2018 for translation adjustment. The table treats the missing information as missing, not zero exposures.

Table D5. Summary statistics of the Main Firm-Level Variables — U.S Sample

	Obs	Mean	St Deviation	Min	1perc	5perc	25perc	Median	75perc	95perc	99perc	Max
Sales	60,477	1,325	3,112	0	0	1	40	209	980	6,885	17,200	26,662
Foreign Sales	42,616	437	1,430	0	0	0	0	6	151	2,338	8,224	14,801
Net Income	59,754	68	245	-491	-258	-73	-5	4	44	438	1,340	2,284
Assets	60,970	2,434	7,639	1	3	8	54	240	1,278	11,894	39,714	116,539
Equity	60,298	640	1,561	0	1	4	26	106	465	3,252	8,972	13,384
FX Transaction Income	12,580	-1	10	-84	-47	-16	-1	-0	0	7	29	56
FX Transaction Income / Sales	12,556	-0.08	0.61	-5.55	-2.30	-0.89	-0.21	-0.03	0.07	0.64	1.78	3.87
FX Transaction Income / Net Income	12,635	-0.53	11.99	-90.04	-45.57	-15.77	-2.27	-0.04	1.35	13.04	43.73	87.77
FX Translation Adjustment	33,601	-2	29	-267	-130	-32	-0	0	0	21	94	191
FX Translation Adjustment / Sales	33,045	-0.02	1.31	-7.54	-4.84	-2.04	-0.16	0.00	0.12	1.99	4.42	7.41
FX Translation Adjustment / Net Income	33,659	-0.82	26.48	-194.78	-101.44	-35.35	-2.03	0.00	1.06	30.76	94.17	176.65
FFX Effect on Cash	50,017	-0	3	-29	-14	-2	0	0	0	1	7	16
FX Effect on Cash / Sales	49,113	-0.02	0.22	-1.57	-0.93	-0.34	0.00	0.00	0.00	0.23	0.74	1.21
FX Effect on Cash / Net Income	50,108	-0.15	3.42	-26.40	-14.72	-4.17	0.00	0.00	0.00	3.07	11.97	22.70
Cumulative Translation Adjustment	32,279	-12	66	-738	-343	-86	-2	0	0	19	107	208
Cumulative Translation Adjustment / Equity	32,353	-1.25	6.27	-58.30	-30.24	-10.98	-1.00	0.00	0.03	4.62	12.12	22.68
Cumulative Translation Adjustment / Assets	32,380	-0.38	1.87	-12.16	-8.30	-3.89	-0.45	0.00	0.01	1.91	4.30	6.27
FX Transaction Income / Sales (Abs Value)	65,334	0.08	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.37	12.47
FX Transaction / Net income (Abs Value)	65,334	1.44	7.86	0.00	0.00	0.00	0.00	0.00	0.00	2.15	29.16	162.96
FX Translation / Sales (Abs Value)	65,334	0.38	1.10	0.00	0.00	0.00	0.00	0.00	0.16	1.11	5.61	14.91
FX Translation / Net income (Abs Value)	65,334	5.84	18.10	0.00	0.00	0.00	0.00	0.00	1.76	15.87	99.57	194.78
FX Effect on Cash / Sales (Abs Value)	65,334	0.08	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.22	1.29	2.40
FX Effect on Cash / Net income (Abs Value)	65,334	0.89	2.87	0.00	0.00	0.00	0.00	0.00	0.00	2.41	15.94	26.40
CTA / Assets (Abs Value)	65,334	0.51	1.40	0.00	0.00	0.00	0.00	0.00	0.20	1.57	7.40	12.98
CTA / Equity (Abs Value)	65,334	1.54	5.40	0.00	0.00	0.00	0.00	0.00	0.44	3.93	26.74	73.74
FX Betas (Abs Value)	65,334	1.05	1.09	0.00	0.01	0.06	0.30	0.70	1.42	2.51	5.12	6.35
FX Betas	65,334	-0.05	1.51	-6.35	-4.57	-2.58	-0.74	-0.04	0.65	1.59	4.42	6.01

This table reports the summary statistics of the variables used in the analysis of U.S. firms. All variables in levels (sales, foreign sales, FX transaction income, FX translation effects, and cumulative FX translation effects) are reported in millions of U.S. dollars, while the ratios are reported in percentages. The variables in levels are winsorized at the 1% threshold. In the last three rows, the missing values in the FX exposures were replaced with zeros. The data are annual and the sample period is 1976–2018.

Table D6. Summary statistics of Additional Firm-Level Variables — U.S Sample

	Obs	Mean	St Deviation	Min	1perc	5perc	25perc	Median	75perc	95perc	99perc	Max
Net Investment	46,977	6.97	41.29	-86.49	-67.20	-37.23	-7.73	1.86	12.99	61.59	173.33	541.86
Growth in PPE	50,919	11.87	29.91	-76.13	-52.01	-18.93	1.30	6.61	15.83	56.12	139.57	344.54
Cash	51,167	-55.27	381.31	-5,777.98	-1,802.66	-358.59	-0.34	10.21	25.01	91.84	226.24	432.98
Market/Book	60,452	1.78	1.43	-1.36	0.32	0.67	0.98	1.29	2.01	4.74	7.99	11.20
Debt Issues	49,076	23.55	77.62	0.00	0.00	0.00	0.00	0.69	13.02	108.54	412.16	982.30
Debt Repayment	49,623	17.55	49.68	0.00	0.00	0.00	0.06	2.89	12.06	80.38	268.84	600.55
Net Debt Issues	47,702	3.87	37.19	-161.29	-70.11	-21.50	-2.81	0.00	2.17	37.52	180.28	471.16
Changes in Current Debt	26,350	0.31	20.33	-170.06	-65.07	-15.17	-0.51	0.00	0.34	15.35	74.48	270.55
Payout Ratio	57,108	16.45	33.13	-88.37	-32.79	0.00	0.00	0.00	25.21	83.33	144.55	227.27
Market Capitalization	34,737	2,398	6,562	1	2	9	68	338	1,484	12,054	37,234	64,430
Sales Outstanding	58,017	60	46	0	0	6	36	54	73	127	254	502
Payables Outstanding	57,628	63	99	4	5	10	24	38	61	185	553	1,288
Inventories	57,783	10.57	12.37	0.00	0.00	0.00	0.94	7.52	15.65	31.81	59.27	106.66
Return on Assets	58,830	-6.17	29.22	-239.77	-140.62	-63.56	-5.58	2.91	6.78	15.01	23.09	32.50
Profit Margin	55,950	-11.13	57.39	-485.53	-325.54	-101.70	-3.54	3.28	8.13	18.94	32.68	52.90
Age	23,832	10	6	3	3	3	5	8	13	22	26	28

This table reports the summary statistics of the variables used in the analysis of U.S. firms. All variables in ratios are reported in percentages. The variables in levels are winsorized at the 1% threshold. Investment is defined as capital expenditure (item No. 128) normalized by the lagged book value of properties, plant and equipment (PPE: item No. 8). Growth in PPE is the yearly growth in PPE (item No. 8). Cash is defined as income before extraordinary items + depreciation and amortization (item No. 14 + item No. 18) normalized by lagged PPE (item No. 8). Market/Book is defined as the market value of assets + shares outstanding × share price at end of fiscal year − book value of equity − deferred tax liabilities (item No. 6 + (item No. 25 × item No. 24) − item No. 60 − item No. 74), normalized by their book value (item No. 6). Debt Issues is defined as item No. 111 normalized by lagged PPE (item No. 8). Debt Repayment is defined as item No. 114 normalized by lagged PPE (item No. 8). Net Debt Issues is defined as Debt Issuance minus Debt Repayment. Changes in current debt is defined as item No. 301 normalized by lagged PPE (item No. 8). Payout ratio is defined as dividend per share (item No. 201) scaled by earnings per share (item No. 57). Market capitalization is given by the variable MKVALT. Sales outstanding are given in days and defined as total receivables (item No. 2) scaled by total sales (item No. 12) and multiplied by 365 days. Payables outstanding are given in days and defined as account payable (item No. 70) scaled by Cost of Goods Sold (item No. 41) and multiplied by 365. Inventories are total inventories (item No. 3) scaled by total sales (item No.12). Return on Equity is computed as the ratio of net income (item No. 172) to total shareholders equity (item No. 60). Age is computed as the difference between the balance sheet year and the firm's IPO year (variable IPODATE). The sample period is 1976–2018.

Table D7. Summary statistics of the Main Firm-Level Variables — Japanese Sample

	Obs	Mean	St Deviation	Min	1perc	5perc	25perc	Median	75perc	95perc	99perc	Max
Sales	30,450	145,675	289,544	1,640	2,690	5,520	18,300	43,400	127,000	639,000	1,560,000	2,550,000
Net income	30,358	2,996	8,316	-22,000	-9,670	-2,160	125	715	2,610	17,300	43,600	73,300
Assets	30,394	182,546	409,867	2,150	3,180	6,270	19,000	44,800	126,000	944,000	2,240,000	3,710,000
Equity	30,389	58,949	114,168	508	888	2,040	7,210	18,300	51,500	277,000	630,000	935,000
FX Transaction Income	14,679	-34	795	-5,590	-3,280	-1,040	-111	-3	80	909	2,770	4,900
FX Transaction Income / Net Income	14,670	-0.52	33.93	-236.57	-135.19	-44.52	-6.46	0.00	6.53	42.86	113.04	204.48
FX Transaction Income / Sales	14,674	-0.03	0.52	-2.39	-1.65	-0.90	-0.22	-0.01	0.16	0.78	1.64	2.59
FX Translation Adjustment	14,761	-85	2,659	-21,230	-10,500	-3,100	-168	-3	102	2,510	10,100	18,500
FX Translation Adjustment / Sales	14,642	-0.02	1.12	-4.91	-3.60	-1.84	-0.32	-0.01	0.23	1.90	3.79	5.28
FX Translation Adjustment / Net Income	14,638	-1.31	54.35	-352.79	-204.10	-80.39	-10.16	-0.10	9.14	72.90	187.05	323.15
FX Effect on Cash	16,551	-5	687	-4,740	-2,780	-737	-39	0	33	690	2,650	5,030
FX Effect on Cash / Sales	16,526	0.00	0.36	-1.74	-1.14	-0.54	-0.08	0.00	0.07	0.58	1.30	1.90
FX Effect on Cash / Net Income	16,542	0.17	17.61	-117.05	-64.76	-22.45	-2.46	0.00	2.71	23.66	64.49	105.63
Cumulative Translation Adjustment	13,772	-1,293	5,479	-52,500	-30,300	-8,850	-619	-36	47	1,620	6,990	14,800
Cumulative Translation Adjustment / Equity	13,731	-1.52	4.76	-35.11	-21.77	-10.38	-2.11	-0.22	0.27	3.50	7.42	10.50
Cumulative Translation Adjustment / Assets	13,738	-0.49	1.63	-9.02	-6.70	-3.79	-0.85	-0.09	0.12	1.62	3.37	4.37
FX Transaction Income / Sales (Abs Value)	32,203	0.16	0.36	0.00	0.00	0.00	0.00	0.00	0.15	0.49	1.87	3.63
FX Transaction / Net income (Abs Value)	32,203	7.48	21.07	0.00	0.00	0.00	0.00	0.00	4.89	20.00	115.90	223.85
FX Translation / Sales (Abs Value)	32,203	0.31	0.77	0.00	0.00	0.00	0.00	0.00	0.21	1.00	4.01	6.80
FX Translation / Net income (Abs Value)	32,203	12.32	33.94	0.00	0.00	0.00	0.00	0.00	7.01	34.73	186.05	352.79
FX Effect on Cash / Sales (Abs Value)	32,203	0.11	0.28	0.00	0.00	0.00	0.00	0.00	0.08	0.33	1.47	2.77
FX Effect on Cash / Net income (Abs Value)	32,203	4.27	11.73	0.00	0.00	0.00	0.00	0.00	2.61	12.00	64.71	117.05
CTA / Assets (Abs Value)	32,203	0.44	1.09	0.00	0.00	0.00	0.00	0.00	0.28	1.43	5.67	9.33
CTA / Equity (Abs Value)	32,203	1.17	3.23	0.00	0.00	0.00	0.00	0.00	0.64	3.49	16.17	38.30
FX Betas (Abs Value)	33,102	0.80	0.65	0.01	0.02	0.06	0.29	0.63	1.16	2.13	2.73	3.20
FX Betas	33,102	-0.39	0.91	-3.20	-2.58	-1.98	-0.96	-0.34	0.18	0.74	1.84	2.26

This table reports some summary statistics of the main variables used in the analysis of Japanese firms. All variables in levels (sales, FX transaction income, FX translation effects, and cumulative FX translation effects) are reported in millions of Yen, while the ratios are reported in percentages. The variables in levels are winsorized at the 1% threshold. In the last three rows, the missing values in the FX exposures were replaced with zeros. The source is Toyo Keizai and the sample period is 1990–2017.

D.6 Persistence of FX Risk Exposures

How persistent are our measures of FX risk exposure? To answer this question, we estimate a simple AR(1) process with a one-year lag for the FX exposure variables, with firm and year fixed effects:

$$FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}. \tag{26}$$

FX transaction, translation, and effect on cash are scaled by sales, whereas cumulative translation adjustment is scaled by total assets. We focus on the sample of firms that report some exposure (including 0).We consider the raw FX exposures values, as well as their absolute values; as the changes in exchange rates are close to $i.i.d$, FX exposures may often flip sign. To correct for any industry level correlations, standard errors are clustered at the two-digit industry level. The results are presented in Tables **??**, **??**, **??** and **??**. In panel regressions on Japanese data, the persistence coefficients ρ are all around 0.1 for the FX transaction, translation, and effect on cash, whether in absolute values or not. In U.S. data, only the absolute values of FX exposure are significantly persistent. The persistent translation exposure is consistent with the behavior of multinational firms: **?** argue that these firms, after their initial investment abroad, find it difficult to relocate their operations and choose to absorb negative shocks instead. The cumulative translation adjustments are by construction persistent, and the associate ρ coefficients are above 0.5 in both countries.

D.7 Exchange Rates and Macroeconomic Variables

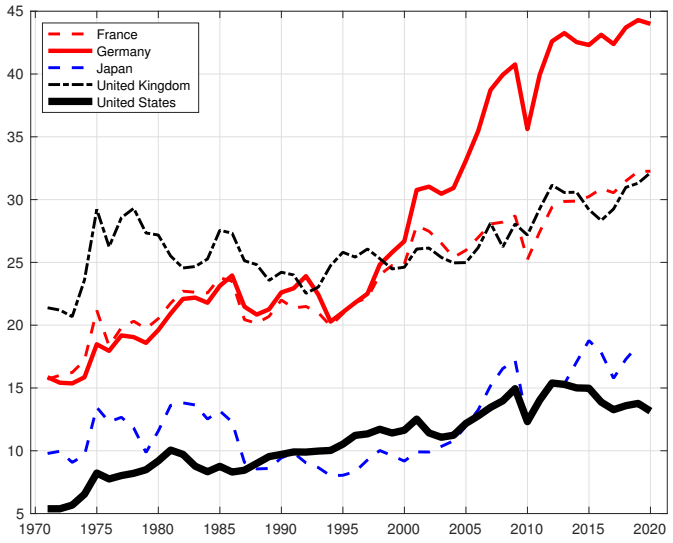
Figure 12 reports the average of exports and imports, scaled by GDP, in five developed countries: France, Germany, Japan, U.K., and U.S. Japan and the U.S. appear relatively similar in this dimension; the two economies are much closer than France, Germany, and the U.K.

Table D8. Summary statistics of Additional Firm-Level Variables — Japanese Sample

	Obs	Mean	St Deviation	Min	1perc	5perc	25perc	Median	75perc	95perc	99perc	Max
Net Investment	28,256	4.96	15.77	-41.11	-26.50	-11.46	-2.50	1.67	8.76	31.70	70.59	130.65
Growth in PPE	28,277	2.60	14.17	-44.01	-28.57	-13.27	-3.85	0.00	6.19	27.31	59.18	109.74
Cash	21,217	14.84	10.39	1.22	1.74	2.99	7.13	12.26	19.80	36.26	49.40	56.88
Growth in Debt	28,004	1.79	16.02	-46.06	-34.29	-20.77	-6.85	0.00	8.16	29.75	59.05	93.29
Tobin's Q	30,320	1.49	1.39	0.20	0.26	0.36	0.66	1.07	1.79	4.08	7.53	12.01
Payout Ratio	17,319	41.28	52.41	0.00	0.00	5.45	16.95	27.05	44.29	123.81	303.16	515.06
Market Capitalization	33,582	111,460	426,975	3	701	1,720	6,378	18,378	66,380	519,377	1,492,895	40,314,940
Sales Outstanding	9,931	80	37	5	9	20	53	78	105	145	171	194
Payables Outstanding	29,126	68	35	5	9	18	40	65	93	131	153	169
Inventories	28,839	12.45	10.25	0.10	0.20	0.76	4.87	10.48	17.18	31.50	49.68	71.24
Return on Assets	29,309	1.76	3.65	-18.63	-11.95	-4.67	0.52	1.80	3.60	7.18	10.08	12.56
Profit Margin	30,948	1.67	5.34	-39.42	-20.70	-6.43	0.38	1.73	3.81	9.01	14.71	19.01
Age	32,985	54	21	5	8	18	41	54	67	90	102	110

This table reports some summary statistics of the main variables used in the analysis of Japanese firms. All variables in ratios are reported in percentages. The variables in levels are in millions of Yen and winsorized at the 1% threshold. Investment is defined as capital expenditure (item No. 656) normalized by the lagged book value of properties, plant and equipment (PPE: item No. 535). Growth in PPE is the quarterly growth in PPE (item No. 535). Cash is defined as cash and equivalents at end of period (item No. 1179) normalized by lagged PPE (item No. 535). Changes in debt is computed as the year on year growth in the book value of debt. Market/Book is defined as the market value of equity + the book value of debt scaled by the book value of total assets (item No. 60). The market value of equity is computed as the number of shares outstanding (item No. 253) x the share price at end of the fiscal year obtained from Datastream stock return data. The book value of debt is computed as the book value of assets (item No. 60) − book value of equity (item No. 64) − deferred tax liabilities (item No. 747). The payout ratio is defined as total dividend paid (item No. 1170) scaled by earnings (item No. 12). Market Capitalization is computed as the number of shares outstanding (item No. 253) x the share price at end of year obtained from Datastream. Sales outstanding are given in days and defined as total receivables (item No. 464) scaled by total sales (item No. 6) and multiplied by 365 days. Payables outstanding are given in days and defined as account payable (item No. 704) scaled by Cost of Goods Sold (item No. 912) and multiplied by 365. Inventories are total inventories (item No. 489) scaled by total sales (item No.6). Return on Equity is computed as the ratio of net income (item No. 12) to total shareholders equity (item No. 64). Age is computed as the difference between the balance sheet year and the firm's establishment year (attribute No. 28). The source is Toyo Keizai and the sample period is 1990-2017.

Figure 12. Trade Openness



This figure reports the average of exports and imports, scaled by GDP, in five developed countries: France, Germany, Japan, U.K., and U.S.

Table D14 reports the results from the following regressions

$$\Delta y_{t+1} = \alpha_0 + \alpha_1 \Delta s_{t+1} + \varepsilon_{t+1},$$

at the quarterly and annual frequencies, where y denotes GDP, corporate investment, exports or imports in Japan. Table D15 reports similar results for the U.S. All the slope coefficients are insignificant, in line with the exchange rate disconnect puzzle.

Table D9. Persistence of FX Exposure at the Firm Level - Japan

	FX Transaction / Sales			FX Effect on Cash / Sales		
	(1)	(2)	(3)	(4)	(5)	(6)
|FX Transaction Income| / Sales	0.15***					
	(10.51)					
FX Transaction Income / Sales		0.13***				
		(8.02)				
FX Transaction Income (Dummy)			0.46***			
			(57.63)			
|FX Effect on Cash| / Sales				0.12***		
				(7.75)		
FX Effect on Cash / Sales					0.11***	
					(6.92)	
FX Effect on Cash (Dummy)						0.56***
						(69.69)
Constant	0.16***	-0.14***	0.11***	0.09***	0.15***	-0.04***
	(6.23)	(-4.08)	(8.15)	(12.57)	(14.67)	(-7.81)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	12,188	12,188	31,678	14,783	14,783	31,678
R-squared	0.4516	0.3273	0.6926	0.5576	0.3666	0.7986

This table presents the persistence in exposure to foreign exchange risk in the Japanese sample. The estimated regressions are AR(1) processes with the following general specification: $FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}$. $FX_{i,t}^{exposure}$ denotes FX transaction income scaled by sales in the first three columns, and FX effect on cash scaled by sales in the last three columns. Columns (1) and (3) use the absolute values of FX exposures. Columns (2) and (4) present the result for the variables in scaled levels. Columns (3) and (6) present results for the dummy variables indicating a non-zero exposure. All regressions control for firm and year fixed effects, and heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table D10. Persistence of FX Exposure at the Firm Level - US

	FX Transaction / Sales			FX Effect on Cash / Sales		
	(1)	(2)	(3)	(4)	(5)	(6)
|FX Transaction Income| / Sales	0.16***					
	(7.21)					
FX Transaction Income / Sales		-0.03				
		(-1.03)				
FX Transaction Income (Dummy)			0.68***			
			(87.05)			
|FX Effect on Cash| / Sales				0.36***		
				(5.85)		
FX Effect on Cash / Sales					-0.03	
					(-0.69)	
FX Effect on Cash (Dummy)						0.76***
						(123.18)
Constant	0.25***	-0.08***	0.09***	0.04***	-0.01	-0.01***
	(12.48)	(-3.02)	(8.68)	(3.31)	(-0.47)	(-5.74)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	10,794	10,794	56,641	40,776	40,776	56,808
R-squared	0.5193	0.2926	0.8388	0.2338	0.2049	0.8902

This table presents the persistence in exposure to foreign exchange risk in the US sample. The estimated regressions are AR(1) processes with the following general specification: $FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}$. $FX_{i,t}^{exposure}$ denotes FX transaction income scaled by sales in the first three columns, and FX effect on cash scaled by sales in the last three columns. Columns (1) and (3) use the absolute values of FX exposures. Columns (2) and (4) present the result for the variables in scaled levels. Columns (3) and (6) present results for the dummy variables indicating a non-zero exposure. All regressions control for firm and year fixed effects, and heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table D11. Persistence of FX Exposure at the Firm Level - US

	FX Translation / Sales			CTA / Assets		
	(1)	(2)	(3)	(4)	(5)	(6)
|FX Translation Adjustment| / Sales	0.01***					
	(2.75)					
FX Translation Adjustment / Sales		-0.00				
		(-0.54)				
FX Translation Adjustment (Dummy)			0.72***			
			(51.98)			
|CTA| / Assets				0.62***		
				(45.25)		
CTA / Assets					0.72***	
					(57.10)	
CTA (Dummy)						0.74***
						(60.88)
Constant	-0.04	-0.68***	-0.01	0.63***	-0.79***	-0.01
	(-0.78)	(-9.26)	(-0.42)	(8.44)	(-9.93)	(-0.64)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	25,948	25,948	56,641	25,189	25,189	56,641
R-squared	0.5732	0.2904	0.8811	0.7607	0.7747	0.8852

This table presents the persistence in exposure to foreign exchange risk in the US sample. The estimated regressions are AR(1) processes with the following general specification: $FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}$. $FX_{i,t}^{exposure}$ denotes FX translation adjustment scaled by sales in the first three columns, and cumulative translation adjustment scaled by assets in the last three columns. Columns (1) and (3) use the absolute values of FX exposures. Columns (2) and (4) present the result for the variables in scaled levels. Columns (3) and (6) present results for the dummy variables indicating a non-zero exposure. All regressions control for firm and year fixed effects, and heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table D12. Persistence of FX Exposure at the Firm Level - Japan

	FX Transaction / Sales			FX Effect on Cash / Sales		
	(1)	(2)	(3)	(4)	(5)	(6)
|FX Transaction Income| / Sales	0.15***					
	(10.51)					
FX Transaction Income / Sales		0.13***				
		(8.02)				
FX Transaction Income (Dummy)			0.46***			
			(57.63)			
|FX Effect on Cash| / Sales				0.12***		
				(7.75)		
FX Effect on Cash / Sales					0.11***	
					(6.92)	
FX Effect on Cash (Dummy)						0.56***
						(69.69)
Constant	0.16***	-0.14***	0.11***	0.09***	0.15***	-0.04***
	(6.23)	(-4.08)	(8.15)	(12.57)	(14.67)	(-7.81)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	12,188	12,188	31,678	14,783	14,783	31,678
R-squared	0.4516	0.3273	0.6926	0.5576	0.3666	0.7986

This table presents the persistence in exposure to foreign exchange risk in the Japanese sample. The estimated regressions are AR(1) processes with the following general specification: $FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}$. $FX_{i,t}^{exposure}$ denotes FX transaction income scaled by sales in the first three columns, and FX effect on cash scaled by sales in the last three columns. Columns (1) and (3) use the absolute values of FX exposures. Columns (2) and (4) present the result for the variables in scaled levels. Columns (3) and (6) present results for the dummy variables indicating a non-zero exposure. All regressions control for firm and year fixed effects, and heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table D13. Persistence of FX Exposure at the Firm Level - Japan

	FX Translation / Sales			CTA / Assets		
	(1)	(2)	(3)	(4)	(5)	(6)
|FX Translation Adjustment| / Sales	0.10***					
	(6.78)					
FX Translation Adjustment / Sales		0.11***				
		(7.11)				
FX Translation Adjustment (Dummy)			0.73***			
			(103.51)			
|CTA| / Assets				0.52***		
				(34.25)		
CTA / Assets					0.63***	
					(45.82)	
CTA (Dummy)						0.72***
						(104.78)
Constant	0.35***	-0.03	-0.03***	0.07	0.05	-0.03***
	(3.52)	(-0.18)	(-6.95)	(0.74)	(0.54)	(-7.91)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	13,082	13,082	31,678	12,317	12,317	31,678
R-squared	0.6054	0.3994	0.8835	0.7233	0.7640	0.8766

This table presents the persistence in exposure to foreign exchange risk in the Japanese sample. The estimated regressions are AR(1) processes with the following general specification: $FX_{i,t}^{exposure} = \alpha_i + \gamma_t + \rho FX_{i,t-1}^{exposure} + \epsilon_{i,t}$. $FX_{i,t}^{exposure}$ denotes FX translation adjustment scaled by sales in the first three columns, and cumulative translation adjustment scaled by assets in the last three columns. Columns (1) and (3) use the absolute values of FX exposures. Columns (2) and (4) present the result for the variables in scaled levels. Columns (3) and (6) present results for the dummy variables indicating a non-zero exposure. All regressions control for firm and year fixed effects, and heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table D14. Exchange Rate Changes and Macro Variables — Japan

	(1) GDP	(2) Investment	(3) Exports	(4) Imports
		Quarterly Data		
Yen index return	-0.03	-0.04	-0.03	0.07
	(-1.17)	(-1.29)	(-0.32)	(1.31)
Constant	0.03	0.04	1.04***	0.93***
	(1.24)	(1.27)	(11.69)	(16.66)
Obs	107	107	107	107
R-squared	0.01	0.02	0.00	0.02
		Annual Data		
Yen index return	0.14	0.10	0.33	0.35
	(0.24)	(0.17)	(0.27)	(0.27)
Constant	-0.09	-0.06	0.81	0.80
	(-0.16)	(-0.11)	(0.66)	(0.62)
Obs	27	27	27	27
R-squared	0.00	0.00	0.00	0.00

Table D15. Exchange Rate Changes and Macro Variables — US

	(1) GDP	(2) Investment	(3) Exports	(4) Imports
		Quarterly Data		
US Dollar index return	-0.02	0.03	-0.19	-0.01
	(-0.73)	(0.53)	(-0.78)	(-0.05)
Constant	0.03	-0.02	1.19***	1.02***
	(0.92)	(-0.40)	(4.96)	(4.19)
Obs	163	163	164	164
R-squared	0.00	0.00	0.00	0.00
		Annual Data		
US Dollar index return	0.03	0.22	-0.08	0.23
	(0.55)	(1.38)	(-0.17)	(0.46)
Constant	-0.01	-0.19	0.11	-0.20
	(-0.10)	(-1.17)	(0.21)	(-0.41)
Obs	40	40	41	41
R-squared	0.01	0.05	0.00	0.01

E Appendix: FX Effects on Real variables

Figures (13) and (14) report the histograms of the first-stage coefficients and their t-statistics obtained in the following regressions:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ represents, respectively from top to bottom, the FX transaction income scaled by sales, the FX translation adjustment scaled by sales, and the FX effect on cash scaled by sales, Δs_t denotes the change in the yen. All regressions control for firm fixed effects ($\delta_{0,i}$). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment.

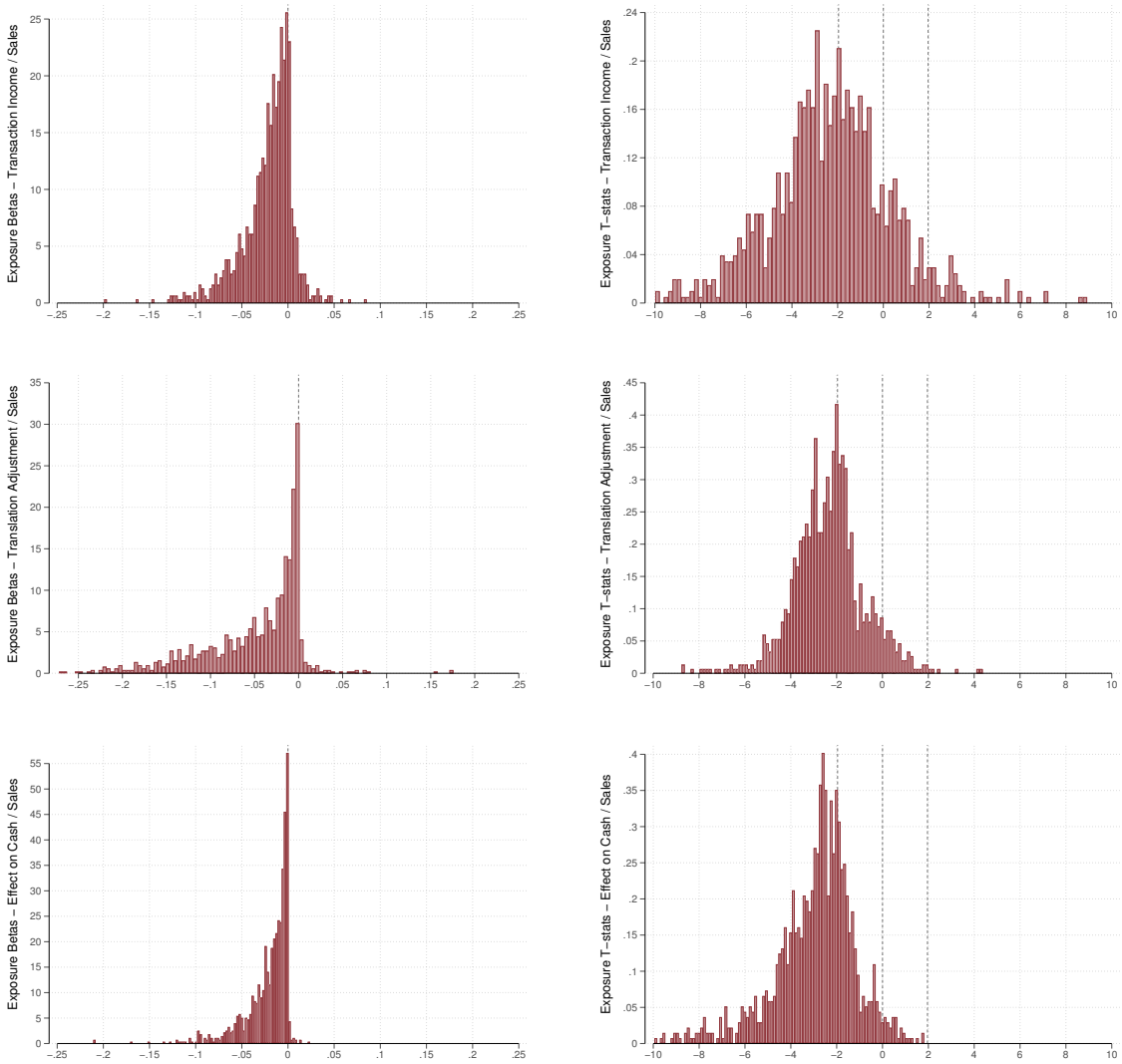
Table E1 reports the determinants of FX transaction income in the subsample of firms that are exposed to that risk.

Table E2 reports similar tests for other measures of FX exposures, namely FX translation and FX effect on cash.

Tables E4 and E5 reports the impact of the FX transaction income on the firms' net profits and investment estimated by OLS.

Tables E6 and E7 reports the impact of the FX transaction income on the firms' net profits and investment, adding macroeconomic variables as controls, on top of the time fixed effects.

Figure 13. Exchange Rate Loadings of Japanese Firms' FX Exposure

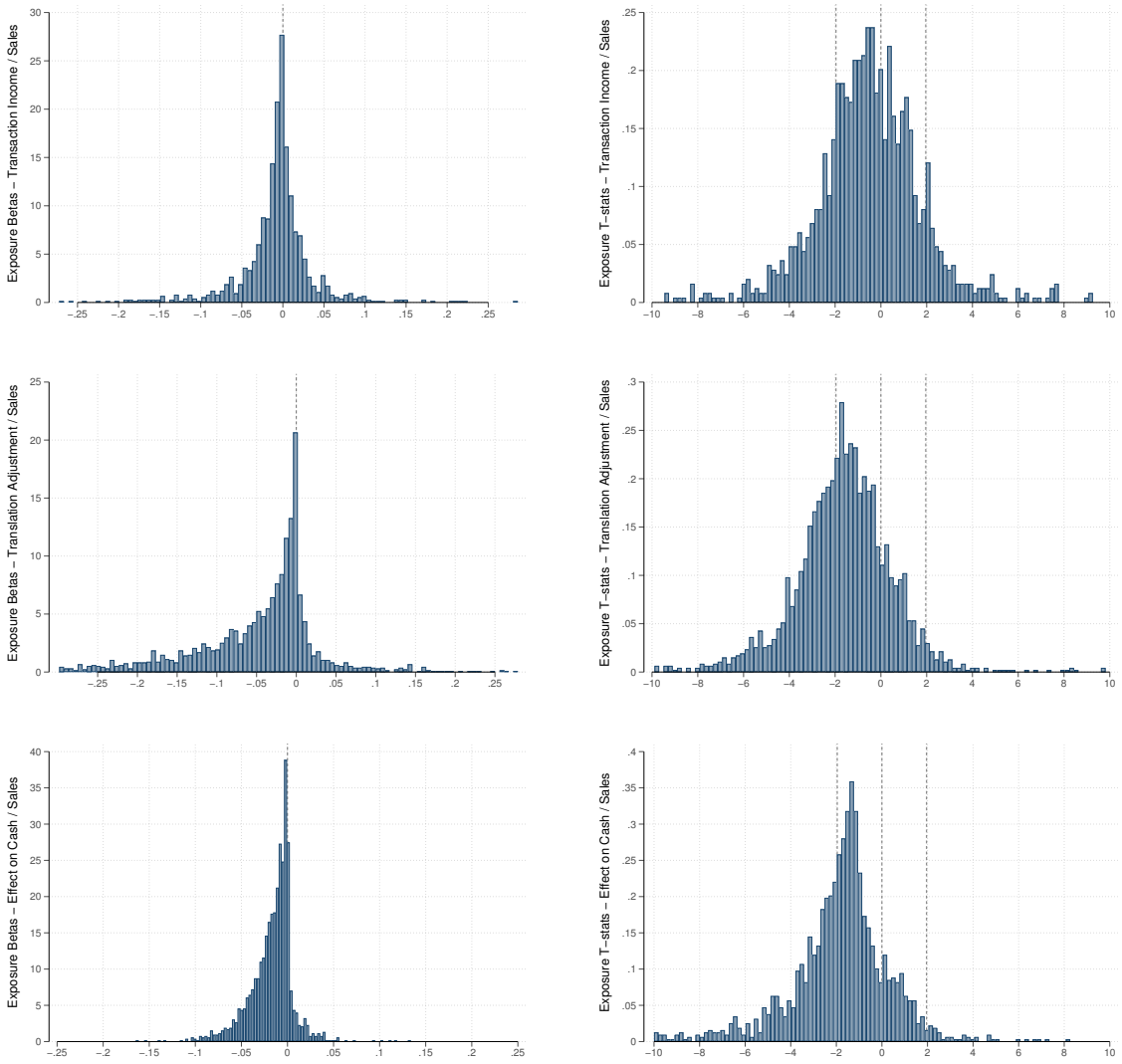


This figure presents the histograms of individual firms' slope coefficients $\delta_{1,i}$ (left) and t-statistics (right) estimated from regressions of foreign currency exposures on changes in the yen index. The figures focus, respectively from top to bottom, on the FX transaction income scaled by sales, the FX translation adjustment scaled by sales, and the FX effect on cash scaled by sales used in the following regressions:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$

where Δs_t denotes the change in the yen. All regressions control for firm fixed effects ($\delta_{0,i}$). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment. All variables are expressed in percentages. The data are annual and the estimation period is 1990–2017. The standard errors are obtained by a heteroskedasticity and autocorrelation consistent estimation following **?**. Slope coefficients (t-statistics) graphs were truncated to the [-0.3, 0.3] ([-10,10]) interval on the horizontal axis, respectively. All charts depict density histograms with 100 bins.

Figure 14. Exchange Rate Loadings of U.S Firms' FX Exposure

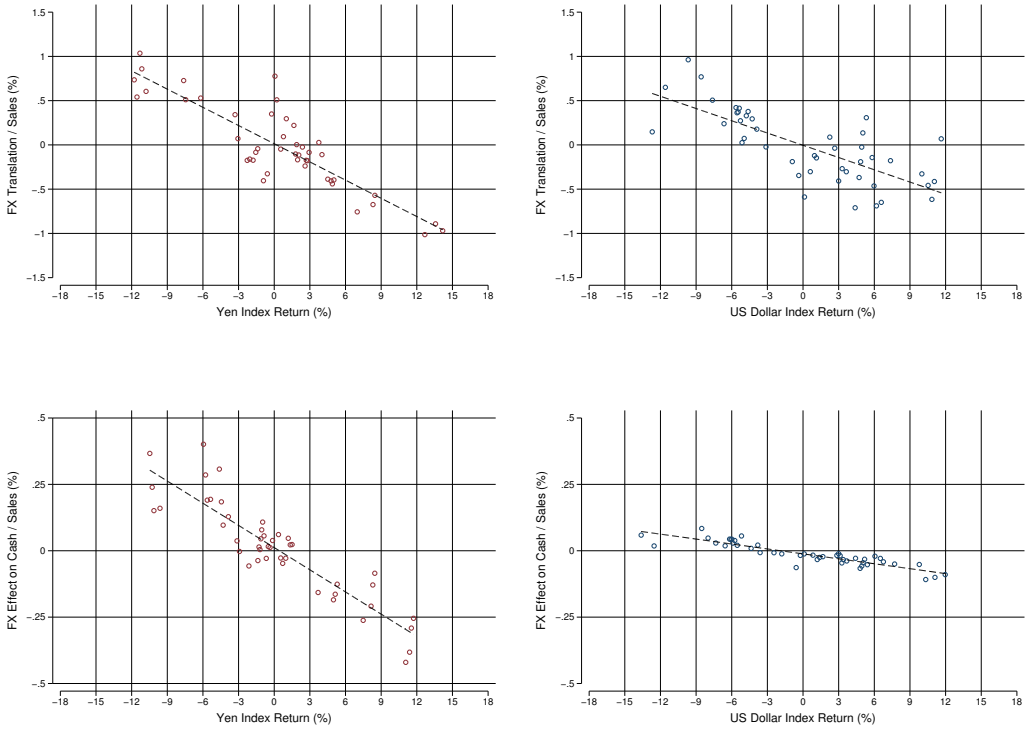


This figure presents the histograms of individual firms' slope coefficients $\delta_{1,i}$ (left) and t-statistics (right) estimated from regressions of foreign currency exposures on changes in the yen index. The figures focus, respectively from top to bottom, on the FX transaction income scaled by sales, the FX translation adjustment scaled by sales, and the FX effect on cash scaled by sales used in the following regressions:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$

where Δs_t denotes the change in the U.S. dollar index. All regressions control for firm fixed effects ($\delta_{0,i}$). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment. All variables are expressed in percentages. The data are annual and the estimation period is 1990–2017. The standard errors are obtained by a heteroskedasticity and autocorrelation consistent estimation following **?**. Slope coefficients (t-statistics) graphs were truncated to the [-0.3, 0.3] ([-10,10]) interval on the horizontal axis, respectively. All charts depict density histograms with 100 bins.

Figure 15. Foreign Currency Translation and Exchange Rates



This figure presents bin scatter plots of the correlation between FX exposures and the exchange rate index return for Japan (left panel) or the US (right panel). The regressions follow the specification below:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX translation risk (upper panels) or the FX effect on cash (lower panels), both scaled by sales, and Δs_t denotes the yearly change of the yen index or dollar index (a positive change indicates a yen or a dollar appreciation). All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), the lagged payout ratio (defined as dividends divided by net income), and Tobin's Q. The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment, and the exchange rate volatility (obtained as as the yearly standard deviation of daily percentage returns). The figures present 45 bins of firm-year observations sorted by exposure. The data are annual and the estimation period is 1990–2017.

Table E1. FX Transaction Income and Exchange Rates — Exposed Firms

	FX Transaction in Japan, scaled by				FX Transaction in U.S., scaled by			
	Sales		Net Income		Sales		Net Income	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FX Index Return	-2.85***	-2.58***	-50.02***	-56.38***	-0.44***	-0.42***	-1.08	-1.34
	(-12.86)	(-6.18)	(-8.07)	(-7.75)	(-7.65)	(-6.92)	(-0.97)	(-1.10)
Sales Growth		0.76		-2.41		0.00		-0.00***
		(0.80)		(-1.69)		(0.04)		(-2.78)
Log Assets (Lag)		-0.09		2.97**		-0.01		-0.09
		(-0.93)		(2.62)		(-0.97)		(-0.92)
Leverage (Lag)		-0.40		2.52		0.00		0.00
		(-1.22)		(0.87)		(0.83)		(0.30)
Payout Ratio (Lag)		-0.15		-11.44		-0.02		2.01
		(-1.05)		(-1.56)		(-0.18)		(0.74)
Tobin's Q		0.00		0.10		0.54**		-3.96
		(0.55)		(1.39)		(2.32)		(-1.44)
FX Volatility		-0.02		3.02		-0.01		0.09
		(-0.09)		(1.06)		(-0.10)		(0.12)
Market Return		-0.00		0.03		0.00		0.00
		(-0.80)		(0.94)		(1.57)		(0.16)
SMB		0.00		-0.02		-0.00		-0.02**
		(0.17)		(-0.30)		(-0.74)		(-2.12)
HML		-0.00		0.01		0.00*		0.00
		(-0.72)		(0.13)		(1.71)		(0.38)
GDP Growth		-0.00		0.48*		0.00***		0.00
		(-0.17)		(1.94)		(4.05)		(1.65)
Net Exports Growth		0.00		-0.00		-0.00**		-0.01**
		(0.47)		(-1.33)		(-2.71)		(-2.36)
Investment Growth		0.00		-0.42*		-0.01***		-0.03
		(0.18)		(-1.88)		(-3.66)		(-1.19)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	17,450	17,450	17,450	17,450	11,310	11,310	11,362	11,362
R-squared	0.18	0.18	0.10	0.10	0.25	0.26	0.20	0.20

This table reports the results of the following regressions:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction risk (scaled by sales or by net income), Δs_t denotes the yearly change of the yen index or dollar index (a positive change indicates a yen or a dollar appreciation). All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points to improve the readability of the slope coefficient. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the year level. t-statistics are reported in parentheses.

Table E2. FX Translation & FX Effect on Cash and Exchange Rates

	Japan				US			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FX Effect on Cash		FX Translation		FX Effect on Cash		FX Translation	
FX Index Return	-1.00***	-1.02***	-2.36***	-3.39***	-0.61***	-0.61***	-2.98***	-3.00***
	(-4.44)	(-3.07)	(-3.42)	(-5.51)	(-8.29)	(-8.07)	(-4.72)	(-4.91)
Sales Growth		0.01		0.02		-0.00		0.00
		(0.16)		(0.27)		(-0.69)		(0.26)
Assets (Log, Lag)		-0.01		-0.08		-0.01		0.01
		(-0.14)		(-0.65)		(-1.27)		(0.40)
Leverage (Lag)		0.07		0.23		0.00		0.00**
		(0.73)		(0.76)		(0.86)		(2.14)
Payout Ratio (Lag)		-0.07		-0.25		0.02		0.13
		(-1.03)		(-0.96)		(0.69)		(1.10)
Tobin's Q		-0.00		0.00		-0.03		-0.02
		(-0.31)		(0.40)		(-0.94)		(-0.11)
FX Volatility		0.00		0.27		-0.06		-0.63
		(0.03)		(0.79)		(-1.27)		(-1.66)
Market Return		-0.00		0.01*		0.00***		0.00
		(-0.45)		(1.75)		(3.16)		(1.18)
SMB		0.00		0.01		-0.00		0.00
		(0.65)		(1.62)		(-0.49)		(0.88)
HML		-0.00		-0.00		0.00**		0.01***
		(-0.83)		(-0.29)		(2.52)		(2.77)
GDP Growth		-0.00		0.02		0.00		0.00
		(-0.38)		(0.76)		(0.55)		(0.34)
Net Exports Growth		-0.00		-0.00***		-0.00		0.00*
		(-1.29)		(-2.94)		(-1.42)		(1.96)
Investment Growth		0.01		-0.01		-0.00		-0.02
		(0.53)		(-0.52)		(-0.94)		(-1.53)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	26,698	26,698	26,698	26,698	48,864	48,864	48,864	48,864
R-squared	0.15	0.16	0.10	0.16	0.17	0.17	0.14	0.16

This table reports the results of the following regressions:

$$FX_{i,t}^{exposure} = \alpha_0 + \beta_1 \Delta s_t + \nu_i + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \epsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX translation or FX effect on cash (scaled by sales), Δs_t denotes the yearly change of the yen index or dollar index (a positive change indicates a yen or a dollar appreciation). All regressions control for firm fixed effects (ν_i). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports and investment. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points to improve the readability of the slope coefficient. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the year level. t-statistics are reported in parentheses.

Table E3. Impact of Exchange Rates on Real Variables: With/Without Year Fixed Effects

	ROA	Profit Margin	Investment / Sales		Investment / Assets	
	(1)	(2)	(3)	(4)	(5)	(6)
FX Income / Sales	0.81***	0.91***	0.96***	0.67***	0.87***	0.52***
	(4.73)	(5.77)	(6.42)	(4.26)	(7.59)	(4.38)
Sales Growth	4.13***	3.73***	1.34***	1.27***	1.04***	0.92***
	(3.71)	(6.31)	(5.60)	(5.22)	(5.92)	(5.36)
Assets (Log, Lag)	-1.50***	-1.10***	-1.45***	-1.36***	-1.15***	-1.08***
	(-4.96)	(-4.50)	(-8.05)	(-7.31)	(-9.47)	(-8.78)
Leverage (Lag)	-1.48	-2.02***	-3.80***	-4.29***	-2.73***	-3.06***
	(-1.42)	(-3.07)	(-7.97)	(-8.10)	(-7.62)	(-7.74)
Payout Ratio (Lag)	-5.33***	-5.75***	-0.57	-0.19	-0.71	-0.53
	(-4.74)	(-4.82)	(-0.58)	(-0.19)	(-1.11)	(-0.86)
Tobin's Q	-0.05**	-0.05***	0.02*	0.02	0.01	0.01
	(-1.97)	(-2.75)	(1.66)	(1.41)	(1.43)	(1.16)
Market Return	0.03***	0.01**	0.01***	0.06***	0.01***	0.06***
	(4.87)	(2.51)	(6.46)	(6.92)	(6.44)	(7.67)
SMB	0.16***	0.14**	-0.03***	-0.02	-0.02***	-0.02*
	(2.82)	(2.52)	(-7.05)	(-1.31)	(-6.69)	(-1.69)
HML	-0.07***	-0.06***	0.01***	-0.06***	0.01***	-0.05***
	(-4.13)	(-3.41)	(7.70)	(-5.02)	(7.73)	(-5.18)
GDP Growth	0.29***	0.31***	-0.16***	-0.12***	-0.13***	-0.13***
	(6.20)	(6.77)	(-12.08)	(-2.71)	(-13.21)	(-3.86)
Net Exports Growth	-0.00***	-0.00***	0.00	-0.00	0.00	-0.00
	(-3.31)	(-3.03)	(1.18)	(-0.91)	(0.66)	(-0.71)
Investment Growth	-0.22***	-0.24***	0.14***	0.16***	0.12***	0.16***
	(-4.92)	(-5.48)	(11.47)	(3.75)	(12.73)	(4.84)
Interest Rate	-3.34***	-3.99***	1.69***	-2.31***	1.19***	-1.53***
	(-4.96)	(-6.63)	(8.22)	(-3.47)	(8.27)	(-2.90)
Year FE	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,262	26,698	24,268	24,268	24,286	24,286
Within R-Squared	0.09	0.09	0.04	0.05	0.04	0.05

This table presents the results of the two-stage estimation:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$
$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2\Lambda_{i,t} + \beta_3\Gamma_t + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen, $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, and $Y_{i,t+1}^{Real}$ denotes a real firm-level outcome variable and represents the firm's annual return on assets, defined as net income scaled by assets in column (1), profit margin defined as net income scaled by total sales in column (2), capital expenditures defined as the change in the stock of property, plant, and equipment (PPE) + depreciation, scaled by total sales in columns (3) and (4), and capital expenditures defined as the change in the stock of property, plant, and equipment (PPE) + depreciation, scaled by total assets in columns (5) and (6). All regressions control for firm fixed effects ($\delta_{0,i}$ and ν_i) and the second stage controls for time fixed-effects (σ_t) in columns (2), (4) and (6), but not in columns (1), (3) and (5). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table E4. Impact of Exchange Rates on the Firms' Bottom Line — OLS Estimations

	Japan				US			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Return on Assets		Profit Margin		Return on Assets		Profit Margin	
FX Income / Sales	0.56***	0.56***	0.62***	0.61***	-0.02	-0.02	0.02	0.02
	(4.57)	(4.67)	(5.24)	(5.28)	(-0.92)	(-0.94)	(1.22)	(1.18)
Sales Growth		4.13***		3.73***		0.81*		0.61***
		(4.19)		(7.63)		(1.83)		(7.20)
Assets (Log, Lag)		-1.51***		-1.10***		6.66***		0.18***
		(-6.44)		(-6.72)		(22.19)		(4.69)
Leverage (Lag)		-1.46*		-1.99***		-7.41***		0.32***
		(-1.77)		(-3.71)		(-6.59)		(3.23)
Payout Ratio (Lag)		-5.33***		-5.78***		-1.08		0.05
		(-5.05)		(-4.95)		(-0.81)		(0.94)
Tobin's Q		-0.05**		-0.05***		-0.08		-0.07***
		(-2.17)		(-3.17)		(-0.57)		(-3.74)
Market Return	0.03***	0.03***	0.02**	0.02***	0.07	-0.23	-0.01	-0.01
	(4.39)	(4.58)	(2.41)	(2.59)	(0.42)	(-1.11)	(-0.82)	(-1.00)
SMB	0.13**	0.19***	0.13**	0.17***	0.78***	-0.11	0.02	-0.01
	(2.47)	(3.45)	(2.38)	(3.24)	(3.42)	(-0.47)	(0.54)	(-0.21)
HML	-0.07***	-0.09***	-0.06***	-0.07***	-0.09	-0.21	-0.02	-0.01
	(-3.90)	(-5.05)	(-3.41)	(-4.44)	(-0.41)	(-0.80)	(-0.75)	(-0.50)
GDP Growth	0.29***	0.30***	0.32***	0.32***	-0.23**	-0.03	-0.02	-0.01
	(6.51)	(6.31)	(6.99)	(6.86)	(-2.02)	(-0.22)	(-1.00)	(-0.41)
Net Exports Growth	-0.00***	-0.00***	-0.00***	-0.00***	1.48***	-0.34	0.06	0.01
	(-3.20)	(-4.05)	(-3.20)	(-3.93)	(3.54)	(-0.83)	(0.92)	(0.09)
Investment Growth	-0.26***	-0.23***	-0.28***	-0.25***	5.24***	-1.20	0.24	0.03
	(-5.67)	(-4.76)	(-5.99)	(-5.22)	(3.33)	(-0.77)	(0.91)	(0.11)
Interest Rate	-1.19**	-3.02***	-2.09***	-3.61***	10.52***	-2.28	0.32	-0.05
	(-2.01)	(-4.81)	(-3.58)	(-6.06)	(4.06)	(-0.87)	(0.76)	(-0.12)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,262	26,262	26,698	26,698	45,977	45,977	46,837	46,837
R-Squared	0.41	0.43	0.35	0.38	0.65	0.66	0.56	0.57

This table presents the results of the panel OLS estimations

$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + \beta_1 FX_{i,t}^{exposure} + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the return on assets (defined as the net income, i.e. after-tax profits, scaled by assets), or the profit margin (defined net income scaled by sales). All regressions control for firm fixed effects, time fixed-effects, and industry fixed effects. The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table E5. Impact of Exchange Rates on the Firms' Investment — OLS Estimations

	Investment in Japan, scaled by			Investment in U.S., scaled by		
	PPE	Assets	Sales	PPE	Assets	Sales
	(1)	(2)	(3)	(4)	(5)	(6)
FX Income / Sales	0.52*	0.15**	0.28***	-0.00	-0.00	0.07
	(1.79)	(2.34)	(3.13)	(-0.17)	(-0.88)	(0.34)
Sales Growth	5.95***	0.92***	1.27***	-0.14	0.36**	-3.55***
	(5.00)	(5.69)	(5.74)	(-0.46)	(2.42)	(-2.81)
Assets (Log, Lag)	-3.87***	-1.08***	-1.36***	-0.61***	-2.56***	-8.64***
	(-7.30)	(-11.06)	(-10.39)	(-2.77)	(-14.28)	(-8.53)
Leverage (Lag)	-12.72***	-3.02***	-4.25***	0.09	-0.21	-4.98***
	(-8.04)	(-9.40)	(-9.87)	(0.65)	(-0.78)	(-3.44)
Payout Ratio (Lag)	-4.91*	-0.57	-0.23	0.11	-2.68	-2.62
	(-1.83)	(-0.94)	(-0.24)	(1.06)	(-1.34)	(-0.38)
Tobin's Q	0.09**	0.01	0.02*	0.02	0.16***	0.43**
	(2.18)	(1.33)	(1.79)	(1.08)	(3.94)	(2.68)
Market Return	0.27***	0.07***	0.07***	-0.03***	-0.10***	-0.37***
	(8.06)	(9.11)	(8.04)	(-5.91)	(-6.41)	(-3.77)
SMB	-0.03	-0.02	-0.02	0.02**	0.31***	0.83***
	(-0.49)	(-1.52)	(-1.18)	(2.24)	(12.30)	(6.01)
HML	-0.31***	-0.06***	-0.07***	-0.02***	-0.11***	-0.30***
	(-7.54)	(-7.14)	(-6.51)	(-6.00)	(-8.84)	(-4.51)
GDP Growth	-0.38**	-0.12***	-0.11***	-0.01	0.00	-0.02
	(-2.26)	(-3.61)	(-2.58)	(-1.50)	(0.27)	(-0.84)
Net Exports Growth	-0.00*	-0.00	-0.00	-0.00	-0.01***	-0.06***
	(-1.77)	(-1.47)	(-1.51)	(-1.01)	(-5.90)	(-3.46)
Investment Growth	0.52***	0.15***	0.16***	0.18**	0.09	0.79
	(3.01)	(4.41)	(3.50)	(2.30)	(1.31)	(1.47)
Interest Rate	-7.13***	-1.51***	-2.28***	-0.21**	-0.10*	-1.28***
	(-2.60)	(-2.68)	(-3.14)	(-2.40)	(-1.93)	(-3.88)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,321	24,286	24,268	37,686	37,346	37,275
R-Squared	0.26	0.25	0.23	0.32	0.45	0.48

This table presents the results of the OLS panel estimation:

$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + \beta_1 FX_{i,t}^{exposure} + \beta_2 \Lambda_{i,t} + \beta_3 \Gamma_t + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the firm's capital expenditures defined as the change in the stock of property, plant, and equipment (PPE) + depreciation, scaled by last year's PPE stock in columns (1) and (4), scaled by total assets in columns (2) and (5), and scaled by total sales in columns (3) and (6). All regressions control for firm fixed effects, time fixed-effects, and industry fixed-effects. The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table E6. Impact of Exchange Rates on the Firms' Bottom Line

	Japan				US			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Return on Assets		Profit Margin		Return on Assets		Profit Margin	
FX Income / Sales	0.76***	0.73***	0.94***	0.91***	0.46	0.35	0.21	0.21
	(4.28)	(4.20)	(5.35)	(5.28)	(0.50)	(0.39)	(1.64)	(1.64)
Sales Growth		4.13***		3.73***		0.81*		0.61***
		(4.19)		(7.66)		(1.84)		(7.20)
Log Assets (Lag)		-1.50***		-1.10***		6.66***		0.18***
		(-6.42)		(-6.69)		(22.19)		(4.68)
Leverage (Lag)		-1.42*		-1.95***		-7.41***		0.32***
		(-1.72)		(-3.63)		(-6.59)		(3.24)
Payout Ratio (Lag)		-5.34***		-5.80***		-1.09		0.05
		(-5.06)		(-4.93)		(-0.81)		(0.88)
Tobin's Q		-0.05**		-0.06***		-0.08		-0.07***
		(-2.18)		(-3.20)		(-0.57)		(-3.75)
Market Return	0.03***	0.03***	0.01**	0.01**	0.07	-0.23	-0.01	-0.01
	(4.26)	(4.49)	(2.12)	(2.33)	(0.43)	(-1.10)	(-0.78)	(-0.96)
SMB	0.14**	0.20***	0.13**	0.17***	0.78***	-0.11	0.02	-0.01
	(2.57)	(3.59)	(2.36)	(3.27)	(3.40)	(-0.48)	(0.51)	(-0.25)
HML	-0.07***	-0.09***	-0.05***	-0.07***	-0.09	-0.20	-0.02	-0.01
	(-4.00)	(-5.21)	(-3.33)	(-4.43)	(-0.39)	(-0.79)	(-0.70)	(-0.44)
GDP Growth	0.31***	0.31***	0.34***	0.33***	-0.23**	-0.02	-0.02	-0.01
	(6.81)	(6.60)	(7.31)	(7.18)	(-2.00)	(-0.20)	(-0.95)	(-0.36)
Net Exports Growth	-0.00***	-0.00***	-0.00***	-0.00***	1.47***	-0.35	0.06	0.00
	(-3.34)	(-4.25)	(-3.19)	(-3.97)	(3.52)	(-0.85)	(0.87)	(0.05)
Investment Growth	-0.27***	-0.24***	-0.30***	-0.26***	5.21***	-1.22	0.23	0.02
	(-5.93)	(-5.00)	(-6.27)	(-5.49)	(3.31)	(-0.79)	(0.87)	(0.08)
Interest Rate	-1.17**	-2.98***	-2.16***	-3.66***	10.49***	-2.31	0.31	-0.06
	(-1.96)	(-4.70)	(-3.71)	(-6.17)	(4.04)	(-0.88)	(0.73)	(-0.15)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,262	26,262	26,698	26,698	45,977	45,977	46,837	46,837
R-Squared	0.41	0.43	0.35	0.38	0.65	0.66	0.56	0.57

This table presents the results of the two-stage estimation:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$
$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2\Lambda_{i,t} + \beta_3\Gamma_t + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the return on assets (defined as the net income, i.e. after-tax profits, scaled by assets), or the profit margin (defined net income scaled by sales). All regressions control for firm fixed effects ($\delta_{0,i}$ and ν_i) and the second stage controls for time fixed-effects (σ_t). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.

Table E7. Impact of Exchange Rates on the Firms' Investment

	Investment in Japan, scaled by			Investment in U.S., scaled by		
	PPE	Assets	Sales	PPE	Assets	Sales
	(1)	(2)	(3)	(4)	(5)	(6)
FX Income / Sales	1.86***	0.64***	0.75***	0.19	0.14	1.04
	(3.90)	(6.08)	(5.04)	(1.19)	(0.55)	(0.57)
Sales Growth	5.94***	0.92***	1.27***	-0.14	0.36**	-3.55***
	(5.00)	(5.68)	(5.73)	(-0.46)	(2.41)	(-2.80)
Log Assets (Lag)	-3.85***	-1.08***	-1.36***	-0.61***	-2.56***	-8.65***
	(-7.26)	(-11.00)	(-10.34)	(-2.77)	(-14.27)	(-8.54)
Leverage (Lag)	-12.71***	-3.02***	-4.24***	0.09	-0.21	-4.97***
	(-8.03)	(-9.41)	(-9.85)	(0.65)	(-0.79)	(-3.43)
Payout Ratio (Lag)	-4.92*	-0.57	-0.24	0.11	-2.68	-2.62
	(-1.83)	(-0.94)	(-0.25)	(1.06)	(-1.34)	(-0.38)
Tobin's Q	0.09**	0.01	0.02*	0.02	0.16***	0.43**
	(2.19)	(1.35)	(1.78)	(1.08)	(3.94)	(2.67)
Market Return	0.24***	0.06***	0.07***	-0.03***	-0.10***	-0.37***
	(7.31)	(7.93)	(7.19)	(-6.58)	(-6.32)	(-3.82)
SMB	-0.02	-0.01	-0.01	0.02**	0.32***	0.83***
	(-0.31)	(-1.22)	(-0.90)	(2.28)	(12.27)	(6.00)
HML	-0.28***	-0.05***	-0.06***	-0.02***	-0.11***	-0.31***
	(-6.79)	(-5.84)	(-5.70)	(-6.18)	(-8.78)	(-4.54)
GDP Growth	-0.36**	-0.12***	-0.10**	-0.01	0.00	-0.02
	(-2.13)	(-3.42)	(-2.37)	(-1.56)	(0.26)	(-0.92)
Net Exports Growth	-0.00*	-0.00	-0.00	-0.00	-0.01***	-0.06***
	(-1.69)	(-1.25)	(-1.49)	(-1.06)	(-5.94)	(-3.39)
Investment Growth	0.50***	0.15***	0.15***	0.19**	0.09	0.82
	(2.90)	(4.24)	(3.32)	(2.40)	(1.30)	(1.56)
Interest Rate	-7.18***	-1.52***	-2.29***	-0.21**	-0.10*	-1.29***
	(-2.62)	(-2.70)	(-3.15)	(-2.40)	(-1.95)	(-3.91)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,321	24,286	24,268	37,686	37,346	37,275
R-Squared	0.26	0.25	0.23	0.32	0.45	0.48

This table presents the results of the two-stage estimation:

$$FX_{i,t}^{exposure} = \delta_{0,i} + \delta_{1,i}\Delta s_t + \delta_{2,i}\Lambda_{i,t} + \delta_{3,i}\Gamma_t + \epsilon_{i,t},$$
$$Y_{i,t}^{Real} = \alpha_0 + \nu_i + \sigma_t + \beta_1 \widehat{FX}_{i,t}^{exposure} + \beta_2\Lambda_{i,t} + \beta_3\Gamma_t + \varepsilon_{i,t},$$

where $FX_{i,t}^{exposure}$ denotes the FX transaction scaled by sales, Δs_t denotes the change in the yen (left panel) or U.S. dollar index (right panel), $\widehat{FX_{i,t}^{exposure}} = \widehat{\delta_{1,i}}\Delta s_t$, and $Y_{i,t}^{Real}$ denotes the dependent variable of interest: the firm's capital expenditures defined as the change in the stock of property, plant, and equipment (PPE) + depreciation, scaled by last year's PPE stock in columns (1) and (4), scaled by total assets in columns (2) and (5), and scaled by total sales in columns (3) and (6). All regressions control for firm fixed effects ($\delta_{0,i}$ and ν_i) and the second stage controls for time fixed-effects (σ_t). The firm-level controls ($\Lambda_{i,t}$) include the contemporaneous annual growth rates in total sales, the firms' sizes measured by the log lagged total assets, the lagged leverage ratio (defined as debt divided by total assets), and the lagged payout ratio (defined as dividends divided by net income). The country-level controls (Γ_t) include the Fama-French three-factor returns (on the aggregate market, on the small-minus-big portfolios, and on the high-minus-low book-to-market portfolios), as well as the contemporaneous growth rates of GDP, net exports, investment, and FX volatility. The exchange rate volatility is computed as the yearly standard deviation of daily percentage returns. All variables are expressed in percentages except the change in exchange rate, which is in basis points. The data are annual and the estimation period is 1990–2017. Heteroskedasticity and autocorrelation consistent standard errors are clustered at the firm level. t-statistics are reported in parentheses.