Exchange Rate Risk in Public Firms

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Abstract

In their income statements, firms report their foreign exchange (FX) transaction income, i.e., the overall effect of exchange rate-induced revaluations of their monetary items, net of any financial hedging. Using such publicly available data, we find a strong comovement between exchange rate shocks and FX transaction income at the firm, industry, and aggregate levels, implying that financial hedging is limited. The FX exposure increases with international trade and foreign currency debt. The FX transaction income passes through to the firms' profits, payouts and subsequent investments, implying that operational hedging is also limited, and that exchange rate changes affect firms.

Keywords: Exchange rates, hedging, corporate income.

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Firms are exposed to exchange rate risk through their trade in goods (imports and exports) and assets (investments and liabilities). A given appreciation of the local currency may bring income gains or losses depending on whether the firms import or export, invest or borrow. Yet, firms may decide to hedge the impact of exchange rates, financially and operationally, either fully or partially. Net of hedging, what is the impact of exchange rates on firms' profits?

At the macroeconomic level, the answer to this question is elusive. A large literature, following Meese and Rogoff (1983), reports that macroeconomic variables 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 an under-studied accounting variable: the FX transaction income. Global accounting standards specify that firms transacting in foreign currencies need to report these transactions by converting the corresponding amounts into their own functional currency equivalent. When exchange rates subsequently move, firms need to report in a specific line of their income statement the effect of these exchange rate movements on the value of their monetary items. Thus, cash and cash equivalents, accounts receivables and payables, loans and bonds, among other items, need to be remeasured, giving rise to FX transaction income. For example, a Japanese firm that invoices for $1M of exports to be paid three months later has to report the impact of the change in exchange rate between the transaction date and the settlement date: $1M does not mean the same amount in yen at the signature of the contract and at the time of the actual payment. Likewise, the same Japanese firm that borrows $1M needs to report the impact of subsequent changes in exchange rates on its debt. The FX transaction income aggregates all gains and losses, both realized and unrealized, on imports and exports,

investments and liabilities, across parents and subsidiaries.

Firms may choose to partially or fully hedge this exchange rate risk, and global accounting standards do not force them to report the details of their financial or operating hedges, but FX transaction income is reported net of financial hedging. To pursue the previous example, the Japanese firm may enter in a FX forward contract at the transaction date that specifies the amount of yen obtained in exchange of a $1M three months later. Likewise, it may sign a FX swap contract that converts the dollar debt payment into yen. In this case, the Japanese firm fully hedges the exchange rate risk, and the FX transaction income simply reflects the cost of hedging, independent of the subsequent change in exchange rate. To the contrary, FX transaction income that strongly comoves with exchange rates suggests an exposure to FX risk that is not fully financially hedged. The FX transaction income thus provides a signal of any public firm's exposure to exchange rate movements net of its financial hedging.

Using such accounting data, we focus on six major countries and currency areas – the United States, the euro area, Japan, Taiwan, South Korea, and India – that vary in terms of trade openness, the share of foreign currency invoicing in international trade, and foreign currency debt issuance. Our sample covers the 1987–2020 period. For each country or area, we first document the properties of FX transaction income, then study the passthrough of FX income to firms' bottom lines, and conclude with the impact of exchange rate changes on firms' profits, payouts, and investments.

At the aggregate level, FX transaction income strongly comoves with exchange rate changes. A 10% appreciation of the local currency is equivalent to a loss of 0.8% and 5.8% operating income in Japan and Taiwan and a gain of 3.2% and 5.1% of operating income in India and South Korea. Aggregate FX transaction income, however, is a small fraction of aggregate macroeconomic variables, like GDP, and a low signal-to-noise ratio makes this correlation difficult to detect in the classic tests of the exchange rate disconnect literature.

In contrast, firms in the U.S. and the euro area report only modest FX transaction gains and losses that are weakly correlated with the value of the dollar and the euro, respectively. This latter result is consistent with the large share of local currency transactions in the U.S. and the euro area reported notably in Boz et al. (2022). The contrasting results obtained for Japan and Taiwan on the one hand and South Korea and India on the other hand call for more investigation, and we turn to micro-level data to determine which observable characteristics are informative about firms' exposure to FX transaction risk.

Using industry-level data on imports and exports, we find a strong link between international trade and FX transaction risk. Intuitively, a Japanese firm that exports in foreign currency with a payment delay incurs a loss when the local currency appreciates. If the firm were to import, it would record a gain. Our empirical results are consistent with such foreign currency pricing: when the local currency appreciates, firms in export-intensive industries tend to report FX transaction losses, while firms in import-intensive industries tend to report FX transaction gains.

Similarly, a firm that borrows in a foreign currency will incur a gain when the local currency appreciates and the foreign currency depreciates: thanks to the exchange rate change, that firm will eventually reimburse a smaller amount of local currency. To the contrary, a firm that invests in foreign currency-denominated assets will incur a loss when the local currency appreciates. In India, South Korea, and Taiwan, we find a strong relationship between foreign currency debt issuance and FX transaction risk: firms with large amounts of foreign currency-denominated debt report FX transaction gains when the local currency appreciates, due to the decline in the local currency value of these liabilities. In the U.S., the euro area and Japan, we do not find a link between the amount of foreign currency debt and the sensitivity of FX transaction income to exchange rates, suggesting that foreign-currency debt may be financially hedged in those countries (e.g. through FX swaps). The relative importance of foreign currency debt (along with imports) contributes

to the aggregate FX transaction gains observed in South Korea and India when their local currency appreciates.

Together these facts imply that many firms are highly exposed to exchange rate risk through international trade and capital structure decisions. Financial hedging of this risk must thus be limited in scope: if these firms fully hedged their exchange rate risk by purchasing FX derivatives, for example, their FX transaction income would not significantly comove with exchange rates, contrary to the data. This finding does not yet imply that exchange rates affect corporate profits, since firms may hedge their FX transaction risk operationally, not just financially. For example, a Japanese firm may pay some workers in foreign currency, and foreign currency wages are generally excluded from the calculation of FX transaction income. A Japanese exporter that invoices in U.S. dollars would incur a FX transaction loss when the U.S. dollar depreciates, but this loss may be offset by lower wages paid in dollars. The passthrough of FX transaction income to firms' profits is thus informative about operational hedges and intra-year competitivity effects.

In the data, we find that any such operational hedges must be limited in scope: we estimate a large positive passthrough on average from FX transaction income to firms' profits before taxes, ranging from roughly half in Japan (because offsetting changes in operating income) to nearly one-for-one in Taiwan. In half of our sample, we cannot reject a perfect passthrough, where the FX transaction income is reflected one-for-one in the firm's bottom line. In all countries in our sample, the passthrough is statistically significant: there is no example of a country where the average firm offsets its FX transaction gains and losses perfectly.

Since exchange rate changes are correlated to FX transaction income and FX transaction income passes through to firms' profits, it is no surprise that exchange rate changes are correlated to firms' profits, conditional on FX transaction income. To go beyond a simple correlation, we compare for a given year and a given industry, the profits of

firms that have different degrees of exposure to exchange rate shocks, as proxied by their lagged FX transaction income. In this difference-in-difference experiment, the impact of exchange rates is statistically significant in Japan, Taiwan, South Korea and India (and marginally in the euro area). Following a 10% appreciation of the local currency, firms in the top FX exposure quartile report income exceeding that of comparable firms in the lowest FX exposure quartile by amounts ranging from 0.2% of total firm assets in Japan to 0.8% in South Korea. The local effect of exchange rate shocks is economically significant when compared to the median profits-to-assets ratio of 4% in our sample.

Experiencing an FX transaction income shock that is not hedged and thus affects their pre-tax profits, firms need to adjust their taxes and then decide how to allocate the windfall, paying some out, keeping the rest in the firm in cash for future investment. We find that for every dollar of FX transaction income firms tend to pay out around 15 cents in taxes, 15 cents to their shareholders, invest at most 30 cents (most of it one year after the shock) and keep the rest (40 cents) in cash.

Our paper exploits FX transaction income, an accounting variable that is available for most publicly traded firms, thus alleviating concerns about the external validity of any finding. This variable is comprehensive as it aggregates both realized and unrealized gains and losses across parent firms and subsidiaries. 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. FX transaction income aggregates across exports and imports, investment and liabilities. Our work is easily replicable and can be extended to other countries beyond the six currency areas that we study. This accounting variable, however, is far from the perfect signal of FX risk. It misses some important FX exposure: for example, it is silent on competitivity issues if transactions do not involve payment delays, subsidiaries' valu-

ation effects, and second-round exposure.[1] Despite its limits, FX transaction income is a useful signal since it highlights some significant impact of exchange rate shocks, even in developed countries where the evidence is scarce and the exchange rate appears previously disconnected from real variables.

The rest of this paper is organized as follows. Section 1 connects our paper to different strands of the literature. Section 2 describes the accounting treatment of FX transaction income. Section 3 presents the aggregate data on FX transaction income and investigates the determinants of exposure to FX transaction risk across firms. Section 4 estimates the passthrough from firms' FX transaction income to their final profits. Section 5 then directly explores the relationship between exchange rate fluctuations and firm profits, using FX transaction income as a signal to identify exposed firms. Section 6 finally measures the impact of FX transaction income on net equity payouts and investment. Section 7 concludes. A separate Appendix describes the data sources and provides additional accounting examples and robustness checks.

1 Literature Review

The paper builds on and contributes to four 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 among the most cited 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

[1] A Japanese firm may suffer from a yen appreciation because, for example, (i) its costs are in yen, without reporting any FX transaction income if its clients and suppliers pay immediately, or (ii) the value of its foreign subsidiary declines, or (iii) indirectly, even if it is not transacting in any foreign currency, because its clients or suppliers are themselves affected by the change in exchange rate.

exchange rates to aggregate capital flows (Kalemli-Ozcan and Varela, 2019, Camanho, Hau, and Rey, 2022, and Lilley, Maggiori, Neiman and Schreger, 2022) and expected productivity (Chahrour et al., 2022).

Exceptions to the exchange rate disconnect puzzle appear (i) in emerging markets, where very large depreciations have a significant impact on the rest of the economy, and (ii) for multinational firms, which are the most likely exposed to currency risk.[2] Using country-specific datasets, some papers report the impact of exchange rates on (i) sectoral and firm-level investment (Campa and Goldberg, 1995, Goldberg, 1997, Nucci and Pozzolo, 2001, Barbiero, 2020, and Taylor, Wang and Xu, 2021); (ii) the location choices of multinational firms (Goldberg and Kolstad, 1995); (iii) the demand for skill labor (Maurin, Thesmar, and Thoenig, 2003); and (iv) the relative consumption levels across households (Cravino and Levchenko, 2017). We share a similar objective, but only rely on data publicly available, covering domestic and multinational firms, across emerging and developed markets, and using a novel accounting variable that signals FX exposure but was never used in this literature.[3]

Second, a more recent literature studies the currency choice of invoicing and its impact on the price passthrough. When firms invoice in their local currency, also known as producer pricing, international trade exhibits no FX transaction risk. The strong link between FX transaction risk and bilateral dollar-based exchange rates speaks to the prevalence of the U.S. dollar as the invoicing currency in international trade (Goldberg and

[2] A growing literature, from Forbes (2002), Aguiar (2005), Desai, Foley, 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), Kohn, Leibovici, and Szkup (2020), Verner and Gyongyosi (2020), Kalemli-Ozcan, Liu, and Shim (2021), Niepmann and Schmidt-Eisenlohr (2022), Salomao and Varela (2022), Bengura, Matsumoto, and Safie (2022), Blanco, Drenik and Zaratiegui (2022), Gyongyosi, Rariga and Verner (2022), and Keller (2024) study the impact of exchange rates on firms and households.

[3] A few papers in the accounting literature study the definition and properties of FX transaction income: Soo and Soo (1994), White, Sondhi, and Fried (2001), and Louis (2003). To the best of our knowledge, Bartov and Bodnar (1994) is the only paper using the FX transaction income in economics and finance — focusing only on equity returns in the U.S. case, where FX transaction risk is limited by the widespread use of the U.S. dollar as invoicing currency.

Tille, 2009, Gopinath, 2016, Boz, Gopinath and Plagborg-Moller, 2017, 2019, Ito et al., 2018, Gopinath and Stein, 2021, and Boz et al., 2022). Our work echoes the exchange rate to price passthrough literature (Gopinath, Itskhoki, and Rigobon, 2010, Devereux, Tomlin and Dong, 2015, and Forbes, Hjortsoe, and Nenova, 2017), but we focus instead on the firm-level passthrough of exchange rate shocks to profits, payouts, and investment.

Third, a theoretical and empirical literature studies how firms manage currency risk and respond to its unhedged component. In theory, 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, DeMarzo and Duffie, 1995); (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 corporate variables 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 datasets, either relying on hand-collected data from the footnotes of annual reports (Allayannis and Ofek, 2001, Boyer and Marin, 2013, Allayannis and Weston, 2015, and Jung, 2022), the textual analysis of annual reports (Kim, Mathur and Nam, 2006, Hoberg and Moon, 2017), or surveys (Bartram, 2019, Berthou et al., 2022, and Lyonnet, Martin and Mejean, 2022).[4] Alfaro, Calani, and Varela (2021) is an exception: using

[4]For example, Guay and Kothari (2003) hand-collect the notional amounts of 234 firms' 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,

Chilean data on trade credit, exports, and FX derivatives, they show that Chilean firms' FX hedging is 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.

Fourth, our work connects to the literature on foreign currency corporate debt. Empirically, the determinants of foreign currency debt among nonfinancial firms include: (i) interest rate differentials (Bruno and Shin, 2017, Acharya and Vij, 2020) and differences across FX-hedged bond yields (Liao, 2020, and Caramichael, Gopinath and Liao, 2021); (ii) liquidity (Coppola, Krishnamurthy, and Xu, 2023), (iii) productivity (Salomao and Varela, 2021) and the geographic distribution of sales (Bleakley and Cowan, 2008, Colacito, Qian and Stathopoulos, 2022); (iv) banks' behavior (Ivashina, Gutierrez and Salomao, 2023) and their impact on trade credit (Hardie, Safie, and Simonovska, 2023); and (v) capital controls (Bacchetta, Cordonier and Merrouche, 2023). Foreign currency debt revaluations around large exchange rate movements lead to less investment (Aguiar, 2005, Kalemli-Ozcan, Kamil, and Villegas-Sanchez, 2016), higher sovereign default risk (Du and Schreger, 2022), higher sales' prices (Kim and Lee, 2024), less bank credits (Agarwal, 2021), as well as exit decisions (Kim, Tesar and Zhang, 2015) and corporate distress (Qiu, 2022). We show that foreign currency debt is one of the key drivers of FX transaction income, but the latter also includes the impact of foreign currency assets, as well as account receivables and payables in foreign currencies. Our sample includes large and small exchange rate variations in developed and emerging countries.

2 FX Transaction Income

This section first describes the accounting rules that govern how firms report their FX transaction gains and losses and then proposes a simple accounting example.

currency, and commodity price risks hedged by large firms are modest relative to their sizes.

2.1 Accounting Rules

The two main accounting standards used globally — the International Financial Reporting Standards (IFRS) and the Generally Accepted Accounting Principles (GAAP) — define similarly how to report the impact of exchange rates on firms' income. The IFRS accounting rules are described in the International Accounting Standard (IAS) No. 21: The Effects of Changes in Foreign Exchange Rates while the GAAP-equivalent rules are in defined in the Accounting Standards Codification (ASC) No. 830: Foreign Currency Matters. Under both rules, foreign currency transaction risk arises at the firm 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. Let us define those terms precisely.

An entity's functional currency is the currency of the primary economic environment in which the entity operates; normally, that is the currency of the environment in which an entity primarily generates and expends cash. When reporting a transaction done in a foreign currency, the firm needs first to convert the foreign currency amount into its functional currency equivalent at the time of the transaction. Under both the IFRS and GAAP accounting rules, when exchange rates subsequently change, monetary items need to be remeasured while nonmonetary items do not. Broadly speaking, a monetary item is an asset or liability that conveys a right to receive or deliver either a fixed or determinable number of units of currency. Monetary items thus include, (i) on the assets side, cash and cash equivalents, investments in debt securities classified as held to maturity, accounts receivables, loans, and deferred tax assets, and (ii) on the liabilities side, accounts payables, bonds payable and other long-term debt, and deferred tax liabilities. Nonmonetary items include investments in equity securities, investments in debt securities classified as trading or available for sale, inventories, plant, property and equipment, goodwill and intangible assets, common and preferred stocks, and noncontrolling interests.

The exchange rate remeasurement leads to FX transaction gains and losses that need to be reported in the income statement. This reported FX transaction income has three key characteristics.

First, the FX transaction income includes both *realized* and *unrealized* gains and losses. 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 reporting date falls between initiation and settlement, then the unrealized transaction gain or loss also appears in the income statement. This is noteworthy, as other unrealized gains or losses are reported in a balance sheet item, the accumulated other comprehensive income.

Second, since the FX transaction income is a line in the income statement, it aggregates the information across all subsidiaries. While some transactions between a firm and its subsidiary (e.g., borrowing and lending) cancel out, FX transaction gains and losses on inter-company transactions do not not cancel out each other. FX transaction income includes all gains and losses on inter-company foreign currency transactions that are not considered a long-term investment.

Third, the FX transaction income is reported net of hedging in most cases. As companies enter into hedging contracts to minimize the impact of exchange rates on their net income, the gains and losses on these FX hedges are generally recognized immediately in net income. Cash flow hedges (i.e., hedges that affect the amount of cash flows to be realized from a future transaction) are an exception: in this case, the hedging gains and losses are reported in accumulated other comprehensive income. In all other cases, whether companies chose to designate derivatives as hedges per se or not, the associated gains and losses are reported in net income.

Figure 1 depicts the values of FX transaction income reported in the annual reports of Nintendo Co., Ltd., a large Japanese company that uses the Japanese yen as its functional currency. Within Nintendo's consolidated statements of income, FX transaction income is

reported as a component of non-operating income (labeled as "foreign exchange gains" or "foreign exchange losses"). Nintendo typically reports large FX transaction losses when the Japanese yen appreciates against the U.S. dollar, and gains when the yen depreciates. The tight link between FX transaction income and exchange rate changes contrast with the well-known exchange rate disconnect apparent at the aggregate level in the growth rates of GDP, investment, exports, and imports, as shown in Figure 2. For example, from March 2007 to March 2008 when the yen appreciated almost 18% against the dollar, Nintendo reported FX transaction income for fiscal year 2007 of −¥92.3 billion. This value represents over 5% of its total assets and 35% of net income in the same year. In order to understand how FX transaction income is determined and its relationship with exchange rates, we now turn to several examples.

2.2 Example

Let us consider the simple example of a Japanese firm that sells in U.S. dollars.[5] 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. The firm's invoice was initially recorded for $¥105M$, but the mark-to-market value of the sale is now only $¥100M$. At that point, to keep track of this unrealized loss, the firm records an FX transaction income of $(100 - 105) \times \$1M = -¥5M$.

On August 1st, at the time of settlement, since the dollar depreciated further and \$1 is now worth only ¥95, the firm needs to record an additional loss of $(95 - 100) \times \$1M = -¥5M$. The total annual FX transaction loss 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

[5] Appendix B provides more examples, detailing the accounting treatment of purchases, with and without hedging, investment, and borrowing decisions.

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 income statement only reports the impact of exchange rates net of 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 30th, the firm needs to report its exchange rate exposure in its quarterly report. At that point, assume that 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 30th and August 1st (i.e., one month), the firm books a gain of $(103 - 98) \times \$1,000,000 \times (1.06)^{-\frac{1}{12}} = ¥4,976M$. Intuitively, the firm is better off having signed a forward contract that converts $\$1M$ into $¥103M$ than entering a forward contract now and receiving $¥98M$ one month later. The total FX transaction exposure is then only $-5M + 4,976M = -¥0,024M$ — this is 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 same value as the spot rate since the forward contract matures that day), the firm books a second hedging gain of $(103 - 95) \times \$1M - 4,976M = ¥3,024M$ and a total FX transaction exposure of $-5M + 3,024M = -¥1.976M$. Hedge accounting may at first appear a bit complicated, but the overall result is intuitive. The firm invoiced for $\$1M$, at a time when that meant $¥105M$, but it immediately settles, through its forward contract, for $¥103M$. The economic loss corresponds to the difference between the spot rate (at the

time of the sale) 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 ($¥0,024M + ¥1.976M = ¥2M$).

This example shows that, even in the presence of perfect hedging, the FX transaction income is not zero: in that case, the FX transaction income corresponds to the forward discount (the difference between the forward and the spot rate at the time of the sale). When covered interest rate parity holds, the log forward discount corresponds to the interest rate difference across two countries. As interest rate differences account for a small and often insignificant part of future exchange rate changes, hedging strongly decreases both the size of the FX transaction gains and losses and their correlation with subsequent changes in exchange rates.

The example above centers around exports and imports, but FX transaction risk also arises when investing or borrowing in foreign currency. In the simplest possible example, assume another Japanese firm issues three-month U.S. dollar-denominated commercial paper on May 1st with a face value of $1M. In the firm's quarterly report published at the end of June, the firm records FX transaction income of $(105 - 100) \times \$1M = +¥5M$, reflecting an unrealized gain from the lower value (in yen) of the principal that it will repay in U.S. dollars one month in the future. On August 1st, the firm records an additional $¥5M$ FX transaction gain after the yen continues to appreciate against the U.S. dollar. The total annual FX transaction income of $(105 - 95) \times \$1M = +¥10M$ reflects the difference in the local currency value of the foreign currency-denominated principal between the final payment and initial issuance dates.[6] Note that foreign currency

[6]For simplicity, we have assumed the commercial paper issued by the firm does not pay interest. Foreign currency interest payments introduce an additional term in the expression for FX transaction income that is determined by the difference between the average spot exchange rate over the period since the previous interest payment (reflecting the average exchange rate at which interest accrues over the period) and the spot exchange rate at the date of the actual interest payment. We provide a detailed description in Appendices B.3 and B.4. However, the revaluation of principal for foreign currency-denominated debt is likely to be much larger in magnitude than the revaluation of interest payments. This is because of both the large value of principal payments relative to individual interest payments, and

debt in this example can serve as a hedge to the exchange rate risk arising from export transactions. When the yen appreciates (and the U.S. dollar depreciates), the exporting firm collects less yen from its previously-invoiced sales in dollars, but it also reimburses less yen to settle any debt denominated in dollars. A firm that perfectly matches the principal and maturity of its dollar debt with the value and settlement date of its accounts receivable would report zero FX transaction income at each reporting date, reflecting the fact that it has perfectly hedged its exposure to exchange rate risk.

2.3 Taking Stock

Before turning to the data, let us review the major strengths and weaknesses of the FX transaction income from an economist's perspective.

First, FX transaction income obviously misses some exchange rate exposure. In the absence of delay of payment, FX transaction risk is zero: e.g., if the Japanese firms sells in U.S. dollars and receives those immediately, it can convert them into yen — there is no exchange rate risk in this example, and no FX transaction income either. Yet, the level of exchange rates may affect such firms too, by affecting for example the competitiveness of their products or the business of their suppliers and clients. This level effect of exchange rates would not show up directly in FX transaction income. At best, FX transaction gains and losses signal that a given firm transacts in foreign currency. We thus view the FX transaction income as only one component of the impact of exchange rates on firms.

Second, while FX transaction income only focuses on exchange rate risk, it offers a comprehensive measure of that risk. As already noted, it covers both realized and unrealized losses, in the parent firm and its subsidiaries, aggregating information on exports and imports, investments and liabilities. The information is publicly available in all public

the fact that principal is revalued based on year-to-year changes in spot exchange rates (rather than the difference between the annual average and year-end exchange rates used to revalue interest payments).

firms, alleviating concerns of external validity. With the important caveat that the quality of data collection varies across countries, economists can thus use FX transaction income to study international corporate finance issues in all developed and emerging markets.

Third, FX transaction income is reported net of financial hedging, and firms do not have to report standardized information on their financial hedging. At best, firms describe their hedging activities in their annual reports, often in simple footnotes. FX transaction income is thus not the right variable to study the determinants of hedging decisions, or how financial hedging is implemented in practice. But it is useful to study the impact of exchange rates on firms. If FX transaction income were reported before financial hedging, any shock may well be offset by a FX forward, futures, swap, or option contract, and thus have no impact on corporate decisions. From our perspective, reporting after financial hedging helps. Net of financial hedging, FX transaction gains and losses affect corporate profits, unless some operational hedging cancels them out.

From a theoretical perspective, FX transaction income is promising, but several empirical questions remain: Do those FX transaction gains and losses reflect actual exchange rate shocks, or only hedging costs? Do they reflect international trade in goods or assets, or both? Are they offset by other corporate actions, as operational hedging would suggest? We now turn to the data to make progress on these questions.

2.4 Data

Our firm-level financial statement data come from the Compustat North America and Global Fundamentals annual files. To study the availability and information content of FX transaction risk broadly, our sample comprises a mix of developed and developing countries: the euro area, India, Japan, South Korea, Taiwan, and the United States

over the 1987–2020 period.[7] We exclude firms in the finance and utility sectors and apply additional filters similar to ones used elsewhere in the corporate finance literature. Finally, we winsorize all firm-level variables at the [1%,99%] level for each country-year. Since many firms report zero FX transaction income in some country-years, we compute the quantiles used in winsorization for this variable by excluding observations equal to zero. Appendix C provides a detailed description of our sample construction, and Appendix D.1 presents select summary statistics for each country.

We supplement the basic firm-level data with additional data on international trade at both the industry and firm level, and foreign currency debt at the firm level.

Our industry-level trade data come from the World Input-Output Database (WIOD). This database provides estimates of total sales and purchases between individual country-industry pairs, including sales to final demand sectors (e.g. households or governments). We use these data to compute net exports (exports minus imports) relative to gross output for 56 narrowly-defined industries within each country in our sample, and map the industry codes available in the Compustat Fundamentals files to these industries.[8] In addition, for a subset of firm-year observations in our sample we obtain firm-level data on foreign sales from the Refinitiv Worldscope dataset. Unfortunately, we do not have any measure of imports or foreign purchases for individual firms.

Our data on foreign currency debt come from the Capital IQ Capital Structure Debt file, which reports characteristics of firms' individual debt liabilities such as maturity and currency of denomination. The Capital IQ data are available for a shorter time period, but include a large majority of the firms in each country we study starting from the early- to mid-2000s until the end of our sample period. We use these data to compute the share of foreign currency-denominated debt (in local currency value) among the firm's total

[7] Our set of euro area countries consists of Belgium, France, Germany, Italy, the Netherlands, and Spain. For these countries, we start our sample in 1999 after the initial adoption of the euro.

[8] Appendix C.4 provides details on the construction of the NAICS-to-WIOD industry concordance table.

outstanding debt in each available year.

Our available data do not provide a fully comprehensive breakdown of every potential source of firm-level exposure to exchange rate risk. While we observe international sales for some firms, we never observe international purchases for individual firms. Furthermore, we do not observe invoicing currency shares for firms' sales and purchases, and instead can only observe the total value (in local currency) of firms' accounts receivable and accounts payable. We do not observe the share of the firms' cash or security holdings which are denominated in foreign currency. We do not observe firms' financial hedging decisions or use of financial derivatives such as forward contracts. However, as previously noted, from the firm's FX transaction income we *do* observe the overall impact of exchange rate movements on the value of these unobserved foreign currency-denominated assets and liabilities, net of any financial hedging positions.

We relate firms' FX transaction income to changes in exchange rates in each country. For non-U.S. countries, we use the change in the nominal bilateral U.S. dollar exchange rates obtained from the Federal Reserve Board's H.10 data release. For the U.S., we use the change in the Bank of International Settlements' effective U.S. dollar exchange rate index, which is computed using trade weights.[9] In all cases, the exchange rate is expressed U.S. dollars per foreign currency: an increase thus corresponds to an appreciation of the local currency.

[9]We focus on the dollar bilateral exchange rates because of the strong factor structure in exchange rates (Verdelhan, 2018). We obtain results similar to those reported in subsequent sections when we use the BIS effective exchange rate indices for each non-U.S. country in our sample. However, for most of these countries the bilateral U.S. dollar exchange rates explain a larger share of the observed variation in firms' FX transaction income, based on regressions similar to those reported in Section 3.3.

3 FX Transaction Risk Across Countries and Firms

At the aggregate level, both the magnitude of aggregate FX transaction income and its correlation with exchange rate changes differ significantly across countries. At the micro level, international trade balances and foreign currency debt issuance emerge as the two strongest signals of exposure to FX transaction risk.

3.1 FX Transaction Income at the Aggregate Level

We first characterize firms' exposure to FX transaction risk at the aggregate level in each country. In Figure 3 we sum FX transaction income across all firms reporting a non-missing value in a given year, and scaling the total FX transaction income by the total operating income for the same group of firms.[10] We plot this against the change in the exchange rate in the same year, with a positive value indicating an appreciation of the local currency.

In the U.S. and the euro area, the aggregate FX transaction income is modest: the absolute value of total FX transaction income, summed across all firms reporting a non-missing value in a given year, is typically less than 2% of the same firms' operating income. This is consistent with the firms' currency invoicing choice (Boz et al., 2022) and the FX hedging of foreign currency bond issuances (Liao, 2020). In the other four countries, however, aggregate FX transaction income is much larger in magnitude. Aggregate FX transaction income varies from -5% to 3% of operating income in Japan, -4% to 10% in Taiwan, -30% to 10% in South Korea, and -8% to 4% in India. These are large numbers since the median profit margin is less than 5% in those countries. These differences are not due to very low operating profits (the denominator), and similar findings emerge when

[10] Operating income, also known as operating profits, corresponds to the total revenue minus the cost of goods sold minus the operating expenses minus depreciation and amortization. It is net of depreciation to proxy for the annual equivalent of the capital expenses. It does not include the interest on debt and tax expenses.

scaling FX transaction income by total assets in Appendix Figure D2. In that case, FX transaction income is typically less than 0.1% of corporate assets in the U.S. and the euro area, but it varies from −0.15% to 0.15% in Japan, −0.2% to 0.3% in Taiwan, −1.6% to 0.6% in South Korea, and −0.7% to 0.3% in India.

Figure 3 thus suggests a strong link between exchange rate changes and an aggregate variable — a clear counterexample to the exchange rate disconnect puzzle in Figure 2. In those same countries, annual real GDP, investment, import and export growth rates exhibit no correlation with the nominal or real annual changes in exchange rates. Our finding, however, is consistent with the exchange rate disconnect puzzle because the aggregate FX transaction income only represents a small percentage of the usual macroeconomic variables used in the literature: aggregate FX transaction income (in absolute value) represents on average less than 0.35% of GDP in the countries in our sample (and a tenth of that in the U.S. and euro area). Such a small signal is difficult to detect in the usual macroeconomic series.[11]

The correlation between aggregate FX transaction income and exchange rates varies across countries. In Japan and Taiwan, a 10% appreciation of the local currency means aggregate FX transaction *losses* equal to 0.8% and 5.8% of operating income. In the euro area, India and South Korea, a 10% appreciation of the local currency means aggregate FX transaction *gains* equal to 0.5%, 3.2% and 5.1% of operating income. For U.S. firms, there is no clear relationship between aggregate FX transaction income and the value of the U.S. dollar. For all non-US firms, even if some benefit from a local currency appreciation while others are hurt, those gains and losses do not wash out in the aggregate. For example, the largest annual declines in aggregate FX transaction income (−22% and −30%) happen in South Korea in 1997 and 2008, in times of the Korean won's sharpest depreciations.

[11] In the Appendix, Figure D1 reports the average absolute value of aggregate FX transaction income as a fraction of GDP and Figure D2 scales total FX transaction income by total assets reported by firms in the same year.

The strong correlation between changes in exchange rates and aggregate FX transaction income suggests that firms do not fully hedge their FX risk and raises a new question: why do some countries record aggregate gains while other record aggregate losses when their local currency appreciates? We turn to micro data to study these cross-country differences.

3.2 FX Transaction Income at the Firm Level

In South Korea and Taiwan, more than 90% of the firm-year observations correspond to non-zero FX transaction income. The ratio is 75% in the euro area, 69% in India, and 56% in Japan, but only only 22% in the U.S. We focus below on those non-zero observations, looking at the intensive margin in each country: among firms that report exposure to FX transaction risk in a given year, how large and persistent is the exposure to currency risk?

Figure 4 shows that a large share of exposed firms in several countries report substantial FX transaction income in absolute values. In Japan, Taiwan, South Korea and India, half of the observations imply a FX transaction income (in absolute value) of more than 3% of pre-tax income. In those countries, a quarter of the observations correspond to FX transaction income of more than 10% of firms' pre-tax income. The percentiles obtained by scaling on assets are naturally lower, but suggest that the high exposures are not simply due to vanishing income. In contrast, exposed firms in the U.S. and euro area report values of FX transaction income which are smaller in magnitude.

Firms' exposures to FX transaction risk appear persistent. In levels, FX transaction income is nearly serially uncorrelated across subsequent years, as one would expect considering the near random walk behavior of exchange rates. Yet, if a firm in our sample reports some FX transaction income this year, there is a 95% probability that it will report some FX transaction income next year. The absolute value of FX transaction income exhibits a strong positive serial correlation at the firm level: firms that previously reported

large FX transaction gains or losses tend to report similarly large FX transaction gains or losses in the future.[12] Looking beyond the absolute values of FX transaction income reveals significant heterogeneity in the sign of these exposures among firms. Although the distribution of FX transaction income in a given year often skews either positive or negative, there are always some firms that report FX transaction gains while the majority of firms report losses (or vice versa).[13]

Overall, firm-level data imply large and persistent heterogeneity in FX exposure across firms. Next, we study the determinants of this exposure.

3.3 Determinants of Firms' Exposure to FX Transaction Risk

To formally investigate the relationship between firms' observable characteristics and their exposure to FX transaction risk, we estimate the following panel regression for each country:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \beta \Delta s_t + \Gamma' \left(\Delta s_t \times X_{i,t-1} \right) + \varepsilon_{i,t}. \tag{1}$$

The dependent variable is firm i's FX transaction gain or loss reported in fiscal year t, scaled by lagged assets, and expressed in basis points (e.g., a value of +100 indicates an FX transaction gain equal to 1% of total assets). Δs_t denotes the change in the value of the domestic currency over fiscal year t (with a positive value $\Delta s_t > 0$ indicating an appreciation of the local currency), measured in percentage points. $X_{i,t-1}$ denotes lagged firm characteristics that are potentially informative about firms' exposure to FX transaction risk. We focus on the role of foreign currency debt and international trade,

[12] The corresponding regressions are reported in Appendix Tables D7 and D8.

[13] As examples, Figures D3 and D4 in the Online Appendix plot the distribution of FX transaction income (scaled by total assets) across firms, in select years with large local currency appreciations and depreciations (respectively).

but also control for the firm cash and net trade credit.[14] We scale all accounting variables by assets and not operating income to show that the results are not due to vanishing operating profits.

The potential role of international financing and international trade is intuitive. If a firm sells a large share of its output abroad in foreign currency, but does not fully hedge the currency risk associated with any delay of payment, then the firm should report an FX transaction loss when the foreign currency depreciates against the domestic currency (i.e., when $\Delta s_t > 0$). Conversely, if a firm sells most of its output in domestic currency but purchases a large share of intermediate inputs abroad in foreign currency (with a delay between purchase invoicing and payment), then the firm should report an FX transaction gain when the foreign currency depreciates.

Our main specification uses the World Input-Output Database to obtain net exports to the rest of the world relative to total gross output, at the country-industry level, and Capital IQ to obtain the domestic currency value of total foreign currency debt, as a fraction of total assets, at the firm level. Table 1 reports estimates of Equation (1) for the subsample of firm-year observations where foreign currency debt is available in Capital IQ.

Firms with large foreign currency debt tend to report large FX transaction gains when the domestic currency appreciates. In Taiwan, South Korea and India, the three countries in our sample where foreign currency corporate debt issuance is most prevalent, we obtain large positive and highly statistically significant coefficient estimates for firms'

[14] Net trade credit is the difference between accounts receivable and accounts payable. A positive value indicates that the firm has extended more credit to its customers than it has received from suppliers. While the Compustat Fundamentals files do not specify the share of each variable denominated in foreign currency, the underlying assets and liabilities, notably cash and net trade credit, may be at least partially denominated in foreign currency. Cash and net trade credit are both standardized to have zero mean and unit standard deviation over the full sample of firm-year observations for each country. Controlling for firm sizes leads to similar results. We leave that control out because the firm size is an ambiguous predictor of exchange rate exposure: large firms may hedge more, but they also may be trading more in foreign currency.

foreign currency debt (relative to assets). When the domestic currency appreciates, firms write down the value of their foreign currency debt and report an FX transaction gain. For a Korean firm with foreign currency debt equal to 10% of assets (roughly the 92nd percentile for observations in our sample), a 10% appreciation of the Korean won against the U.S. dollar leads to an additional FX transaction gain of 0.6% of total assets.[15]

Firms in export-intensive industries tend to report large FX transaction losses when the domestic currency appreciates. In Taiwan, for example, the most export-intensive industries have net exports equal to 50% of their gross output. The coefficient estimates in Table 1 imply that a 10% appreciation of the New Taiwanese dollar against the U.S. dollar leads a typical firm in a high-export industry to report a FX transaction loss equal to $10 \times (-4.20 - 14.04 \times 0.5)$ basis points $\approx 1.1\%$ of total firm assets, more than twice as large as the 0.4% FX transaction loss that would be reported by a typical firm in an industry with no net exports. We find a similar relationship across industries in all countries except the U.S. and the euro area, where again a much larger share of trade is invoiced in the same currency in which firms report their financial statements (Boz et al., 2022).[16]

Estimated coefficients on both cash and net trade credit are negative for almost all countries, although the point estimates are modest in magnitude. Since both cash and

[15]Since Capital IQ reports the currency denomination of liabilities only for a subset of firm-year observations, Table D9 in the Appendix considers the full sample of firm-year observations using total debt in place of foreign currency debt. As expected, estimated coefficients for total debt (including both domestic and foreign currency debt) reported in Table D9 are much smaller in magnitude than the coefficients on foreign currency debt in Table 1. If all of the foreign currency debt is in U.S. dollars so that the bilateral exchange rate perfectly captures the debt revaluation, and if that debt is orthogonal to the other variables, controlling for the other firm characteristics, then the coefficients on foreign currency debt represent the share of foreign currency debt that is not hedged. In practice though, not all of the foreign currency debt is issued in U.S. dollars and since we measure net exports at the industry-level, we may miss some net exports at the firm-level that covary with foreign currency debt.

[16]Foreign sales are available for a subset of firm-year observations in our sample. In the Appendix, Table D10 reports estimates for regressions similar to the ones reported in this section, but with foreign sales included as an additional firm characteristic. As expected, estimated coefficients for the foreign sales share are negative and statistically significant in most countries. Coefficients on industry-level net exports remain negative and statistically significant for most countries, but are generally smaller in magnitude.

net trade credit are net assets on firms' balance sheets, these negative coefficients are consistent with the presence of a small foreign currency-denominated component of cash holdings and trade credit, the value of which is marked down when the domestic currency appreciates, resulting in an FX transaction loss.

International financing and international trade thus appear as key determinants of FX transaction income. Figure 5 and Figure 6 provide a visualization of these relationships. For each country we estimate a similar panel regression to Equation (1), but replacing industry net exports with a collection of indicator variables for industries j:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \Delta s_t \times \sum_j \beta_j \mathbf{1}_{Industry(i)=j} + \Gamma' \left(\Delta s_t \times \tilde{X}_{i,t} \right) + \varepsilon_{i,t}, \quad (2)$$

where $\tilde{X}_{i,t}$ denotes cash, net trade credit, and the value of debt liabilities, each scaled by total firm assets. Figure 5 reports the country-demeaned coefficients $\widetilde{\beta}_j$ for each industry on the vertical axis, against the industry's ratio of net exports to gross output on the horizontal axis. A strong negative relationship emerges in the four countries with large shares of foreign currency invoicing (Japan, Taiwan, South Korea, and India). Firms in export-intensive industries, such as automobile or furniture manufacturing, tend to report the largest FX transaction losses in years when the local currency appreciates. In the same years, firms in import-intensive industries such as petroleum refining tend to report the largest FX transaction gains. This pattern is to be expected if firms in these countries face delays between delivery of goods and payment for both foreign sales and purchases, yet do not fully hedge the resulting exchange rate risk when these transactions are invoiced in foreign currency. An appreciation of the local currency leads firms that are net sellers to the rest of the world to report an FX transaction loss on the foreign currency payments they will receive from customers in the future, while firms that are net purchasers from the rest of the world report FX transaction gains on the future payments

they must make to suppliers.

Similarly, Figure 6 provides a visualization of the relationship between foreign currency debt and FX transaction risk exposure across firms. We estimate a similar panel regression to Equation (1), but replacing foreign currency leverage with indicator variables for five foreign currency leverage quintiles (defined using the ratios of non-zero foreign currency debt to total assets):

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \Delta s_t \times \sum_{k=1}^{5} \eta_k \mathbf{1}_{FCLeverageQuintile(i,t)=k} + \Gamma' \left(\Delta s_t \times \tilde{X}_{i,t} \right) + \varepsilon_{i,t}. \tag{3}$$

The top panel of Figure 6 focuses on the U.S., euro area, and Japan, while the bottom panel focuses on Taiwan, South Korea, and India. In the latter set of countries, a 10% appreciation of the local currency against the U.S. dollar leads firms in the top foreign currency leverage quintile to report an FX transaction gain of roughly 0.4% of total assets in India, 0.5% of assets in Taiwan, and 1.2% of assets in South Korea. In contrast, for the U.S., euro area, and Japan, the estimated coefficients for each of the foreign currency leverage quintile indicators are all nearly zero, even for the small set of firms with large shares of foreign currency debt. This suggests that U.S., European, and Japanese firms tend to hedge the currency risk arising from their foreign currency debt, benefiting from the deep FX swap markets in their currencies.

To summarize, we find a strong and intuitive link between FX transaction income and exchange rate changes that is consistent with industry-level net trade and firm-level foreign currency debt exposures. To link the micro-level evidence back to macro aggregates, we build an asset-weighted, characteristic-specific loading in each country.[17] Recall that, at the aggregate level, local currency appreciation brings aggregate FX transaction

[17]Let $\widehat{\delta}_{i,k,t}$ denote the estimated sensitivity of FX transaction income to exchange rate due to the k characteristic: $\widehat{\delta}_{i,k,t} \equiv \widehat{\gamma}_k X_{i,k,t}$, where $\widehat{\gamma}_k$ is the k-component of the vector Γ estimated in Equation (1). Likewise, the "baseline" component is $\widehat{\delta}_{i,0,t} \equiv \widehat{\beta}$. The asset-weighted loading due characteristic k in

losses in Japan and Taiwan, but aggregate gains in the euro area, India and South Korea. Figure 7 decomposes the asset-weighted average loading (the black bars) in three groups of firm characteristics (the colored boxes): i) trade: industry-level net exports and firm-level net trade credit, ii) finance: firm-level foreign currency debt, and iii) the rest, which is less precisely identified and includes the baseline component and firm-level cash. The figure offers a potential interpretation of the cross-country differences apparent in Figure 3. In Taiwan, when the Taiwanese dollar appreciates, foreign currency debt only partially compensates the losses linked to international trade. Such hedging effect is tiny in Japan, where both trade and the "other" determinants imply aggregate losses when the local currency appreciates. In South Korea, the importance of foreign currency debt leads to FX transaction gains when the won appreciates, and those gains are exacerbated by the "other" determinants, and only partially balanced by the exports. In India, all components contribute to FX transaction gains when the rupee appreciates, pointing to the importance of foreign currency debt and imports, with a large role for the "other" factors.

While micro-level data offer a partial explanation of the cross-country differences in the impact of exchange rates, such data also highlight the potential and need for subsequent research. Foreign currency debt and international trade only describe a fraction of the variations in FX transaction income across time, firms, and countries. To understand further the determinants of FX transaction income, additional data would be helpful, notably the firm-level amounts (and the currency composition of) cash, securities holdings, imports and exports. Those series are not readily accessible across countries yet (hence our use of a single exchange rate for all firms in the same country). While we do not

country c, denoted $\overline{\widehat{\delta}}_{c,k}$, is then:

$$\overline{\widehat{\delta}}_{c,k} \equiv \sum_{i,t} \frac{\text{Assets}_{i,t}}{\sum_{i',t'} \text{Assets}_{i',t'}} \times \widehat{\delta}_{i,k,t}.$$

observe such detailed data at the firm level and cannot test all its potential determinants, the FX transaction income that we do observe still summarizes the net impact of any exchange rate movements on the value of all of the firm's foreign currency-denominated assets and liabilities. We turn now to the passthrough of firms' FX transaction income to profits.

4 Firm Passthrough of FX Transaction Income to Profits

In the absence of operational hedging — i.e., if no other component of income is negatively correlated with the FX transaction income — the passthrough should be one, since FX transaction income is itself a component of the profits. If firms are more exposed to exchange rates than their FX transaction income indicates, the passthrough could be even larger than one. In the case of perfect operational hedging, however, the passthrough should be zero.

To build intuition for a low passthrough, consider the example of a Japanese exporter that invoices its sales in U.S. dollars. A broad strengthening of the dollar will generate FX transaction gains for *past* sales for which the firm has not yet collected payment. Yet, if prices are sticky in dollars, then the strengthening of the dollar may reduce *future* sales for the rest of the year because the Japanese exports become more expensive to any non-dollar economy; any such changes in expected future transactions are not reflected in the firm's FX transaction income. Likewise, if the same firm purchases inputs throughout the year in U.S. dollars with no delay of payment (or incur distributional costs in dollars), then a strengthening of the dollar will increase its costs. Yet, these higher costs are not accounted for in the firms' FX transaction income since they are immediately paid. In both cases, the passthrough is lower than one because of competitivity effects.

To quantify the passthrough from FX transaction income to final profits, we estimate the following panel regression for each country:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \beta \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t}, \qquad (4)$$

where α_i denotes the firm i fixed effect, while $\theta_{Industry(i),t}$ denotes industry i-year t fixed effects. In order to study firms' dynamic responses, the sample comprises firm-year observations (i,t) where firm i is continuously present in the sample from year $t-1$ to year $t+2$. In those regressions, the dependent variable is pre-tax income because tax payments generate an incomplete passthrough even in the absence of operational hedging. In robustness checks reported in Appendix Table D11, estimated passthrough coefficients for post-tax income remain large and significant, although they are smaller in magnitude due to the effect of corporate taxes. Using pre-tax income, our results are easily comparable across countries.

Panel A of Table 2 reports the estimated passthrough coefficients from FX transaction income to firms' pre-tax profits. In all countries, the passthrough coefficients are positive and statistically significant, ranging from 0.55 in Japan to nearly 1 in the euro area and Taiwan. The large positive passthrough coefficients imply that any operational hedging of FX transaction gains and losses, or offsetting gains and losses elsewhere in the income statement, are limited in scope.

To further understand the passthrough from firms' FX transaction income to their pre-tax profits, we estimate similar regressions using firms' non-operating and operating income (after depreciation) as dependent variables. The former, reported in Panel B of Table 2, suggest that no other component of non-operating income comoves with FX transaction income. Since FX transaction income is generally included in the calculation of firms' non-operating income, the regression coefficients are unsurprisingly close to one

in all countries (with the exception of South Korea, potentially highlighting some measurement errors there). More crucially, Panel B of Table 2 instead reports estimates using operating income (after depreciation) as the dependent variable. Since FX transaction income is generally *not* included in the calculation of firms' operating income, the mechanical relationship present for pre-tax income or non-operating income is absent here. We obtain negative coefficient estimates across all countries, significantly so for Japan and India, indicating that firms' operating income tends to be negatively correlated with their FX transaction income. The strength of this relationship varies considerably across countries: for Japanese firms, a 100¥ increase in FX transaction income tends to be offset by a 42¥ reduction in operating income, resulting in the relatively low passthrough from FX transaction income to profits reported in Panel A of Table 2.

We next investigate whether FX transaction income reported in the current year is correlated with firm income in the years that follow. Conventional wisdom about exchange rate dynamics suggests that the answer is likely to be negative: nominal exchange rates are close to a random walk in levels, implying that changes in nominal exchange rates are serially uncorrelated. Since firms' FX transaction income is primarily determined by changes in exchange rates, we expect a weak or zero correlation between current FX transaction income and future FX transaction income or profits reported by the same firm.[18] To check, we estimate a dynamic version of Equation (4), using *future* profits at an horizon of h years ahead:

$$\frac{\text{Pre-tax Income}_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t+h} + \beta_h \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t+h} \quad (5)$$

[18] One potential exception is the case where firms financially hedge their exposure to exchange rate risk using FX forward contracts. Section 2.2 shows that such a firm will report FX transaction income equal to the difference between the forward and spot rates on the date when the contract is purchased. Such forward discounts are persistent, but the magnitude of this component will likely be small relative to the large gains and losses arising from movements in spot exchange rates if the same position is not hedged. Our inclusion of firm fixed effects in regression (5) helps to eliminate this persistent component for firms that consistently hedge using forward contracts over the sample period.

Because FX transaction income and profits are measured in different years when $h > 0$, the mechanical relationship between the two variables that arose in the previous regressions with $h = 0$ is no longer present. Figure 8 shows the estimated passthrough coefficients at horizons $h = 0$, 1, and 2. For the majority of countries and for horizons beyond the initial shock (i.e., $h > 0$), the passthrough coefficients β_h are small and statistically insignificant.The coefficients for the U.S. are estimated least precisely, due to the relatively small number of U.S. firms reporting large FX transaction gains and losses. Overall, firms' FX transaction gains and losses are transitory shock to profits in the same year, with no effects on future profits over short to medium horizons.

5 Exchange Rates and Firms' Profits

After showing that exchange rate changes are correlated to FX transaction income in Section 3 and that FX transaction income passes through to firm profits in Section 4, we turn now to the impact of exchange rate changes on firms' profits. Conditional on FX transaction income, the correlation between exchange rate shocks and firms' profits follows naturally from the previous results. To go further, we study the causal impact of exchange rate shocks on corporate profits.

In trying to establish a causal link, three concerns immediately arise: the external validity of any finding, a potential reverse causality, and potential omitted variables. While the first two concerns are relatively minor in our case, the third one is more difficult to address. Since our sample includes all public firms in six different countries, any finding should be representative of the economy. Likewise, no firm seems large enough to determine the exchange rate, so reverse causality is unlikely. It is, however, possible that other variables affect firms' profits at the same time as the exchange rate changes. Although we cannot definitely rule out all omitted variables, we seek to limit their role

by introducing dummies for each year and each industry, i.e., industry-year fixed effects. Intuitively, the local impact of exchange rate changes on profits is then obtained by comparing, for a given year and a given industry, the profits of two firms that have different degrees of exposure to exchange rate shocks.

Past FX transaction income is our signal to FX exposure. To build intuition, let us go back to our initial example of Japanese firms that export in U.S. dollars (but receive them with a delay), assuming for now that exports are the sole determinants to FX exposure. When the yen appreciates ($\Delta s > 0$), such a firm reports a negative FX transaction income. Across firms, when the yen appreciates, the larger the exports, the more negative the FX transaction income. Likewise, when the yen depreciates ($\Delta s < 0$), the larger the exports, the more positive the FX transaction income. By sorting FX transaction income in ascending order when the yen appreciates ($\Delta s > 0$) and descending order otherwise, we would sort firms from large to small exporters. While this intuition is built on exports, in practice though, FX transaction income signals more than exports: as we saw, it aggregates information on exports and imports, assets and liabilities. Our sorting procedure seeks to differentiate firms using all the information in their past FX exposure, sorting firms from those that tend to report losses to those that tend to report gains when their local currency appreciates.

Within each country and year t, we sort firms into four "FX exposure quartiles" based on the ratio of their realized FX transaction income in year $t-1$ (scaled by the firm's total assets at the end of the year $t-1$), excluding the firm-year observations with zero FX transaction income from our analysis. By assigning firms to FX exposure quartiles using FX transaction income measured in a different period than the total pre-tax profits used in this regression, we remove any mechanical link between the two variables. As a robustness check, sorts based on contemporaneous FX transaction income are reported in the Appendix. FX transaction income is not exogenous (e.g., firms decide to exports in

foreign currency), but changes in exchange rates are likely exogenous.

The impact of exchange rate changes on profits is then estimated by:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \Delta s_t \times \sum_{k=2}^{4} \lambda_k 1_{\text{FX exposure quartile } (i,t-1)=k} + \Gamma' X_{i,t-1} + \varepsilon_{i,t}. \tag{6}$$

The lowest FX exposure quartile is excluded from the set of interaction terms due to the inclusion of industry-year fixed effects. The dependent variable – the ratio of the firm's pre-tax income to lagged assets – is expressed in basis points, while the change in the exchange rate Δs_t is in percentage points. The coefficients λ_k measure the expected difference in income (measured in basis points, relative to total assets) between firms in FX exposure quartile k relative to firms in the lowest quartile, following a 1% appreciation of the local currency. The set of lagged firm-level control variables $X_{i,t-1}$ includes log total assets, the ratio of cash to total assets, total leverage (measured as the ratio of total debt to total assets), and the market-to-book ratio for the firm's assets (measured as the sum of the firm's stock market capitalization plus the book value of its liabilities, divided by the book value of assets). The latter variable is forward-looking and may thus capture, at least partly, firm-level expectations.

Table 3 reports the estimation results. In Japan, Taiwan, South Korea, and India, the profits of the most exposed firms increase significantly more than those of the least exposed firms when the local currency appreciates. Except for Taiwan, the impact of exchange rates increases monotonically across quartiles. Following a 10% appreciation of the local currency, firms in the top FX exposure quartile report income exceeding that of comparable firms in the lowest FX exposure quartile by amounts varying from $10 \times 2.72 = 27.2$ basis points, i.e., 0.3% of total firm assets in Japan, to $10 \times 7.46 = 74.6$ basis points, i.e., 0.7% in South Korea. For comparison, the median value of the dependent variable across firm-year observations in all six countries is roughly 4%. Those estimates

are local treatment effects, not the full impact of exchange rates on profits.

A causal interpretation relies on the assumption that no other variable comoves with exchange rate shocks and affects differentially our firm quartiles, without being absorbed by the industry-year fixed effects and the firm-level controls. We do not have any example of such an omitted variable, but we do not rule it out. For example, if risk-averse managers decide to hedge more their exchange rate risk than usual (for their firm and industry), their firms record unusually low FX transaction income. If those managers were to hedge more just before a local currency appreciation and if firm profits were to decrease because of their higher risk-aversion, then firms that record low FX transaction income would also experience low profits, but not because of the local currency appreciation. We cannot rule out this mechanism, but we note that it relies on managers being able to predict a local currency appreciation. This seems unlikely, as the academic literature suggests that exchange rates are well approximated by a random walk.

6 FX Transaction Income, Payouts, and Investment

Since exchange rates affect corporate profits, how do firms adjust their subsequent cash, payouts, and investments? We follow the money in a two-stage least squares estimation, conditioning on the FX transaction income that firms report and pooling firms across countries to maximize identification power. To normalize the impact of the FX shocks across countries, we first project pre-tax income on FX transaction income for firms in each country:

$$\begin{aligned}\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} =& \alpha_i + \theta_{Country(i),Industry(i),t} + \Gamma'_{Country(i)} X_{i,t-1} \\ &+ \delta_{Country(i)} \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + u_{i,t},\end{aligned} \tag{7}$$

where α_i denotes firm fixed effects, $\theta_{Country(i),Industry(i),t}$ the country-industry-year fixed effects, $X_{i,t-1}$ the country-specific lagged firm-level control variables (the ratio of ordinary post-tax income to total assets, log total assets, the ratio of cash to total assets, total debt relative to assets, and the ratio of the market value of assets to their book value). We estimate separate coefficients for firms in each country, which accounts for the differential passthrough from FX transaction income to pre-tax income across countries that we document in Section 4.

In the second stage, we measure the sensitivity of taxes, net equity payouts (defined as the sum of dividends and net equity repurchases), and investments at different horizons h ($h \in \{0, 1, 2\}$) to the passthrough-adjusted FX transaction income, pooling firm-year observations across countries:

$$\frac{Y_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \beta_h \frac{\widehat{\text{Pre-tax Income}}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + \varepsilon_{i,t+h}, \quad (8)$$

with the same set of fixed effects and controls as in the first stage. Here $\frac{\widehat{\text{Pre-tax Income}}_{i,t}}{\text{Assets}_{i,t-1}}$ denotes the fitted values from the first-stage regression in Equation (7). The coefficient β_h measures the response of the selected firm outcome $Y_{i,t+h}$ to the passthrough-adjusted FX transaction income in year t; this coefficient is common across all countries, and thus reflects an average response across all firm-year observations in our full sample. The inclusion of country-industry-year fixed effects helps to control for changes in investment opportunities that affect all firms in a country and an industry in the same manner, such as changes in the local currency cost of foreign capital goods as exchange rates fluctuate. We consider the impact of FX transaction income on taxes, net equity payouts, as well as the change in monetary items and the change in long-term assets. This decomposition

describes all the possible use of cash flows.[19] Tables 4 and 5 report the second-stage estimates of β_h in Equation (8) in the pooled sample for all firm outcomes and horizons. In the year they experience the exchange rate shock, for every additional dollar of pre-tax income, firms pay on average 14 cents in taxes — an estimate consistent with the average global effective tax rate — and pay out 5 cents to shareholders. The rest remains inside the firm, either as cash or an increase in long-term assets (defined as the difference between total assets and current assets and cash). The increase in monetary items (trade payables and receivables, debt, cash) is not surprising, and at least partly mechanical since, by definition, FX transaction income measures the impact of FX changes on monetary items. The increase in the value of the long-term assets is limited and not significant, and could also be partly mechanical for firms with foreign subsidiaries — the potential valuation effect limits our ability to follow the money.

One year after the initial shock, firms pay out on average 9 more cents to their shareholders and invest 17 cents, while their monetary items decrease by 21 cents. These responses are highly statistically significant. Similar results obtain with the changes in the firms' property, plant and equipment (PPE, net of depreciation) and capital expenditures (net of the sales in PPE) reported in Appendix Table D13: both measures of investment record an increase of 12 cents one year after the shock. There is no significant subsequent change in long-term assets two years after the shock. Cumulatively, for every

[19] Accounting standards ensure that

$$\begin{aligned} \text{Assets} &= \text{Current Assets (CA, including Cash)} + \text{Long-term Assets (PPE and Other Fixed Assets)} \\ \text{Assets} &= \text{Current Liabilities (CL)} + \text{Long-term Debt (LTB)} + \text{Equity} \\ \Delta\text{Equity} &= \text{Pre-tax Income} - \text{Taxes} - \text{Net Equity Payouts} \end{aligned}$$

They imply that the pre-tax income is

$$\begin{aligned} \text{Pre-tax Income} &= \text{Taxes} + \text{Net Equity Payouts} + \Delta(\text{CA-CL}) - \Delta\text{LTB} + \Delta\text{Long-term Assets} \\ &= \text{Taxes} + \text{Net Equity Payouts} + \Delta\text{Monetary Items} + \Delta\text{Long-term Assets}. \end{aligned}$$

dollar of pre-tax income generated by these FX valuation gains, firms pay roughly 10-15 cents in taxes, 15-20 cents to shareholders, invest at most 30 cents and keep the rest in cash.

Exchange rate shocks may affect firms because of competitivity and cash flow effects. To build intuition on the former, assume that exchange rates follow a random walk ($E_t(s_{t+1}) = s_t$). In this case, any exchange rate shock is permanent. For example, if export prices are set in U.S. dollars and cannot be adjusted (e.g., because of competition pressures), then an appreciation of the yen may increase labor costs in yen and render the Japanese business less profitable, leading to an investment reduction. The competitivity effect reinforces the cash flow effect, since the increase in yen leads to FX transaction losses. Froot, Scharfstein and Stein (1993) show that firms should not fully hedge their exchange rate risk when losses happen in times of reduced investment opportunities. Alternatively, when the rupee appreciates, an Indian firm with dollar debt may experience a decline in its competitivity (because of labor costs in rupees) at the same time it records an FX transaction gain (because of dollar debt). In this case, the competitivity and cash flow effects move in opposite directions.

On top of the competitivity effect, firms' investment may react to exchange rate shocks through a pure cash flow channel. If firms face frictions in raising external finance, they may adjust their investment in response to FX transaction gains or losses even if their investment opportunities remain unchanged. A large literature in corporate finance estimates the investment-cash flow sensitivity. Among the most recent estimates, Erickson and Whited (2010, 2012) report investment-cash flow sensitivities of less than 10 cents, while Lewellen and Lewellen (2016) report an average increase of 40 cents for every additional dollar of cash flows. Our estimate falls in this range. It may be limited by the existence of large cash balances or our focus on the intensive margin, keeping only firms

that remain in the sample two years after the shock.[20] Yet, we find that exchange rate shocks affect not only firm's profits but also their payouts and investment decisions.

7 Conclusion

Firms have to report in their FX transaction gains and losses the direct impact of exchange rate changes on their monetary items, notably cash, accounts receivables and payables, and foreign currency debt. Using only publicly available data, this paper describes the properties and determinants of FX transaction income, its passthrough to and impact on firm profits, and its consequences for payouts and investment.

At the aggregate level, FX transaction income comoves with exchange rate changes: while an appreciation of the local currency leads to FX transaction gains in Japan and Taiwan for example, it leads to losses in South Korea and India. Firm-level data indicate that net trade exposure and foreign currency debt are key determinants of the FX transaction income: when the local currency appreciates, exporters record FX transaction losses as the value of their accounts receivables decrease. Borrowers in foreign currency also record FX transaction gains in this case, as the local currency value of debt that they must eventually reimburse decreases. The correlation between FX transaction income and exchange rate changes suggests that firms do not fully hedge financially their FX exposure.

FX transaction income passes through to firms' profits, suggesting that operational hedging is limited. With full operational hedging, the passthrough should be zero. In the

[20] Bruno and Shin (2017) argue that many non-U.S. firms issuing dollar-denominated debt already have large cash balances before issuing, then stockpile additional cash using the proceeds from issuance. In that case, FX transaction gains and losses arising from revaluation of foreign currency debt may have a limited effect on investment if the firms issuing the debt are not financially constrained. Alternatively, the real effects of large FX transaction gains and losses may be concentrated on the extensive margin of firm exit, rather than the intensive margin of lower investment among firms that still continue to operate. Kim, Tesar and Zhang (2015) provide evidence of such effects for small South Korean firms with large amounts of foreign currency debt around the 1997-1998 Asian financial crisis.

absence of any operational hedging, it should be one. In the data, it ranges from 0.5 to one in the six countries in our sample. Cumulatively over two years, firms pay up to 15% of their FX transaction income gains in taxes, 20% to shareholders, and invest at most 30%, while keeping the rest in cash.

Since exchange rate shocks are correlated to FX transaction income, and FX transaction income shows up in firms' profits, it is no surprise that exchange rate changes affect firms' profits. Using FX transaction income as a signal to sort firms along their potential exposure to exchange rates, we find a statistically significant impact of exchange rate shocks, after controlling for firm characteristics and all industry- and time-specific shocks.

FX transaction income thus appears as a useful signal to study the impact of exchange rate changes on firms.

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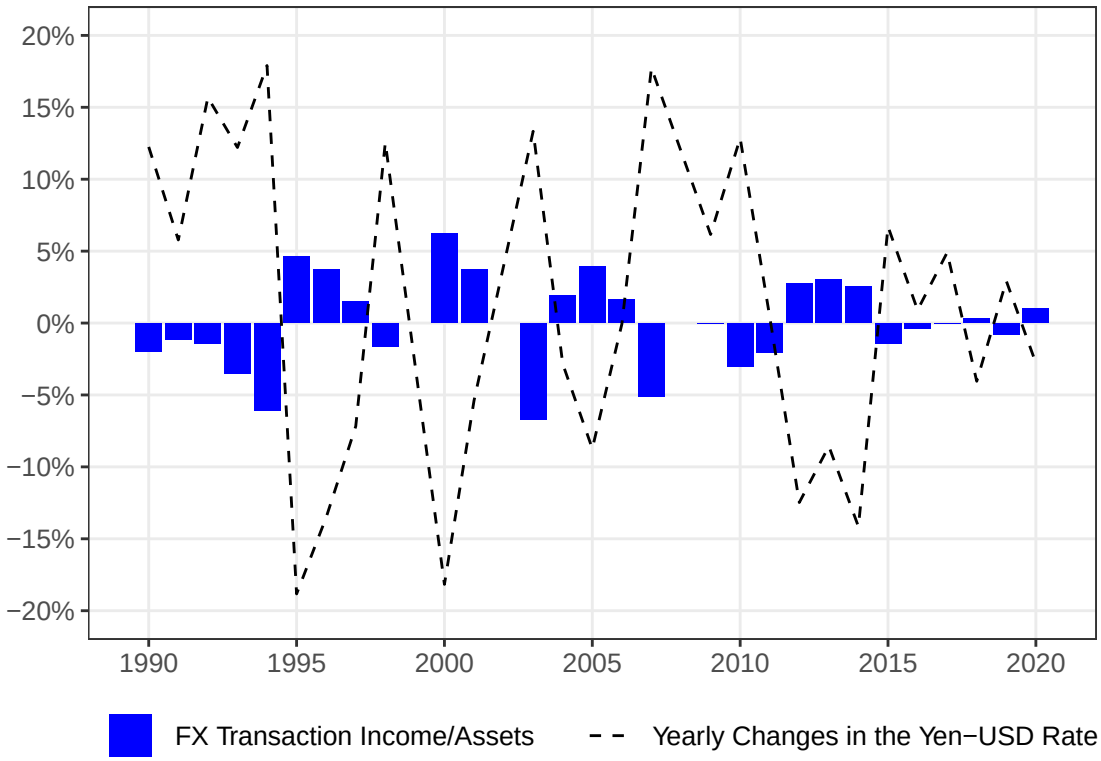
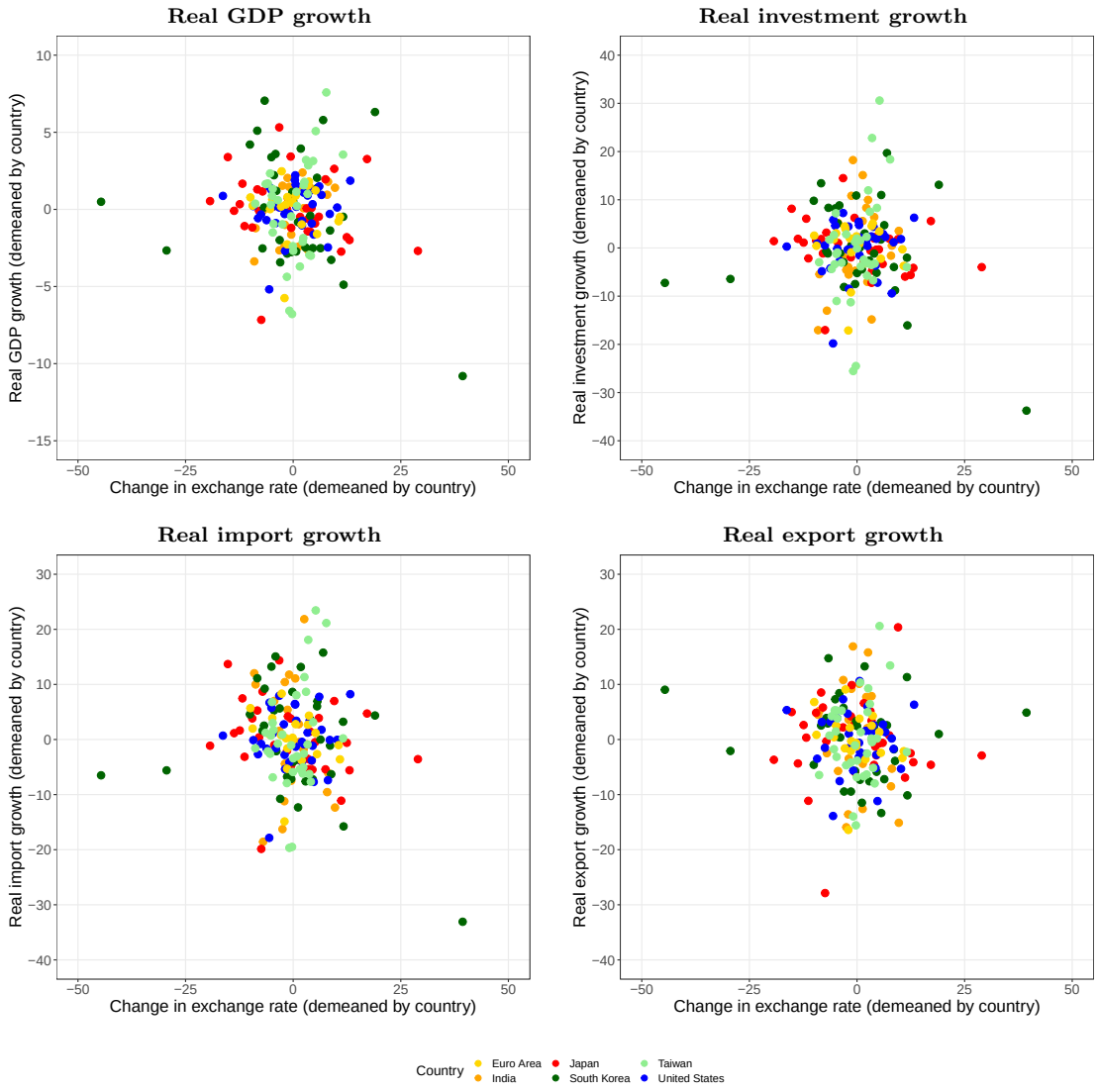
Figure 1. Foreign Transaction Income: the Example of Nintendo Co.



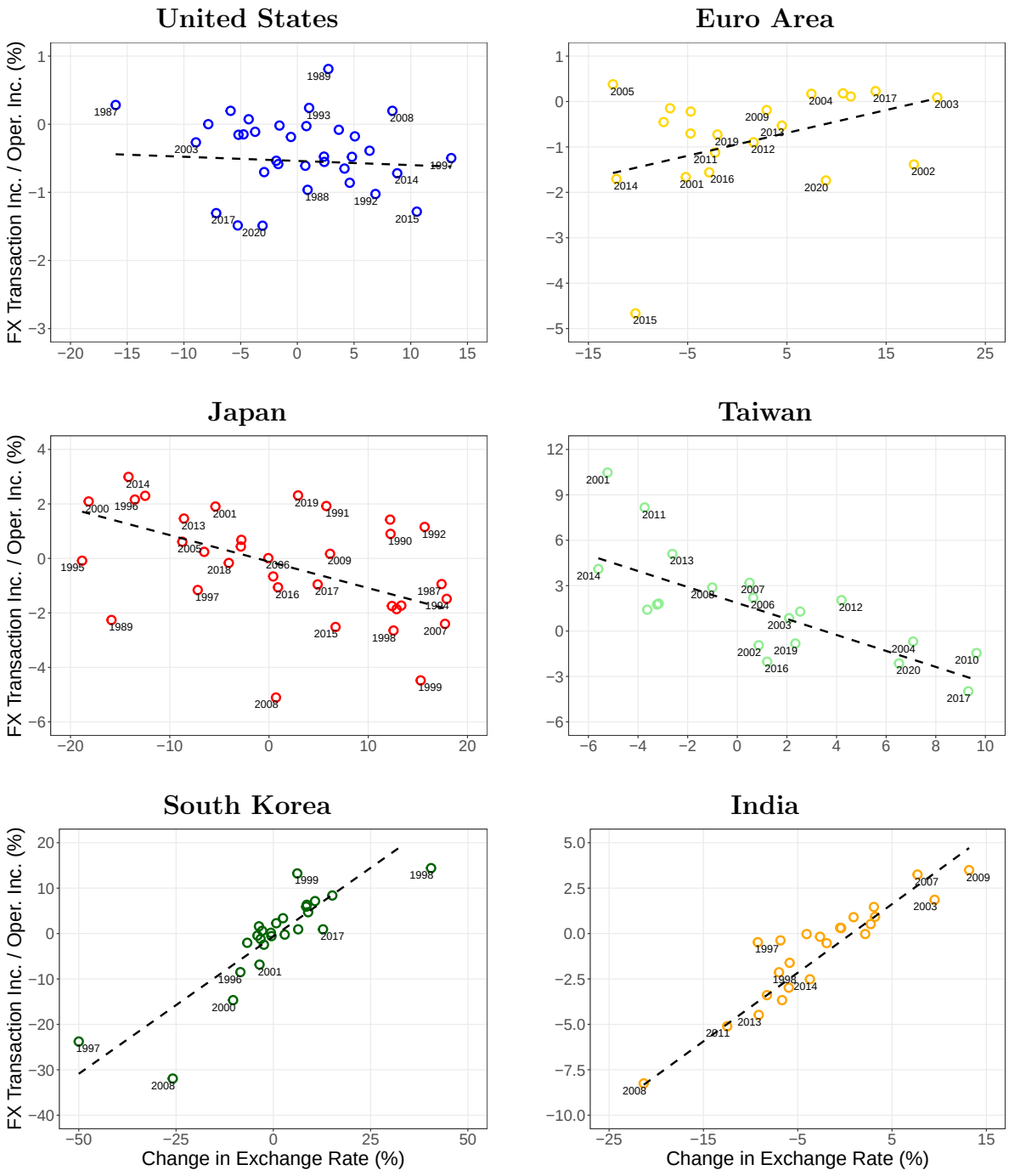
The figure above presents the FX transaction income (scaled by total assets) reported in Nintendo's consolidated statements of income. The dashed line represents the yearly change in the exchange rate defined in U.S. dollars per yen, such that a positive change corresponds to an appreciation of the yen. The source is Nintendo's annual financial statements, as recorded in the Compustat Global Fundamentals Annual file.

Figure 2. Exchange Rate Changes and GDP, Investment, Exports and Imports Growth



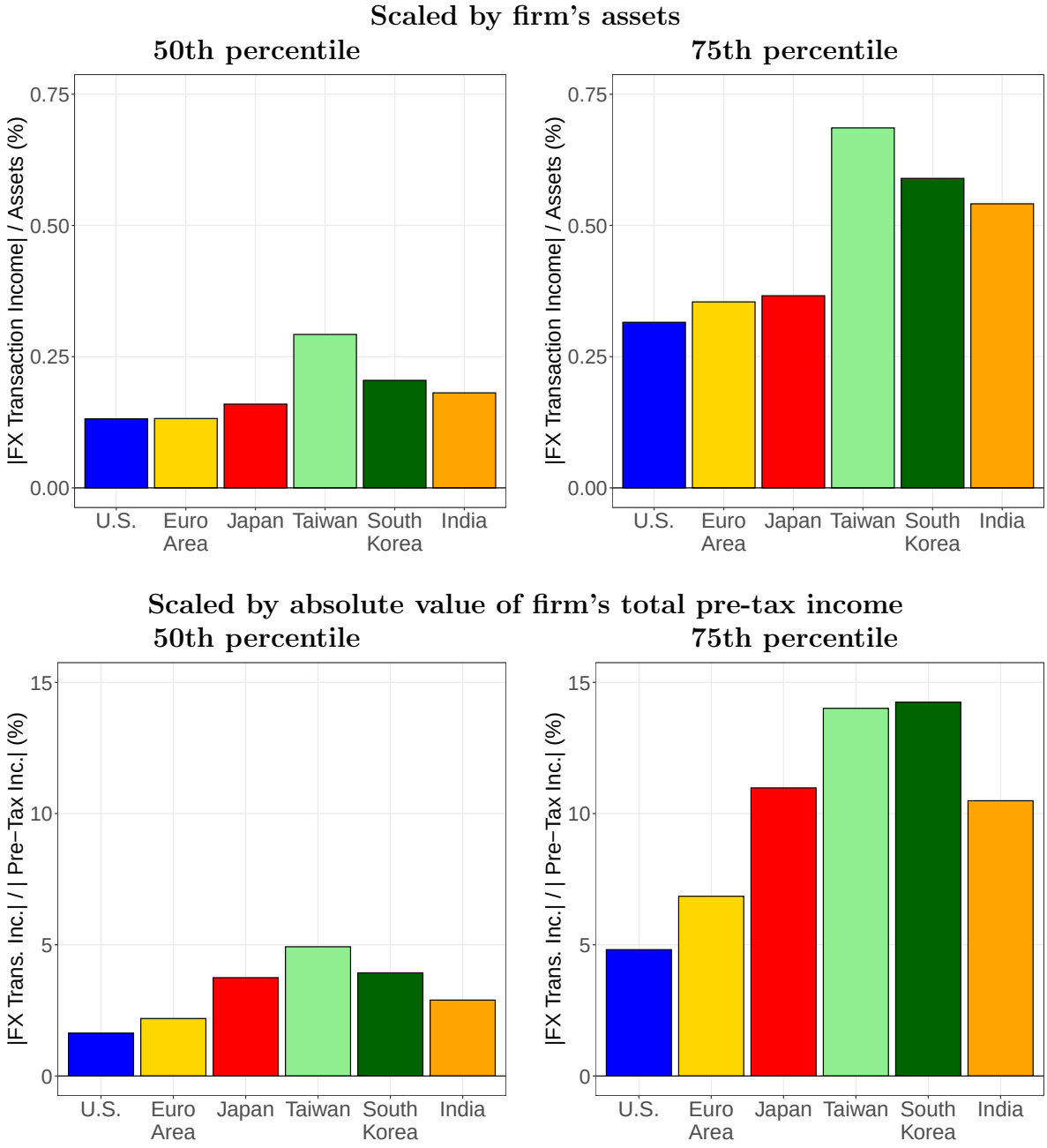
The figure above reports the annual changes in the nominal exchange rates of the euro area, India, Japan, South Korea, Taiwan, and the United States over the 1987–2020 period (on the horizontal axis) against the real GDP growth, real investment growth, real import and export growth. For the U.S., the exchange rate is the Bank of International Settlements' effective U.S. dollar exchange rate index. For the other countries, it is the nominal bilateral U.S. dollar exchange rates. A positive exchange rate change corresponds to an appreciation of the local currency.

Figure 3. Aggregate FX Transaction Income (Relative to Operating Income) and Exchange Rates



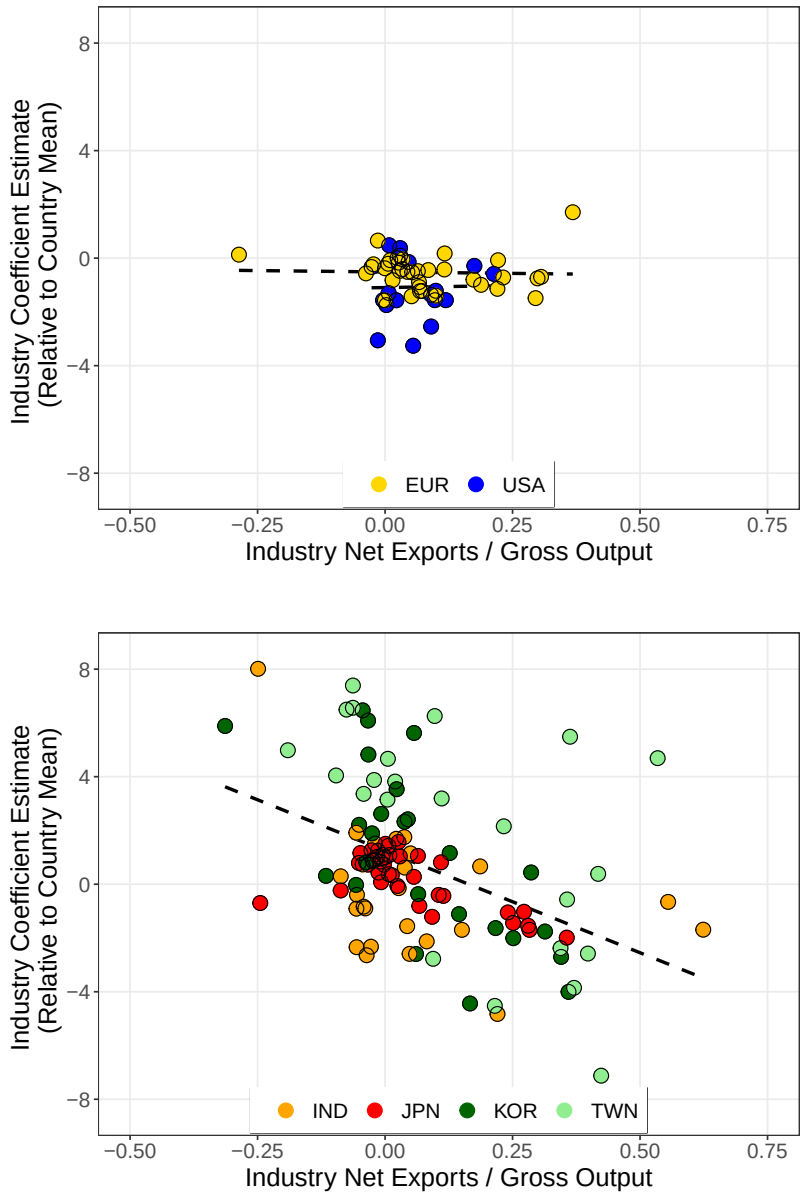
This figure presents aggregate FX transaction income in each year for the six countries and currency areas in our sample, as function of the annual change in exchange rate. Aggregate FX transaction income is the sum of FX transaction income across all firms in the sample for which a non-missing value is available in a given year. The aggregate FX transaction income is scaled by aggregate operating income for the same set of firms. The figure includes only country-years for which at least 200 firms report non-missing FX transaction income. The exchange rate is the BIS trade-weighted U.S. dollar index for the U.S., and the corresponding bilateral exchange rate against the U.S. dollar for all other countries. Exchange rates are defined in U.S. dollars per local currency. A positive change in exchange rate indicates an appreciation of the local currency.

Figure 4. 50th and 75th Percentiles of Non-Zero FX Transaction Income



This figure depicts the percentiles of the scaled, absolute value of FX transaction income, computed for each country across all firm-year observations where FX transaction income is non-zero. The top panels report the 50th (left) and 75th (right) percentiles of FX transaction income scaled by the firm's total assets in the same year. The bottom panels report the 50th (left) and 75th (right) percentiles of FX transaction income scaled by the firm's total pre-tax income in the same year.

Figure 5. FX Transaction Risk and International Trade

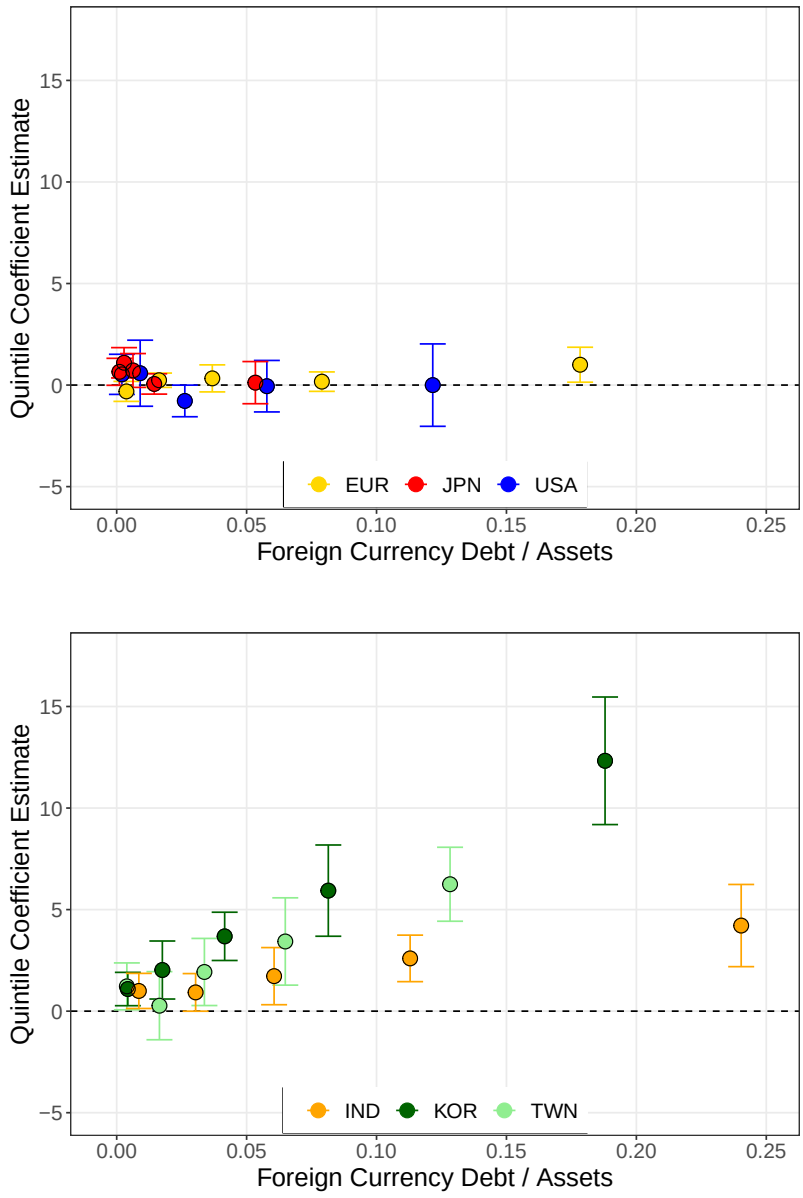


This figure presents, across industries, the estimated FX transaction income sensitivity to exchange rates, as function of the share of net exports in gross output in the corresponding industry. In each country, the FX transaction income sensitivity to exchange rates of industry j, denoted β_j, is estimated in the following panel regression:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t}} = \alpha_i + \Delta s_t \times \sum_j \beta_j \mathbf{1}_{Industry(i)=j} + \Gamma' \left(\Delta s_t \times \tilde{X}_{i,t} \right) + \varepsilon_{i,t},$$

where firm i FX transaction income at date t (scaled by assets) depends on the interactions between the exchange rate change Δs_t with a set of industry indicator variables, denoted $\mathbf{1}_{Industry(i)=j}$, controlling for firm characteristics, $\tilde{X}_{i,t}$ (the log of total firm assets, cash, net trade credit, and the value of debt liabilities, each scaled by total firm assets). In each country, the estimated industry coefficient $\widehat{\beta}_j$ are demeaned to obtain $\widehat{\beta}_j - \sum_{j'} \widehat{\beta}_{j'} \times N_{j'}/N$, where N_j denotes the number of firm-year observations for industry j and N is the total number of observations in that country. Only industries with at least 100 firm-year observations are included in the sample. The ratio of net exports (total exports minus total imports) to gross output for each industry is obtained using data from the World Input-Output Database. The upper panel focuses on the euro area and the U.S., while the lower panel focuses on India, Japan, South Korea, and Taiwan. A positive change in exchange rate indicates an appreciation of the local currency. Thus, a downward trend in this figure means that the more an industry exports, the larger the losses in FX transaction income when the local currency appreciates (and the dollar depreciates).

Figure 6. FX Transaction Risk and Foreign Currency Debt

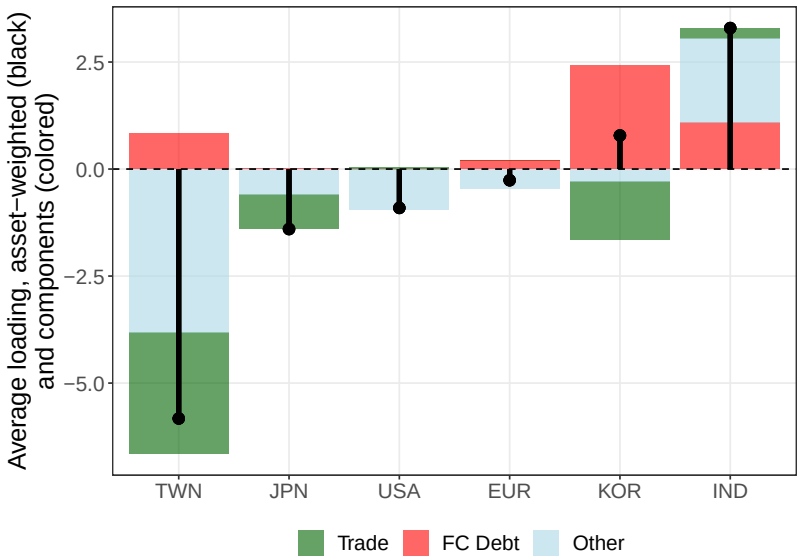


This figure presents the estimated FX transaction income sensitivity to exchange rates, as function of the average levels of foreign currency debt (relative to total assets). In each country and each year, firms are sorted by their amounts of foreign currency debt outstanding (relative to total assets) into five quintiles. In each country, the FX transaction income sensitivity to exchange rates of quintile k, denoted η_k, is estimated in the following panel regression:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t}} = \alpha_i + \Delta s_t \times \sum_{k=1}^{5} \eta_k \mathbf{1}_{FCLeverageQuintile(i,t)=k} + \Gamma' \left(\Delta s_t \times \tilde{X}_{i,t} \right) + \varepsilon_{i,t},$$

where firm i FX transaction income at date t (scaled by assets) depends on the interactions between the exchange rate change Δs_t with a set of foreign currency leverage quintile indicators, denoted $\mathbf{1}_{FCLeverageQuintile(i,t)=k}$, controlling for firm characteristics, $\tilde{X}_{i,t}$ (the log of total firm assets, cash, net trade credit, and the value of debt liabilities, each scaled by total firm assets). The standard errors are obtained by clustering the residuals by firm and year, and the confidence bands represent plus and minus two standard errors around the point estimates. The upper panel focuses on the euro area, Japan, and the U.S., while the lower panel focuses on India, South Korea, and Taiwan. A positive change in exchange rate indicates an appreciation of the local currency. Thus, a upward trend in this figure means that the larger the foreign currency debt, the larger the gains in FX transaction income when the local currency appreciates (and the dollar depreciates).

Figure 7. Micro-to-Macro Determinants of FX Transaction Income Across Countries



This figure reports, for each country, the aggregate sensitivity of FX transaction income to exchange rate changes, built from the firm-level panel regressions:

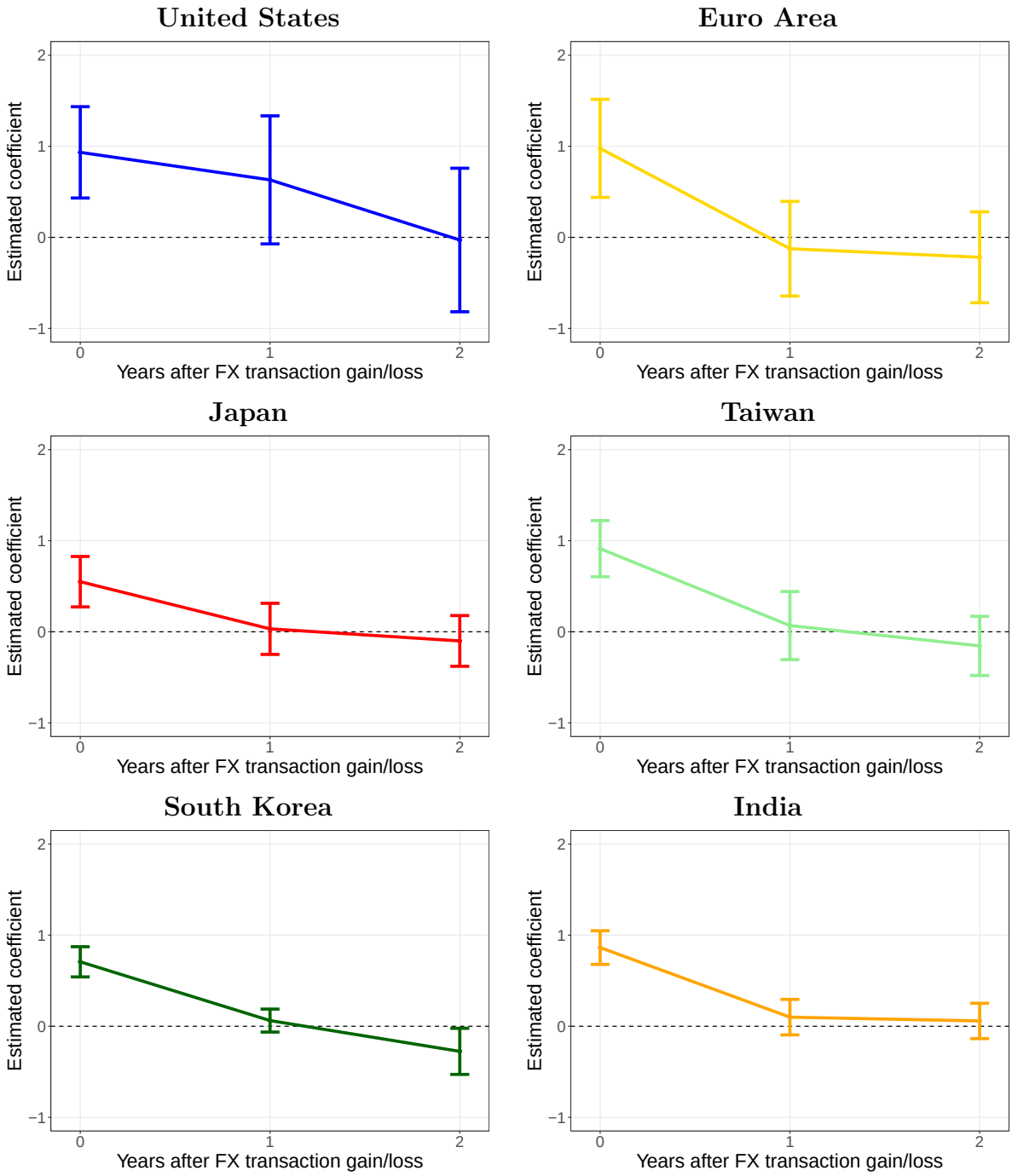
$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \beta \times \Delta s_{c,t} + \sum_{k=1}^{K} \gamma_k \times X_{i,k,t-1} \times \Delta s_{c,t} + \varepsilon_{i,t},$$

where the firm characteristics, denoted $X_{i,k,t-1}$, are the industry-level net exports (as a fraction of output, averaged over the full sample period), the firm-level foreign currency debt (scaled by assets), and the firm-level controls (cash and net trade credit, both scaled by assets). For each country c, the panel estimates are the "baseline" component, $\widehat{\delta}_{i,0,t} \equiv \widehat{\beta}$, and the component attributable to firm characteristic k, denoted $\widehat{\delta}_{i,k,t} \equiv \widehat{\gamma}_k X_{i,k,t}$. The asset-weighted loading due to characteristic k in country c, denoted $\overline{\widehat{\delta}}_{c,k}$, is then defined as an asset-weighted average of the loadings $\widehat{\delta}_{i,k,t}$ across all firm-year observations for country c:

$$\overline{\widehat{\delta}}_{c,k} \equiv \sum_{i,t} \frac{Assets_{i,t}}{\sum_{i',t'} Assets_{i',t'}} \times \widehat{\delta}_{i,k,t}.$$

The figure decomposes the asset-weighted average loading (the black bars) across three groups of firm characteristics (the colored boxes): i) industry-level net exports and firm-level net trade credit, ii) firm-level foreign currency debt, and iii) the rest, which includes the baseline component and cash. Exchange rates are defined in U.S. dollars per local currency. A positive change in exchange rate indicates an appreciation of the local currency.

Figure 8. FX Transaction Income and Firms' Pre-Tax Profits: Dynamics



This figure presents the responses β_h of pre-tax income at date $t+h$ to FX transaction shocks at date t. For each country and each horizon $h = 0, 1, 2$, the coefficients β_h are estimated from the following panel regressions:

$$\frac{\text{Pre-tax Income}_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t+h} + \beta_h \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t+h},$$

where α_i denotes firm fixed effects, and $\theta_{Industry(i),t}$ denotes industry-year fixed effects. In each country, the same sample is used for all horizons. The standard errors are obtained by clustering the residuals by firm and year, and the confidence bands represent plus and minus two standard errors around the point estimates.

Table 1. Determinants of Firms' Exposure to FX Transaction Risk

	FX Transaction Income$_t$/Assets$_{t-1}$ (basis points)						
	USA	EUR	JPN	TWN	KOR	IND	Pooled
Exchange rate change Δs_t (%)	-1.05^{***}	-0.57^{***}	-0.71^{***}	-4.20^{***}	-0.52	2.07^{***}	-0.22
	(0.22)	(0.12)	(0.10)	(0.33)	(0.67)	(0.62)	(0.18)
$\Delta s_t \times$Industry Net Exports / Output	0.50	-0.57	-6.93^{***}	-14.04^{***}	-13.74^{***}	-2.56	-10.80^{***}
	(1.90)	(0.76)	(0.69)	(1.12)	(1.80)	(1.82)	(1.32)
$\Delta s_t \times$Foreign Currency Debt$_{t-1}$/Assets$_{t-1}$	-0.20	4.93^{**}	0.96	52.63^{***}	61.86^{***}	18.89^{***}	39.03^{***}
	(6.70)	(2.26)	(7.43)	(6.81)	(6.44)	(3.96)	(8.78)
$\Delta s_t \times$Cash$_{t-1}$/Assets$_{t-1}$ (std.)	-0.33^{*}	-0.35^{***}	-0.23^{***}	-2.68^{***}	-1.29^{***}	-0.38^{***}	-0.63^{***}
	(0.19)	(0.08)	(0.06)	(0.45)	(0.16)	(0.13)	(0.12)
$\Delta s_t \times$Net Trade Credit$_{t-1}$/Assets$_{t-1}$ (std.)	-0.03	-0.20^{**}	-0.005	-1.89^{***}	-1.17^{***}	-0.61^{*}	-0.35^{***}
	(0.19)	(0.08)	(0.04)	(0.20)	(0.18)	(0.31)	(0.11)
Fixed Effects				Firm			
Observations	8,075	17,117	33,043	19,112	17,153	18,403	112,903
R^2	0.23	0.17	0.23	0.39	0.24	0.26	0.21
Note:							*p<0.1; **p<0.05; ***p<0.01

This table reports the sensitivity of FX transaction income to changes in exchange rates, obtained from the following panel regression:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \beta \Delta s_t + \Gamma' \left(\Delta s_t \times X_{i,t-1}\right) + \varepsilon_{i,t},$$

where the dependent variable is converted to basis points (i.e. the original ratio is multiplied by 10^4), Δs_t denotes the change in the exchange rate in percentage points, with a positive value indicating an appreciation of the local currency, α_i denotes firm fixed effects, and the vector $X_{i,t-1}$ corresponds to the firm characteristics: foreign currency debt, industry-level net exports (as a fraction of gross output, and averaged over the full sample period), and as controls, the ratio of cash to assets, and the ratio of net trade credit to assets. Cash and net trade credit are standardized to have zero mean and unit standard deviation in each country. The sample consists of firms with non-missing values for FX transaction income and other firm characteristics. Standard errors are reported in parentheses and are double-clustered by firm and year. The "Pooled" column uses firm fixed effects, with standard errors double-clustered by firm and country-year.

Table 2. Passthrough of FX Transaction Income to Firms' Profits

	Panel A: Pretax Income$_t$/Assets$_{t-1}$						
	USA	EUR	JPN	TWN	KOR	IND	Pooled
FX Trans. Income$_t$/Assets$_{t-1}$	0.93***	0.98***	0.55***	0.91***	0.71***	0.86***	0.77***
	(0.25)	(0.27)	(0.14)	(0.15)	(0.08)	(0.09)	(0.05)
R^2	0.74	0.66	0.53	0.63	0.53	0.68	0.63
	Panel B: Non-Operating Income$_t$/Assets$_{t-1}$						
FX Trans. Income$_t$/Assets$_{t-1}$	0.77***	1.11***	1.00***	0.99***	0.76***	1.05***	0.91***
	(0.06)	(0.11)	(0.05)	(0.04)	(0.09)	(0.04)	(0.06)
R^2	0.63	0.34	0.32	0.36	0.35	0.45	0.37
	Panel C: Operating Income$_t$/Assets$_{t-1}$						
FX Trans. Income$_t$/Assets$_{t-1}$	−0.15	−0.29	−0.42***	−0.09	−0.07	−0.23**	−0.17***
	(0.20)	(0.18)	(0.10)	(0.15)	(0.10)	(0.09)	(0.06)
Fixed Effects	Firm, Country-Industry-Year						
Observations	8,822	13,503	53,459	16,596	17,743	14,845	124,968
R^2	0.79	0.72	0.58	0.66	0.55	0.67	0.68
Note:							*p<0.1; **p<0.05; ***p<0.01

This table reports the passthrough of FX transaction income to other parts of the firms' income statement. Panel A reports estimates from the regression

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \beta \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t},$$

where α_i denotes firm fixed effects and $\theta_{Industry(i),t}$ denotes industry-year fixed effects (based on the World Input-Output Table industry classification). The sample consists of firm-year observations (i,t) for which firm i is continuously present in the sample from years $t-1$ to $t+2$. Panel B (Panel C) reports estimates from a similar regression using non-operating income (operating income) as the dependent variable. Standard errors are reported in parentheses and are double-clustered by firm and year. The "Pooled" column uses firm and country-industry-year fixed effects, with standard errors double-clustered by firm and country-year.

Table 3. Conditional Effect of Exchange Rates on Corporate Profits

	Pretax Income$_t$/Assets$_{t-1}$ (basis points)					
	USA	EUR	JPN	TWN	KOR	IND
Δ Exchange Rate (%) $\times$ 1(2nd FX exposure quartile)	4.75	4.53**	2.49**	7.65***	0.71	−0.11
	(4.67)	(1.89)	(1.05)	(2.12)	(1.68)	(1.97)
Δ Exchange Rate (%) $\times$ 1(3rd FX exposure quartile)	12.55**	4.37*	2.59**	7.40***	3.88*	3.63
	(4.68)	(2.31)	(0.99)	(1.93)	(2.09)	(2.51)
Δ Exchange Rate (%) $\times$ 1(4th FX exposure quartile)	6.59	2.17	2.72**	4.52*	7.46***	5.48***
	(6.09)	(3.25)	(1.10)	(2.54)	(1.75)	(1.65)
Fixed Effects	Firm, Industry-Year					
Lagged Controls	Log Assets, Cash / Assets, Leverage, Market-to-Book					
Observations	11,020	11,935	27,725	19,338	22,362	14,567
R^2	0.77	0.71	0.60	0.65	0.55	0.71
Note:						*p<0.1; **p<0.05; ***p<0.01

This table reports estimates of the impact of exchange rate changes on pre-tax income, across different groups of firms sorted by their exposure to FX transaction risk. For each country and each year, firms are sorted into quartiles, based on their FX transaction income in the previous year, in ascending order when $\Delta s_t > 0$ and descending order otherwise. The estimates of the impact of exchange rates on pre-tax income are obtained from the following panel regression:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \Delta s_t \times \sum_{k=2}^{4} \lambda_k \mathbf{1}_{\text{FX exposure quartile}_{i,t-1}=k} + \Gamma' X_{i,t-1} + \varepsilon_{i,t},$$

where Δs_t denotes the change in the exchange rate in percentage points, with a positive value indicating an appreciation of the local currency, α_i denotes firm fixed effects, and $\theta_{Industry(i),t}$ denotes industry-year fixed effects (based on the World Input-Output Table industry classification). The set of lagged firm-level control variables $X_{i,t-1}$ includes log total assets, the ratio of cash to total assets, total leverage, and the market-to-book ratio for the firm's assets. The first quartile is the omitted category. The sample consists of firm-year observations (i, t) with non-missing and non-zero FX transaction income in the previous year $t-1$. The dependent variable is converted to basis points (i.e. the original ratio is multiplied by 10^4). Standard errors are reported in parentheses and are double-clustered by firm and year.

Table 4. FX Transaction Income and Other Firm Outcomes: Cumulative

	Total	Taxes	Net Equity Payout	Δ Monetary Items	Δ Long-Term Assets
			Horizon $h = 0$, cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	0.98***	0.14***	0.05**	0.65***	0.13*
(passthrough-adjusted)	(0.05)	(0.01)	(0.02)	(0.08)	(0.07)
			Horizon $h = 1$, cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	1.05***	0.16***	0.15***	0.44***	0.30***
(passthrough-adjusted)	(0.09)	(0.02)	(0.04)	(0.09)	(0.08)
			Horizon $h = 2$, cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	0.86***	0.12***	0.19***	0.24	0.31**
(passthrough-adjusted)	(0.13)	(0.03)	(0.05)	(0.15)	(0.13)
Fixed Effects			Firm, Country-Industry-Year		
Observations			124,063		

Note: *p<0.1; **p<0.05; ***p<0.01

This table reports two-stage least squares estimates of the relationship between FX transaction income and other firm outcomes. In the first stage, we estimate a pooled regression of pre-tax income on contemporaneous FX transaction income with country-specific coefficients:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \delta_{Country(i)} \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + u_{i,t}$$

where α_i denotes firm fixed effects and $\theta_{Country(i),Industry(i),t}$ denotes country-industry-year fixed effects (based on the World Input-Output Table industry classification). The set of lagged firm-level control variables $X_{i,t-1}$ includes the ratio of ordinary (post-tax) income to total assets, log total assets, the ratio of cash to total assets, total leverage, and the market-to-book ratio for the firm's assets; the coefficients $\Gamma_{Country(i)}$ for these controls are also country-specific. In the second stage, we estimate a pooled regression of a selected firm outcome $Y_{i,t+h}$ (where $h \in \{0, 1, 2\}$) on the fitted values from the first stage regression and the same set of fixed effects and lagged firm-level control variables:

$$\frac{Y_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \beta_h \frac{\widehat{\text{Pre-tax Income}}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + \varepsilon_{i,t+h}$$

Each column presents estimates for a different firm outcome $Y_{i,t+h}$. "Taxes" denotes the cumulative sum of income taxes paid over years t through $t + h$. "Net Equity Payout" denotes the cumulative sum of dividends and net equity repurchases (share repurchases minus new equity issuance) over years t through $t + h$. "Δ Monetary Items" denotes the change in our proxy for monetary items (current assets minus total liabilities) from the end of year $t - 1$ to the end of year $t + h$. "Δ Long-Term Assets" denotes the change in non-current assets (total assets minus current assets) from the end of year $t-1$ to the end of year $t+h$. "Total" denotes the sum of these four variables. The sample consists of firm-year observations (i, t) with non-missing FX transaction income in years t through $t + 2$. Standard errors are reported in parentheses and are double-clustered by firm and country-year.

Table 5. FX Transaction Income and Other Firm Outcomes: Non-Cumulative

	Total	Taxes	Net Equity Payout	Δ Monetary Items	Δ Long-Term Assets
	Horizon $h = 0$, non-cumulative				
FX Trans. Income$_t$/Assets$_{t-1}$	0.98***	0.14***	0.05**	0.65***	0.13*
(passthrough-adjusted)	(0.05)	(0.01)	(0.02)	(0.08)	(0.07)
	Horizon $h = 1$, non-cumulative				
FX Trans. Income$_t$/Assets$_{t-1}$	0.05	0.01	0.09***	−0.22***	0.16**
(passthrough-adjusted)	(0.08)	(0.01)	(0.03)	(0.08)	(0.06)
	Horizon $h = 2$, non-cumulative				
FX Trans. Income$_t$/Assets$_{t-1}$	−0.22**	−0.03*	0.03	−0.21*	−0.01
(passthrough-adjusted)	(0.10)	(0.02)	(0.03)	(0.11)	(0.08)
Fixed Effects	Firm, Country-Industry-Year				
Observations	124,063				

Note: *p<0.1; **p<0.05; ***p<0.01

This table reports two-stage least squares estimates of the relationship between FX transaction income and other firm outcomes. In the first stage, we estimate a pooled regression of pre-tax income on contemporaneous FX transaction income with country-specific coefficients:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \delta_{Country(i)} \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + u_{i,t}$$

where α_i denotes firm fixed effects and $\theta_{Country(i),Industry(i),t}$ denotes country-industry-year fixed effects (based on the World Input-Output Table industry classification). The set of lagged firm-level control variables $X_{i,t-1}$ includes the ratio of ordinary (post-tax) income to total assets, log total assets, the ratio of cash to total assets, total leverage, and the market-to-book ratio for the firm's assets; the coefficients $\Gamma_{Country(i)}$ for these controls are also country-specific. In the second stage, we estimate a pooled regression of a selected firm outcome $Y_{i,t+h}$ (where $h \in \{0, 1, 2\}$) on the fitted values from the first stage regression and the same set of fixed effects and lagged firm-level control variables:

$$\frac{Y_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \beta_h \frac{\widehat{\text{Pre-tax Income}}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + \varepsilon_{i,t+h}$$

Each column presents estimates for a different firm outcome $Y_{i,t+h}$. "Taxes" denotes income taxes paid in year $t + h$. "Net Equity Payout" denotes the sum of dividends and net equity repurchases (share repurchases minus new equity issuance) in year $t+h$. "Δ Monetary Items" denotes the change in our proxy for monetary items (current assets minus total liabilities) from the end of year $t + h - 1$ to the end of year $t + h$. "Δ Long-Term Assets" denotes the change in non-current assets (total assets minus current assets) from the end of year $t + h - 1$ to the end of year $t + h$. "Total" denotes the sum of these four variables. The sample consists of firm-year observations (i, t) with non-missing FX transaction income in years t through $t + 2$. Standard errors are reported in parentheses and are double-clustered by firm and country-year.

Online Appendix

–Exchange Rate Risk in Public Firms–

This online Appendix contains four sections:

- Section A describes a model of optimal FX hedging and investment — a work in progress;
- Section B describes in details and through examples the accounting treatment of FX transaction income;
- Section C describes the data sources, construction, and filters;
- Section D presents summary statistics and additional empirical results.

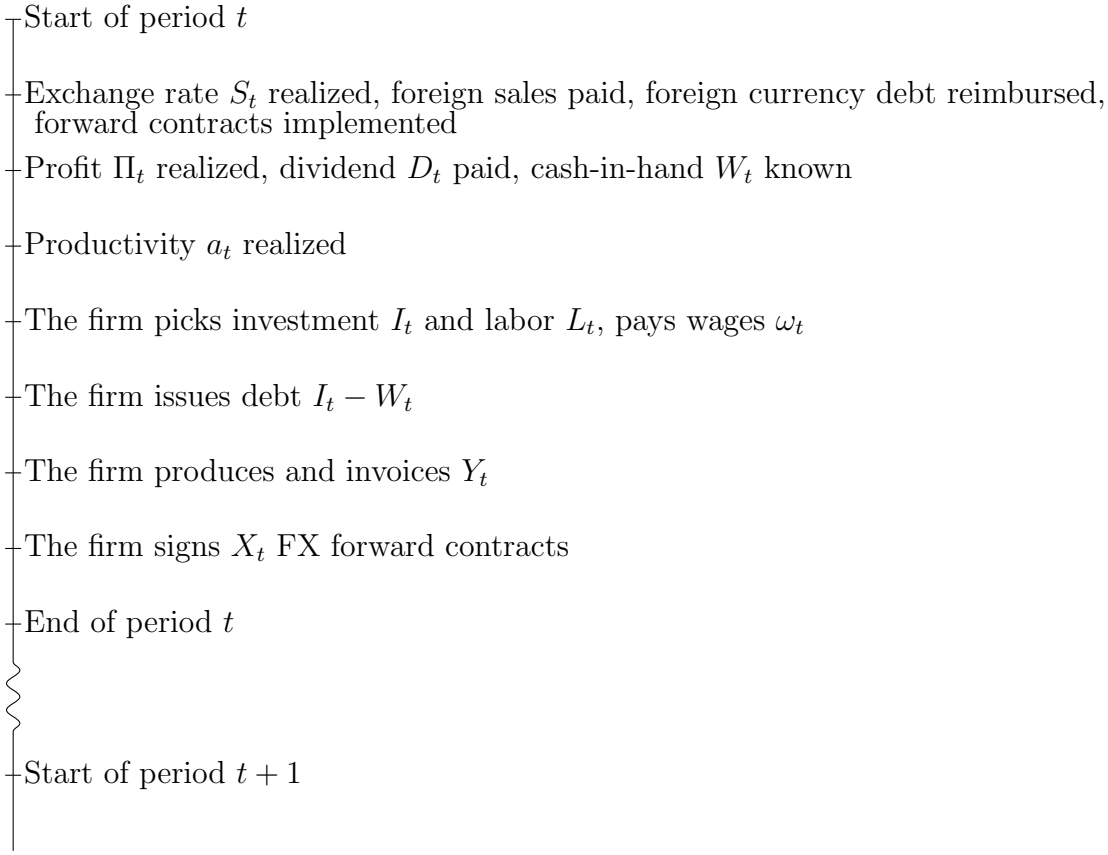
A Appendix: Model

In the model, there are two countries and three types of agents: firms, households, and financial intermediaries. The nominal exchange rate S_t is expressed in foreign currency per unit of domestic currency: an increase in S_t thus corresponds to an appreciation of the domestic currency. We assume that firms invoicing at date t are only paid at date $t+1$. This is the key novel friction in the model, and it applies to both domestic and foreign sales.[21] We have in mind the maximization problem of, for example, a Japanese firm that sells and borrows in U.S. dollars and thus potentially bear some exchange rate risk. By contrast, U.S. firms tend to produce, borrow, and invoice in U.S. dollars and thus bear no such exchange rate risk. The model is a partial equilibrium, and households and intermediaries are left out of this succinct presentation.

Timing At the start of each period t, the exchange rate S_t is realized, affecting the domestic currency equivalent of the foreign currency sales invoiced at date $t-1$ and received at date t. The firm pays out dividends D_t out of its profits Π_t, and allocates the rest to its cash-in-hand, now worth W_t. After learning its productivity and taking all prices as given, the firm picks its investment and production levels for period t. If the internal funds W_t are not sufficient to cover its investment, the firm issues one-period

[21] Trade financing takes three main forms: (i) cash in advance terms require the importer to pay before goods are 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, Antras and Foley (2015) 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.

debt. It produces and invoices in the same period t, and then decides how much to hedge the currency risk inherent in its foreign currency debt and foreign currency sales. The hedging decision in period t affects the cash flows received in period $t+1$, not the production decision in period t, and thus the cash-in-hand W_{t+1}.



Firms' production At the start of each period t, the firm learns its productivity, a_t, and the total demand for its goods, Y_t. The firm sells an exogenous fraction h of its product to the domestic market at the price P_t in local currency, and the rest abroad in foreign currency (e.g., U.S. dollars) at the price $P_t^{\$}$. In order to produce, the firm needs capital K_t and labor L_t. Labor earns wages ω_t. Having gathered capital and labor, the firm produces and invoices an amount Y_t equal to:

$$Y_t = e^{a_t} K_t^{\alpha} L_t^{1-\alpha}, \tag{9}$$

where α is the capital share. The firm's productivity follows an AR(1) process in logs: $a_t = \rho a_{t-1} + \sigma_a \epsilon_t^a$, where ϵ_t^a is a standard Gaussian shock. Capital depreciates at the rate δ and increases with additional investment I_t:

$$K_t = (1 - \delta) K_{t-1} + I_t. \tag{10}$$

The firm starts the period with some internal funds W_t and may need some external financing B_t to finance the part of its investment I_t not covered by internal funds: $B_t = I_t - W_t$.

The firm borrows a fraction c of its debt in domestic currency and a fraction $1 - c$ in foreign currency (e.g., U.S. dollars). The currency composition of debt is here exogenous, and occurs before any exchange rate derivative transaction. The choice may be linked to CIP deviations, hedging, or behavioral reasons, but is not specified in the model. External financing costs increase with the firm's total debt. The firm borrows cB_t in local currency at date t and pays back $\left(1 + r + \frac{\nu}{2} \frac{B_t}{K_{t-1}}\right) cB_t$ next period. Thus, the firm pays a premium over the risk-free rate r, and that premium increases with the firm's leverage. Likewise, the firm borrows in dollars $(1 - c)B_t$ at date t, an amount equal to $(1 - c)B_t/S_t$ in local currency, and reimburses $\left(1 + r^{\$} + \frac{\nu^{\$}}{2} \frac{B_t}{K_{t-1}}\right) \frac{(1-c)B_t}{S_{t+1}}$ next period. We assume that the U.S. dollar risk-free interest rate is lower than the foreign one: $r^{\$} < r$.

The firm maximizes the present value of its future profits (paid out as dividends), taking as given the local and foreign demand for its product, as well as the local and dollar prices and wages. The firm chooses the amounts of labor, investment, and debt, as well as the exchange rate exposure that it hedges with a forward contract.

Forward contracts The firm is exposed to exchange rate risk because of the foreign currency sales it invoiced in the previous period and the foreign currency debt it previously borrowed. Using forward contracts, the firm may hedge its foreign currency exposure.

The firm must pay a quadratic cost to participate in derivative markets; it proxies for information, collateral, and transaction costs. When signing X forward contracts, the cost is $\frac{p}{2}(X/K)^2K$.

In the previous period, the firm buys X_{t-1} forward contracts, committing to sell some foreign currency, e.g. U.S. dollars, (in period t) at a rate F_{t-1}, also expressed in foreign currency per unit of domestic currency.[22] To honor the forward contract at date t, the firm buys X_{t-1} dollars at a price $1/S_t$ and sells them at a price $1/F_{t-1}$, leading to an income of $X_{t-1}(1/F_{t-1} - 1/S_t)$. If the foreign currency (e.g., U.S. dollar) depreciates between $t-1$ and t (an increase in S), the firm collects less from its foreign currency sales (once converted in local currency) than it invoiced, but it has less foreign currency debt to reimburse and potentially benefits from its forward contract.

Firms' investment, hiring, and hedging decisions Given the internal funds available at the start of period t, the firm chooses its investment I_t, labor L_t and hedging X_t to maximize the present value of its future dividends D_t:

$$Max_{(I_t,L_t)\in\mathbb{R}^{+2},X_t\in\mathbb{R}} \quad \mathbb{E}_t \sum_{j=1}^{\infty} \beta^{t+j} D_{t+j}, \tag{11}$$

where $\beta < 1/[1+r]$ denotes the shareholders' discount rate. The dividends are paid out of the profits, and those profits at date $t+1$ are:

$$\begin{aligned} \Pi_{t+1} &= \frac{1}{S_{t+1}}\left[(1-h)P_t^{\$}Y_t - \left(1+r^{\$}+\frac{\nu^{\$}}{2}\frac{B_t}{K_{t-1}}\right)(1-c)B_t\right] + X_t\left(\frac{1}{F_t}-\frac{1}{S_{t+1}}\right) \\ &+ hP_tY_t - \left(1+r+\frac{\nu}{2}\frac{B_t}{K_{t-1}}\right)cB_t - \omega_t L_t - I_t - \frac{\kappa}{2}\left(\frac{I_t}{K_{t-1}}\right)^2 K_{t-1} - \frac{p}{2}\left(\frac{X_t}{K_{t-1}}\right)^2 K_{t-1} \end{aligned} \tag{12}$$

[22] The hedging costs are linked to the convex borrowing costs: the marginal cost of one additional unit of foreign currency debt that is hedged is the same as the marginal cost of one additional unit of domestic currency debt, thus $\nu^{\$}F/S + p = \nu$. Intuitively, lenders charge the same risk premium for hedged foreign currency debt and local currency debt because they carry the same default risk.

We normalize the price level in the foreign country P_t to one. Profits are dated by the time the firm receives payment (at date $t+1$) for goods produced and invoiced in the previous period (at date t). Debt is dated by the time it is issued: for example, the firm issues an amount of domestic currency debt cB_t at date t and pays it back with interest $\left(1 + r + \frac{\nu}{2}\frac{B_t}{K_{t-1}}\right) cB_t$ at date $t+1$. The first line of Equation (12) describes the firm's total foreign currency exposure (due to its foreign currency-invoiced sales and the foreign currency debt that comes due), as well as the income from its FX forward contracts. The second line of Equation (12) corresponds to the firm's domestic sales, domestic debt, labor cost, investment, as well as the physical investment's adjustment costs and the participation costs in the FX derivatives market.

Both prices and wages react partially to exchange rates, with elasticities $\epsilon_P \geq 0$ and $\epsilon_w \geq 0$:

$$P_t^{\$} = P S_t^{\epsilon_P}, \tag{13}$$

$$\omega_t = \omega S_t^{\epsilon_\omega}. \tag{14}$$

The case $\epsilon_P = 0$ corresponds to dollar pricing, while the case $\epsilon_P = 1$ corresponds to producer-currency pricing. We assume that labor costs depend on the exchange rate ($\epsilon_\omega \neq 0$) because, for example, some distribution costs or the costs of a customer base are paid in U.S. dollars, as in Corsetti and Dedola (2005) and Fitzgerald et al. (2019). Equations (13) and (14) imply that when the domestic currency appreciates (an increase in S_t), the firm sells at higher prices in foreign currency (e.g., U.S. dollars), and its labor cost may increase ($\epsilon_\omega > 0$) or decrease ($\epsilon_\omega < 0$), thus affecting its competitivity.

From the perspective of the firms, the exchange rate is exogenous and follows a random walk:

$$\Delta \log S_{t+1} = e^{\frac{1}{2}\sigma^2_{\Delta s,a} + \frac{1}{2}\sigma^2_{\Delta s,u}} + \sigma_{\Delta s,a}\epsilon^a_{t+1} + \sigma_{\Delta s,u} u_{t+1}. \tag{15}$$

where u is a standard Gaussian shock, uncorrelated to the other shocks. The change in exchange rate is a random walk: the expected exchange rate only depends on its current value:

$$\mathbb{E}_t\left(\frac{1}{S_{t+1}}\right) = \frac{1}{S_t} e^{-\frac{1}{2}\sigma^2_{\Delta s,a} - \frac{1}{2}\sigma^2_{\Delta s,u}} \mathbb{E}_t e^{\left(-\sigma_{\Delta s,a}\epsilon^a_{t+1} - \sigma_{\Delta s,u} u_{t+1}\right)} = \frac{1}{S_t}. \tag{16}$$

Financial markets may be incomplete, thus the log change in exchange rates is not equal to the foreign minus domestic difference in log stochastic discount factors. In times of low productivity (i.e., bad times, $\epsilon^a_{t+1} < 0$), the domestic currency depreciates and the foreign currency (e.g., U.S. dollar) appreciates ($\Delta s < 0$). The expected currency excess return from borrowing in U.S. dollars and investing locally is equal to $r - r^{\$} + E_t(\Delta \log S_{t+1}) = r - r^{\$} + e^{\frac{1}{2}\sigma^2_{\Delta s,a} + \frac{1}{2}\sigma^2_{\Delta s,u}} > 0$.

Firms' internal funds The profits not paid out as dividends increase the firm's cash-on-hand. The firm's internal funds available at the start of period date t are thus:

$$W_t = W_{t-1} + \Pi_t - D_t. \tag{17}$$

Let $W_{FC,t-1}$ denote the firm's foreign currency exposure due to its foreign currency sales and its foreign currency debt that comes due, and $W_{DC,t-1}$ denote its domestic currency cash-on-hand due to domestic sales, domestic debt, net of the payments to the factors of production. The firm's internal funds available at the start of period date t can be rewritten as:

$$W_t = \frac{1}{S_t} W_{FC,t-1} + X_{t-1}\left(\frac{1}{F_{t-1}} - \frac{1}{S_t}\right) - \frac{p}{2}\left(\frac{X_{t-1}}{Y_{t-1}}\right)^2 K_{t-1} + W_{DC,t-1}. \tag{18}$$

FX transaction income While the accountant books foreign currency sales and debt in period t at the exchange rate S_t, the firm actually receives and converts those dollar

payments in its domestic currency in period $t+1$ at the rate S_{t+1}. The accountant keeps track of this adjustment in the FX transaction income reported at date $t+1$, along with the income from the FX forward contracts:

$$FXT_{t+1} = \left[\underbrace{(1-h)P_t^{\$}Y_t}_{\text{Sales invoiced in U.S. dollars}} - \underbrace{(1-c)B_t}_{\text{Dollar debt}} \right] \underbrace{\left(\frac{1}{S_{t+1}} - \frac{1}{S_t} \right)}_{\text{Sales and debt revaluation}} + \underbrace{X_t \left(\frac{1}{F_t} - \frac{1}{S_{t+1}} \right)}_{\text{Income from FX forwards}}. \tag{19}$$

Firms' heterogeneity In the model, all firms are similar. In practice, they may differ in their currency exposure (from the share h of domestic to total sales, h, (with $(1-h)$ positive for exporters and negative for importers) and the foreign of domestic c vs foreign currency debt), in their user cost of derivatives, p, in the quadratic financing costs ν and $\nu^{\$}$, in the covariance between productivity shocks and exchange rare shocks, in the price and wage elasticities ϵ_P and ϵ_ω.

Intuitively, exporters and importers record opposite transaction gains and losses when the local currency appreciate. The share of foreign currency debt may also vary across firms, for example with their ability to collateralize their capital or sales, trading off the lower cost of capital in foreign currency, its hedging benefits, with its additional risks and costs.

As in Froot, Schafstein and Stein (1993), firms in the model hedge currency risk because external finance is costly: the convex costs of debt makes the firm effectively risk-averse. To avoid large fluctuations in profits that would entail large changes in debt, the firm hedges its currency risk. As Rampini and Vishwanathan (2001) note, in the absence of participation costs though, small firms should hedge more as they are arguably the more financially constrained. By assuming that the participation costs are higher for small firms than large firms, the model can be consistent with the relative hedging demand of large firms.

To show how these parameters matter precisely, we simulate the model with different parameter values.

Firm's maximization problem To sum up, the firm's maximization problem is then:

$$Max_{(I_t,L_t)\in\mathbb{R}^{+2},X_t\in\mathbb{R}} \quad \mathbb{E}_t \sum_{j=1}^{\infty} \beta^{t+j} D_{t+j},$$

subject to

$$\begin{aligned}
Y_t &= e^{a_t} K_t^{\alpha} L_t^{1-\alpha} \\
K_t &= (1-\delta)K_{t-1} + I_t \\
B_t &= I_t - W_t \\
\Pi_{t+1} &= \frac{1}{S_{t+1}} \left[(1-h) S_t^{\epsilon_P} Y_t - \left(1 + r^{\$} + \frac{\nu^{\$}}{2} \frac{B_t}{K_{t-1}} \right) (1-c) B_t \right] + X_t \left(\frac{1}{F_t} - \frac{1}{S_{t+1}} \right) \\
&+ hP_tY_t - \left(1 + r + \frac{\nu}{2} \frac{B_t}{K_{t-1}} \right) cB_t - \omega S_t^{\epsilon_\omega} L_t - I_t - \frac{\kappa}{2} \left(\frac{I_t}{K_{t-1}} \right)^2 K_{t-1} - \frac{p}{2} \left(\frac{X_t}{K_{t-1}} \right)^2 K_{t-1} \\
W_{t+1} &= W_t + \Pi_{t+1} - D_{t+1} \\
D_{t+1} &\geq 0
\end{aligned}$$

Intuition The model sidesteps several key corporate choices that have been studied in different strands of the literature: whether and how much to sell abroad, in which currency to invoice foreign sales, whether and how much to borrow in different currencies. Instead, the model starts with a firm that is exposed to currency risk because it invoices in U.S. dollars and has some dollar debt. The model then describes its optimal hedging decision and the remaining currency exposure.

The firm picks its investment level to reach the amount of physical capital needed to satisfy the exogenous demand for its product. To finance its investment, the firm needs to borrow any amount not covered by its internal wealth. Such external financing occurs

in domestic and foreign currencies. Foreign currency debt potentially hedges the currency risk of foreign sales. The firm then may use FX forwards to hedge its remaining exchange rate risk.

The firm hedges its currency risk, because a decrease in the value of the foreign currency between invoicing and payments dates entails a revenue loss. A lower profit this period implies lower internal wealth next period and thus more debt because dividends cannot be negative. Since the cost of debt increases quadratically with the amount of debt, the firm prefers to hedge its currency risk. Yet, the firm only hedges partially that risk because of the hedging costs (the interest rate difference and the participation cost p of the forward contracts, and the proportional and quadratic costs of the dollar debt).

In the current version, the instantaneous passthrough of FX transaction income on the firms' profits is one when wages are independent of exchange rates ($\epsilon_\omega = 0$). Since wages are paid immediately, their variations are not measured in FX transaction income. Thus, if wages vary with exchange rates ($\epsilon_\omega \neq 0$), they also impact the firms' profits and the passthrough of FX transaction income on the firms' profits is not one.

Intuitively, the optimal hedging share should increase with the expected depreciation of the U.S. dollar and the volatility of the exchange rate, and decrease with the cost of hedging and the comovement between exchange rate and productivity shock. If a firm productivity tends to be high when the U.S. dollar appreciates (i.e., $cov(\epsilon^a_{t+1}, \Delta s) < 0$) and the firm is long dollars (i.e., its sales in U.S. dollars are larger than its dollar debt), then the firm will enjoy extra ressources, from the dollar appreciation, at a time when it wants to invest more; its optimal hedging decision is then to hedge less than a firm that does not benefit from this natural hedge.

Firm's value function Let us scale all variables by lagged capital and use lower cases to denote the scaled variables, e.g. $y_t = Y_t/K_{t-1}$. The value function V is homogenous of

degree one in capital, thus $V(W_t, K_t) = v(w_t)K_{t-1}$. To save space, let us define the cost of external finance per unit of lagged capital as:

$$C(i_t - w_t, S_{t+1}) = \frac{1-c}{S_{t+1}}\left(1 + r^{\$} + \frac{\nu^{\$}}{2}(i_t - w_t)\right)(i_t - w_t) + c\left(1 + r + \frac{\nu}{2}(i_t - w_t)\right)(i_t - w_t).$$

Since the exchange rate follows a random walk, the expected cost of external finance depends on $i_t - w_t$ and S_t. The function v satisfies:

$$v(w_t, a_t) = Max_{(i_t,l_t)\in\mathbb{R}^{+2}, x_t\in\mathbb{R}} \mathbb{E}_t \left[d_{t+1} + \beta v(w_{t+1}, a_{t+1})(1 - \delta + i_t)\right],$$

subject to

$$\begin{aligned}
y_t &= e^{a_t} k_t^{\alpha} l_t^{1-\alpha} \\
k_t &= 1 - \delta + i_t \\
b_t &= i_t - w_t \\
\pi_{t+1} &= \frac{1}{S_{t+1}}(1-h) S_t^{\epsilon_P} y_t + h y_t + x_t\left(\frac{1}{F_t} - \frac{1}{S_{t+1}}\right) \\
&- C(i_t - w_t, S_{t+1}) - \omega S_t^{\epsilon_\omega} l_t - i_t - \frac{\kappa}{2} i_t^2 - \frac{p}{2} x_t^2 \\
w_{t+1} k_t &= w_t + \pi_{t+1} - d_{t+1} \\
d_{t+1} &\geq 0
\end{aligned}$$

The scaled dividend d_{t+1} is paid from the profits measured at date $t+1$, when the firm receives the payment for the goods it produced at date t. We assume that the firm needs to borrow some debt, thus $b_t = i_t - w_t$. The problem becomes:

$$v(w_t, a_t) = Max_{(i_t,l_t)\in\mathbb{R}^{+2}, x_t\in\mathbb{R}} \mathbb{E}_t \left[d_{t+1} + \beta v(w_{t+1}, a_{t+1})(1 - \delta + i_t)\right],$$

subject to

$$\begin{aligned} d_{t+1} &= w_t - w_{t+1}\left[1-\delta+i_t\right] \\ &+ \frac{1}{S_{t+1}}(1-h)S_t^{\epsilon_P}e^{a_t}\left[1-\delta+i_t\right]^{\alpha} l_t^{1-\alpha} + he^{a_t}\left[1-\delta+i_t\right]^{\alpha} l_t^{1-\alpha} \\ &+ x_t\left(\frac{1}{F_t}-\frac{1}{S_{t+1}}\right) - \frac{p}{2}x_t^2 - C(i_t - w_t, S_{t+1}) - \omega S_t^{\epsilon_\omega} l_t - i_t - \frac{\kappa}{2}i_t^2 \geq 0. \end{aligned}$$

TBC.

B Appendix: Accounting for FX Transaction Risk

This section presents the accounting treatment of foreign currency purchases, investment and debt, with and without hedging.

B.1 Purchase without hedging

Suppose that USCo is a U.S. 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. The foreign currency liability account is then settled on May 1, 20X0. 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 in Table B1:

Table B1. Foreign Currency Transaction - Entries on February 1, 20X0

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

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. The company will update its account payables and record a foreign currency transaction loss of $50,000, as shown in Table B2.

Table B2. 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

Suppose that on settlement day, May 1, 20X0, the foreign exchange rate 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 B3.

Table B3. 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, as in Table B4.

Table B4. Foreign Currency Transaction - Entries on May 1, 20X0

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

Both realized and unrealized gains and losses due to foreign exchange transactions are reported in the income statement.[23] 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 reported on June 31, 20X0.

The inventory that USCo bought is a non-monetary item (other examples include investments in common stocks and property, plant, and equipment). Unlike monetary items as cash or accounts payables/receivables, the value of non-monetary items (inventory in our example) is not adjusted for subsequent changes in exchange rates.

[23]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.

B.2 Purchase 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 enters 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 B5 below summarizes the exchange rates and corresponding gains and losses recorded over the three month period of the hedging contract.

Table B5. 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.

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 (as previously noted, the only exception are cash flow hedges that concern future transactions). Table B6 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 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: $(1.25-1.27)\times$ €$1M=-\$20,000$. It is also equal, by construction, to the sum of the two FX transaction exposures reported: $-\$10,194-\$9,806=-\$20,000$.

Table B6. 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 B6 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 last column (denoted "FX gain/loss with Hedging") 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). The sum of these two entries is the total FX transaction loss after hedging. Intuitively, the firm agrees to pay 1,000,000 euros on February 1, 20X0 at a time when the

euro is worth $1.25 and decides to avoid exchange rate risk by signing a forward contract such that each euro costs $1.27. The FX loss is thus ($1.25 - $1.27) × 1,000,000 = $20,000.

B.3 Investment without hedging

Let us now consider investments in debt and equity denominated in a foreign currency. Three cases arise:

- the debt securities are held to maturity: in this case, they are monetary items and the foreign currency transaction gains or losses are recognized in the income statement;
- the debt or equity securities are available for sale: in this case, according to IFRS, firms should report FX transaction income in earnings, whereas according to GAAP (ASC 320), firms should report it in Other Comprehensive Income;
- the debt or equity securities are for trading: the changes in fair value due to exchange rate changes are recognized in the income statement (ASC 320-10-35-1).

Let us go through an example of the first case. Suppose that USCo, whose functional currency is the U.S. dollar, purchases a ten-year bond with a face value of 1,000,000 Euros on January 1, 20X0. The bond pays a 6 percent annual interest and is sold at par (i.e., at its face value). Assume that USCo classifies the bond as held to maturity and that the exchange rates are 1€= $1.2 on January 1, 20X0, 1€= $1.4 on December 31, 20X0, and that the average value of the daily spot exchange rate is 1€= $1.3 in 20X0.

USCo records the initial investment (€1,000,000×1.2 = $1,200,000) as in Table B7.

Table B7. Initial Investment - Entries on January 1, 20X0

Account	Increase	Decrease
Investment in held-to-maturity security	1,200,000	
Cash		1,200,000

The bond pays an interest income of 6% of €1,000,000, i.e., €60,000. The accrued interest receivable is recorded at the weighted-average exchange rate of 1€= $1.3 and thus equal $78,000. At the end of the year, USCo records the new value of the bond, along with the interest income and the foreign currency transaction gain. That gain comes from two parts: (i) the value of the bond increases by $200,000, from $1,200,000 to $1,400,000 because the value of the euro increases from 1€= $1.2 at the start of the year to 1€= $1.4 at the end of the year; (ii) the value of the accrued interest income increases by $6,000, from $78,000 at the average exchange rate of 1€= $1.3 to $84,000 at the end of the year rate of 1€= $1.4. The total foreign currency transaction gain is thus $206,000, as noted in Table B8.

Table B8. Foreign Currency Transaction - Entries on December 31, 20X0

Investment in held-to-maturity security	1,400,000
Accrued interest receivable	78,000
Interest income	84,000
Foreign currency transaction gain	206,000

B.4 Borrowing without hedging

The calculation of foreign currency transaction gains for foreign currency-denominated debts incurred by the firm is essentially the same as for held-to-maturity debt securities owned by the firm, as described in the previous section. The key difference is that because debts incurred by the firm represent a liability rather than an asset, an appreciation of the foreign currency against the firm's functional currency results in an FX transaction loss rather than a gain.

We consider the same example as in Section B.3, but instead assume that USCo *issues* a ten-year Euro-denominated bond at par with a face value of 1,000,000 Euros and 6 percent annual interest payments.

On January 1, 20X0 USCo records the initial proceeds from issuance (€1,000,000×1.2 = $1,200,000) as in Table B9.

Table B9. Initial Debt Issuance - Entries on January 1, 20X0

Account	Type	Increase	Decrease
Long-term debt	Liability	1,200,000	
Cash	Asset	1,200,000	

The accrued interest payable is again recorded at the weighted-average exchange rate of 1€= $1.3 and equals $78,000. At the end of the year, USCo records the new value of the bond, along with the interest income and the foreign currency transaction loss resulting from the appreciation of the euro against the U.S. dollar. As before, the loss consists of: (i) the $200,000 increase in the U.S. dollar value of the euro-denominated principal; (ii) the $6,000 difference between the value of the accrued interest income (based on average spot exchange rate throughout the year) and the actual interest payment (based on the spot exchange rate on December 31, 20X0). The total foreign currency transaction loss is $206,000, reported in Table B10.

Table B10. Foreign Currency Transaction - Entries on December 31, 20X0

Long-term debt	1,400,000
Accrued interest payable	78,000
Interest expense	84,000
Foreign currency transaction loss	206,000

C Appendix: Data Sources

This Appendix describes our data sets, starting with the firm-level accounting data in subsection C.1, then firm-level stock prices in subsection C.2, firm-level debt in subsection C.3, and industry-level international trade data in subsection C.4.

C.1 Firm-Level Accounting Data

Our sample covers the euro area, India, Japan, South Korea, Taiwan, and the United States. Our set of euro area countries consists of Belgium, France, Germany, Italy, the Netherlands, and Spain. For these countries, we start our sample in 1999 after the initial adoption of the euro.

Accounting data for firms in the United States and Canada are obtained from the Compustat North America Fundamentals Annual file, while accounting data for firms in all other countries are obtained from the Compustat Global Fundamentals Annual file. We use only firm-year observations with consolidation format `consol == C` (consolidated) in the Compustat North America Fundamentals Annual file, but include observations with both `consol == C` or `consol == N` (non-consolidated) in the Compustat Global Fundamentals Annual file since many firm-year observations are available only in non-consolidated format. For both datasets, we use only observations with industry format `indfmt == INDL`, and we exclude observations with financial services industry format `indfmt == FS`. The time period of our sample covers fiscal years 1987 to 2020.

We then apply the following filters:

1. We keep firm-year observations with non-missing fiscal year (`fyear`), non-missing industry (`sic`), and non-missing currency of document (`curcd`).

2. We exclude firms operating in the financial services and real estate industry (`6000 <= sic < 6800`) or in the utilities industry (`4900 <= sic < 5000`).

3. We keep only firm-year observations for which the fiscal year end month (`fyr`) corresponds to the most common fiscal year end month in each country:

   - United States, Euro Area, Taiwan, and South Korea: December (`fyr == 12`)
   - Japan and India: March (`fyr == 3`)

4. We drop firms that switch their currency of document (`curcd`) at any point in the sample.[24]

5. We keep only firm-year observations for which the country of the headquarters location (`loc`) and the country of incorporation (`fic`) are the same, and for which the currency of document (`curcd`) is the domestic currency of the country in which the firm is located and incorporated.[25]

6. To exclude very small firms, we exclude firm-year observations where total assets (`at`) are either missing or less than 5 million 2019 U.S. dollars. We also exclude firm-year observations where sales (`sale`) are either missing or less than 1 million 2019 U.S. dollars.[26]

7. We keep only firm-year observations for which total property, plant and equipment (PPE) net of depreciation (`ppent`) is non-missing and positive.

8. We exclude firm-year observations in the North America file for which the `cusip` field is missing, and firms in the Global file for which the `isin` field is missing.

[24] The one exception is for firms headquartered in the euro area. Since firms do not all initially report their financial statements in euros immediately after its introduction in 1999, for each firm we discard annual observations before the firm first uses the euro as its currency of document. We then drop the firm from the sample only if it switches to a different functional currency after it initially switches to the euro.

[25] For the euro area, we keep firms that are headquartered and incorporated in different countries, as long as both countries are part of the six Euro Area countries we include in our sample.

[26] We convert total assets and sales from nominal local currency values to real U.S. dollars (using the implicit U.S. GDP price deflator `GDPDEF` obtained from the FRED database). However, we use nominal local currency values of all firm-level variables throughout all other parts of our analysis.

9. We merge end-of-fiscal-year data on firm's stock price, common shares outstanding and market capitalization, all computed using data from the Security Daily files. The Security Daily file contains a `gvkey` field that we use to map firm stock price data to firm-year observations in the Fundamentals Annual files. In some cases, there are multiple common stocks (identified by the `cusip` code in the North America file and the `isin` code in the Global file) that are mapped to the same `gvkey`. To identify a unique match in these cases, we keep only the stock-year observation from the Security Daily files for which the `cusip` or `isin` code matches the corresponding code listed in the Fundamentals Annual file.[27] We drop firm-year observations that we are not able to match to the Security Daily file, and for which fewer than 30 weekly return observations are available over the fiscal year.

10. We remove firm-year observations where total assets increase or decrease by more than 50% relative to the value from the previous year, or where either sales or net PPE increase or decrease by a factor of 10 relative to the previous year. We also remove observations where the firm reports value of operating income after depreciation (`oiadp`) or non-operating income (`nopi`) that is larger in magnitude than the value of total assets reported at the end of the previous year.

11. We remove a small number of remaining firm-year observations with missing values for several balance sheet variables (current assets `act`, total liabilities `lt`, common equity `ceq`, cash and cash equivalents `che`, debt in current liabilities `dlc`, and long-term debt `dltt`) and income statement variables (pretax income `pi`, income taxes `txt`, ordinary income `ib`, operating income before depreciation `oibdp`, operating

[27] In a small number of cases this process does not yield a unique match, because the `cusip` and `isin` fields in the Fundamentals Annual file are header fields containing the most recent security identifier used by the firm (rather than the historical security identifier used by the firm in each previous year). In these cases where we cannot identify a single unique match in the Security Daily file when multiple candidate matches are available, we exclude these firm-year observations from the sample.

income after depreciation `oiadp`, and non-operating income `nopi`) used throughout our analysis.

12. Finally, we drop all observations for firms that are not present in the filtered sample for at least three consecutive years.

Throughout our analysis, we measure all firm-level variables in nominal local currency values. We winsorize all annual firm-level variables used in regressions at the [1%,99%] level, year by year. Since FX transaction income has a large number of zero observations in some countries, when winsorizing FX transaction income and any ratios constructed using this variable in the numerator, we compute the percentiles used in winsorization by excluding these zero observations.

In addition to the firm-level data from the Compustat Fundamentals Annual files, we use data on foreign sales obtained from the Refinitiv Worldscope Fundamentals Annual and Segments files. We use Worldscope observations with restated data (indicated by a value of `B` in the variable `freq`) when available, and original non-restated data (indicated by a value of `A` in `freq`) otherwise. We first match firm-year observations across the Compustat and Worldscope datasets by either CUSIP (for U.S. firms) or ISIN (for non-U.S. firms) codes, and by fiscal year. We are able to match over 90% of the total observations in our final Compustat dataset to an observation in Worldscope. We then compute the foreign sales share as the ratio of foreign sales (`ITEM7101` in the Worldscope Segments file) to total sales (`ITEM1001` in the Worldscope Fundamentals Annual file).[28] Foreign sales are available for only a fraction of the firm-year observations that appear in Worldscope. For our main Compustat sample, a non-missing value of the foreign sales share is available from Worldscope for roughly 60% of firm-year observations, while only

[28]If the value of sales reported in the Worldscope Fundamentals Annual file differs from the value of sales reported in the Compustat Fundamentals Annual file by more than 10% for a given firm-year observation, we set the foreign sales share as missing. Similarly, if foreign sales reported in Worldscope are negative or greater than total firm sales, we set the foreign sales share as missing.

35% of firm-year observations have a positive value for the foreign sales share.

Additional Variable Definitions

- **Long-term assets** are defined as non-current assets, i.e. total assets (`at`) minus current assets (`act`).
- **Monetary items** are defined as current assets (`act`) minus total liabilities (`lt`).
- **Dividends** are defined as either total dividends (`dvt`), dividends paid to common stock (`dvc`), or dividends from the statement of cash flows (`dv`). We take the first non-missing value from these three variables, in order of preference. If all three of these variables are missing for a given firm-year observation, we set the value of dividends to zero.
- **Net equity repurchases** are defined following Jensen, Kelly and Pedersen (2023) as purchase of common and preferred shares (`prstkc`, primarily used in Compustat North America) plus purchase of Treasury shares (`purtshr`, primarily used in Compustat Global) minus sale of common and preferred stock (`sstk`). We replace missing values with zeros for each of the three input variables.
  - Because cash flow statement information is not available for firms in Japan before fiscal year 1999, we use an alternative definition based on information from the Compustat Global Security Daily file. Net equity repurchases are defined for these firms as -1 times the change in adjusted shares outstanding (`cshoc` times `ajexdi`) from the end of the previous fiscal year to the end of the current fiscal year, times the average of the adjusted share prices (`prccd` divided by `ajexdi`) at the end of the previous and current fiscal years.

- **Net equity payouts** are defined as the sum of dividends and net equity repurchases, as defined above.

- **Capital expenditures minus sale of PPE** is defined as capital expenditures (`capx`) minus either sale of property (`sppe`, for Compustat North America) or proceeds from sale of fixed assets (`psfix`, for Compustat Global). We replace missing values of `sppe` or `psfix` with zero.

  – Because cash flow statement information is not available for firms in Japan before fiscal year 1999, we set this variable as missing for these firms.

C.2 Firm-Level Stock Prices

We use daily stock prices from the Compustat North America Security Daily file and the Compustat Global Security Daily file. The North America file uses CUSIP codes as stock identifiers, while the Global file uses ISIN codes as stock identifiers. We apply the following filters to the daily data file for each country in our sample:

1. We remove weekend observations.

2. We remove stocks with missing ISIN or CUSIP codes. For non-U.S. countries, we remove stocks where the first two digits of the stock's ISIN code do not match the ISO Alpha-2 code of the country.

3. We remove observations where prices are quoted in a currency (indicated by the `curcdd` variable) other than the country's domestic currency.

4. We remove observations where the share price (`prccd`) is missing. For non-U.S. countries, we also remove observations where shares outstanding (`cshoc`) is missing.[29]

[29] We do not apply this filter for U.S. observations for two reasons. First, the `cshoc` variable in the

5. We keep only observations for common stocks, indicated by the issue type code `tpci == 0`.

6. We keep only observations where the share price (`prccd`), adjustment factor (`ajexdi`), and total return factor (`trfd`) variables needed to compute returns are all nonmissing and positive.[30]

7. We keep only observations where the price status code (`prcstd`) is nonmissing and indicates non-stale price data (`prcstd == 10` for non-U.S. countries, and `prcstd == 3` for the U.S.).

We then convert the data to monthly frequency by taking the last daily observation for each stock observed in each month and use month-end values for share prices, shares outstanding, market capitalization, and book-to-market ratios.

C.3 Firm-Level Debt Data

We use detailed data on the value and currency of denomination of firms' debt liabilities from Capital IQ's Capital Structure Debt file. This dataset reports characteristics of firms' individual liabilities or narrowly-defined categories of liabilities (e.g. individual bond issuances, capital leases, etc.) collected from financial statements and other filings. We identify individual firms in the Capital Structure Debt file using both the `companyid` identifier and the `gvkey` field, since some firms identified by the `companyid` field are pre-

Compustat North America Security Daily file is poorly populated before 1999. Second, the Compustat North America Fundamentals Annual file contains year-end share price and shares outstanding fields which we can use to compute market capitalization, so we do not need to rely on the number of shares outstanding reported in the Security Daily file. For the Compustat Global Security Daily file, the `cshoc` variable is well-populated throughout the sample period, and the Compustat Global Fundamentals Annual file does not include share prices and shares outstanding.

[30] For the North America Security Daily file, the total return factor (`trfd`) appears to be filled with missing values for some stocks that never pay dividends. In cases where the total return factor is missing for all observations for a given stock, we fill missing values with 1. We also fill the first value of `trfd` for each stock with 1, if the original value is missing.

sented with duplicated observations corresponding to different `gvkey` values. Data are often reported for the same financial period (indicated by the `periodenddate` field) from multiple different filings (with the date of each filing indicated by the `filingdate` variable). For each firm-period-filing (indicated by a unique combination of the `companyid`, `gvkey`, `periodenddate`, and `filingdate` fields), we compute summary measures of firms' debt liabilities from the Capital Structure Debt file as follows:

1. We first convert all reported debt values to millions of units of the firm's reporting currency using the `unittypeid` field.[31]

2. Following Lou and Otto (2020), we drop any debt items for which the `descriptiontext` field contains the term "facility", because this indicates the total available value of credit lines and other sources of liquidity available to the firm, rather than amounts that have been previously drawn and must be paid back in the future.

3. We exclude firm-period-filings for which there is an individual debt item with negative reported value (`dataitemvalue`).

4. We compute the total outstanding amount of debt for each firm-period-filing by summing values over all individual debt items. We also compute the total outstanding amount of the firm's debt denominated in each individual currency (as indicated by the `issuedcurrencyid` field), as well as the share of debt denominated in each currency as a fraction of the firm's total debt.

In some cases, the different filings for the same firm-period yield different values for total debt.[32] We then select the filing that most closely matches the data reported in

[31] `unittypeid` values of 0, 1, and 2 indicate data reported in actual units of currency (e.g. $), thousands of units of currency (e.g. $1,000), or millions of units of currency (e.g. $1,000,000), respectively.

[32] Some of these observations may correspond to filings where principal values of debt are reported in different currencies. The Capital Structure Debt file does not indicate the currency in which `dataitemvalue` is reported. By manually reviewing individual filings, we concluded that these values are generally reported in the same currency for each filing. However, this currency may differ from the currency in which Compustat Fundamentals data are reported for the same firm-year.

Compustat Fundamentals for each `gvkey-datadate` pair. After summarizing the Capital Structure Debt file data by firm-period-filing, we match each filing to the corresponding observation in the Compustat Fundamentals file using the common `gvkey` firm identifier, and matching each `periodenddate` reported in Capital IQ with the `datadate` reported in Compustat Fundamentals. We then keep only the filing where the difference between total debt computed from the Capital Structure Debt file and total debt computed from the Compustat Fundamentals file (as the sum of debt in current liabilities `dlc` and long-term debt `dltt`) is the smallest; if there are multiple such filings, we keep the one with the earliest `filingdate`.[33] We discard any matches for which the total debt values computed from Capital Structure Debt file and Compustat Fundamentals differs by more than 10% of the firm's total assets reported in Compustat Fundamentals (field `at`).

After linking the Capital IQ debt summmary data to `gvkey-datadate` observations in Compustat Fundamentals, we then compute an upper bound on the share of the firm's total debt denominated in local currency as the sum of the following shares:

- The share of the firm's debt denominated in the firm's currency of document (`curcd` in the Compustat Fundamentals files), as explicitly indicated by the `issuedcurrencyid` field.[34]

- The share of the firm's debt with a missing code for currency of denomination `issuedcurrencyid`.

- The share of the firm's debt where the currency of denomination is listed as "Multi Currency" (`issuedcurrency = 514`).

[33] In a small number of cases, there are multiple `companyid`'s that are mapped to the same `gvkey` in the Capital Structure Debt file, so that the procedure described above yields more than one filing corresponding to the distinct `companyid`'s. In these cases, we verify that all of the firm-period-filing summary variables that we construct are the same across the different `companyid`'s.

[34] The `issuedcurrencyid` codes for currencies included in our sample are: 50 for euros, 72 for Indian rupees, 79 for Japanese yen, 85 for Korean won, 156 for Taiwanese dollars, and 160 for U.S. dollars.

We compute the share of the firm's debt denominated in foreign currency as 1 minus the local currency debt share.[35]

Capital IQ's coverage of our Compustat Fundamentals sample varies over time. Through the 2000 fiscal year, Capital IQ contains data for few firm-year observations in our sample. Coverage improves for all countries in our sample starting in 2001. From 2005 onwards, we are able to match a majority of firms appearing in each year to their debt capital structure data in Capital IQ.

C.4 Industry-Level International Trade Data

We use data from the World Input-Output Database (WIOD) to construct measures of exports, imports, and gross output for 56 industries in the six currency areas in our sample. The November 2016 Release of the WIOD provides estimates of annual gross trade flows between country-industry pairs (e.g. between the basic metals manufacturing sector in India and the auto manufacturing sector in Japan) from 2000 to 2014. The industry classification includes 56 industries (e.g. "Manufacture of motor vehicles, trailers and semi-trailers") and 5 final demand sectors. We first compute international trade summary statistics using input-output tables for each year. For each country-industry we compute imports as total purchases of intermediate goods from other countries, exports as total sales to other countries, and the ratio of net exports (imports minus exports) to gross

[35] Our estimate of the local currency debt share is an upper bound on the true local currency debt share, since we treat any debt items with either missing information for currency of denomination or that are denominated in multiple currencies (e.g. for revolving credit facilities) as being denominated in the firm's local currency. Therefore, our estimate of the share of the firm's debt denominated in foreign currency is a lower bound on the true foreign currency debt share. All shares are computed using total debt values computed from Capital IQ data, so by construction the shares of debt denominated in each individual currency sum to 1 for each firm-year, even when there are discrepancies between total debt values reported in Capital IQ and Compustat Fundamentals. We include debt items with currency listed as "Foreign Currency" (without a specific currency specified) in the firm's foreign currency debt share, since these items are excluded when computing the firm's local currency debt share.

output.[36] Finally, we compute the average of this ratio over the available years 2000-2014. This is the main country-industry international trade balance variable that we use throughout our analysis.

Mapping each firm observed in the Compustat Fundamentals file to one of the 56 WIOD industries poses several challenges. The industries in the WIOD 2016 Release are defined using International Standard of Industrial Classification (ISIC) Revision 4 codes. The Compustat Fundamentals file does not contain ISIC codes for each firm. It does contain North American Industry Classification System (NAICS) codes for each firm, and the U.S. Census Bureau provides a concordance table mapping 6-digit NAICS codes to 4-digit ISIC codes. However, three issues arise when attempting to link the NAICS codes provided in Compustat to ISIC codes on which the WIOD industries are based using these concordance tables. First, some individual 6-digit NAICS codes are mapped to multiple ISIC codes, which in turn are mapped to multiple WIOD industries. Second, many of the NAICS codes provided in Compustat's `naics` variable have fewer than 6 digits, requiring us to build additional concordance tables from each of the broader 2, 3, 4, and 5-digit NAICS industries to a single WIOD industry. Third, Compustat contains industry codes from multiple different versions of NAICS (1997, 2002, 2007, 2012, and 2017).[37]

To address the first two problems, we build a concordance from all (2-digit through 6-digit) 2017 NAICS codes to WIOD industries. Our algorithm for mapping individual NAICS codes to unique WIOD is similar to the one used by Covarrubias, Gutierrez and Philippon (2020). We start from the official U.S. Census Bureau concordance table mapping each 6-digit 2017 NAICS code to one or more 4-digit ISIC codes. Next, we map each 4-digit ISIC code to a unique WIOD industry (based on the first two digits of the

[36] For each euro area industry, we aggregate sales across all 19 euro area member countries, and exclude purchases and sales between member countries when computing imports and exports.

[37] We use versions of the Compustat Fundamentals files downloaded prior to June 2022, when 2022 NAICS codes began to be used.

ISIC code). We then sequentially build concordance tables from each n-digit NAICS code (where $n = 2, 3, 4, 5, 6$) to a single WIOD industry using the following algorithm. For each individual n-digit NAICS code:

1. We collect all entries in the official 2017 NAICS-to-ISIC concordance table where the 6-digit NAICS code belongs to the given n-digit NAICS industry (or when $n = 6$, we collect all entries where the 6-digit NAICS code matches the given code).

2. Among the collected entries, we count the frequency with which the 6-digit NAICS codes are mapped to each WIOD industry.

    - If there is a single WIOD industry that appears most frequently among the collected entries, we map the n-digit NAICS code to that WIOD industry in our final concordance table.

    - If there are multiple WIOD industries that appear most frequently among the collected entries, we first truncate the last digit from the given n-digit NAICS code to construct a $(n-1)$-digit NAICS code. We then refer to our final concordance table from $(n-1)$-digit NAICS codes to WIOD industries to obtain the single WIOD industry that the truncated NAICS code is mapped to. We then map the original n-digit NAICS code to this WIOD industry in our final concordance table.

We first build the concordance table for $n = 2$-digit 2017 NAICS codes. For each 2-digit NAICS code, there is a single WIOD industry that appears most frequently among the set of concordance table entries described in the algorithm above. Therefore, the "tiebreaking" rule between WIOD industries described above is never invoked, and we can construct the concordance table from 2-digit NAICS codes to WIOD industries, without referring to a non-existent concordance table using 1-digit NAICS codes. We then

construct our concordance table from $n = 3$-digit NAICS codes to WIOD industries, using the concordance table for 2-digit NAICS codes when necessary. We continue this sequential procedure to produce all of the desired concordance tables from 2017 NAICS codes to WIOD industries.

To address the third problem - the fact that Compustat's `naics` variable contains NAICS codes from different NAICS versions (1997, 2002, 2007, 2012, and 2017) - we use the official Census Bureau concordance tables between NAICS versions. These tables map, for example, 6-digit 2012 NAICS codes to 6-digit 2017 NAICS codes. However, the official concordance tables do not provide a mapping between the 2- through 5-digit NAICS codes reported for many firms in Compustat. In addition, individual 6-digit NAICS industries in the earlier NAICS version are in some cases mapped to multiple 6-digit NAICS industries in the latter NAICS version. To expand our concordance table to cover all 2- through 5-digit NAICS codes in prior NAICS versions, we use the following algorithm.

1. We start by collecting all 6-digit NAICS codes that appears in the list of 2012 NAICS codes but not in our existing NAICS-to-WIOD industry concordance table (which initially contains the complete list of 2017 NAICS codes).

2. For each of these 6-digit 2012 NAICS codes, we use the official concordance table to obtain the corresponding set of 6-digit 2017 NAICS codes.

    - If our existing NAICS-to-WIOD industry concordance table maps all of these NAICS codes to the same WIOD industry, we update our NAICS-to-WIOD industry concordance table to map the given 6-digit 2012 NAICS code to this WIOD industry.

    - If our existing NAICS-to-WIOD industry concordance table maps some of these NAICS codes to different WIOD industries, we manually determine the most

appropriate WIOD industry to which the given 6-digit 2012 NAICS code should be matched, then update our NAICS-to-WIOD industry concordance table. The list of manual matches used across all NAICS versions is provided below.

3. We repeat the above steps to map each n-digit 2012 NAICS codes that does not appear in our existing NAICS-to-WIOD industry concordance table to a single WIOD industry (starting from $n = 5$ and working backwards sequentially to $n = 2$). At this stage, our existing NAICS-to-WIOD industry concordance table contains entries mapping each $(n + 1)$-digit 2012 NAICS code to a single WIOD industry. For each selected n-digit 2012 NAICS code that is not already present in this table, we obtain the set of $(n + 1)$-digit 2012 NAICS codes in the table that match the first n digits.

    - If our existing NAICS-to-WIOD industry concordance table maps all of these NAICS codes to the same WIOD industry, we update our NAICS-to-WIOD industry concordance table to map the given n-digit 2012 NAICS code to this WIOD industry.
    - If our existing NAICS-to-WIOD industry concordance table maps some of these NAICS codes to different WIOD industries, we again manually determine the most appropriate WIOD industry to which the given n-digit 2012 NAICS code should be matched, then update our NAICS-to-WIOD industry concordance table.

Using this algorithm, we extend our NAICS-to-WIOD industry concordance table to include all 2- through 6-digit 2012 NAICS codes that are not present in the list of 2017 NAICS codes. We then apply the same algorithm to sequentially add any 2007 NAICS codes (using the official 2007 NAICS to 2012 NAICS concordance table), 2002 NAICS codes (using the official 2002 NAICS to 2007 NAICS concordance table), and 1997 NAICS

codes (using the official 1997 NAICS to 2002 NAICS concordance table) that were not already present in the table. We also manually map 4 NAICS codes that appear in Compustat, but not in any of the official Census Bureau files; the NAICS codes and corresponding WIOD industries are listed at the bottom of the table below.

NAICS Industry Code/Description	**NAICS Year**	**WIOD Industry Number/Description**
334119: "Other Computer Peripheral Equipment Manufacturing"	2007	17: "Manufacture of computer, electronic and optical products"
339111: "Laboratory Apparatus and Furniture Manufacturing"	2002	19: "Manufacture of machinery and equipment n.e.c."
525930: "Real Estate Investment Trusts"	2002	44: "Real estate activities"
51811: "Internet Service Providers and Web Search Portals"	2002	39: "Telecommunications"
4212-4229: industries within "Wholesale Trade" (excluding 4211: "Motor Vehicle and Motor Vehicle Parts and Supplies Wholesalers")	1997	29: "Wholesale trade, except of motor vehicles and motorcycles"
51419: "Other Information Services"	1997	40: "Computer programming, consultancy and related activities; information service activities"
5132: "Cable Networks and Program Distribution"	1997	38: "Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities"
5141: "Information Services"	1997	40: "Computer programming, consultancy and related activities; information service activities"
421: "Wholesale Trade"	1997	29: "Wholesale trade, except of motor vehicles and motorcycles"
513: "Broadcasting and Telecommunications"	1997	39: "Telecommunications"
514: "Information Services and Data Processing Services"	1997	40: "Computer programming, consultancy and related activities; information service activities"
337120: "Blind and Shade Manufacturing"	Unknown	22: "Manufacture of furniture; other manufacturing"
33713: "Wood Furniture Manufacturing"	Unknown	22: "Manufacture of furniture; other manufacturing"
33714: "Nonwood Furniture Manufacturing"	Unknown	22: "Manufacture of furniture; other manufacturing"
48122: "Nonscheduled Specialty Air Transportation"	Unknown	33: "Air transport"

D Appendix: Additional Tables and Figures

This Appendix first reports summary statistics in Section D.1 and then additional results, following the structure of the paper, starting with aggregate FX transaction income in Section D.2, before turning to histograms of FX transaction income in Section D.3, its persistence in Section D.4, determinants in Section D.5, and passthrough to profits in Section D.6. Finally, section D.7 revisits the impact of exchange rate changes on profits.

D.1 Summary Statistics

The following tables present summary statistics for firm-year observations in each country. All level variables are reported in units of local currency, converted to a convenient scale for presentation (e.g. millions of U.S. dollars, billions of Japanese yen, etc.).

Summary statistics immediately highlight the contrast between the U.S. and the other countries. For example, among all the Taiwanese public firm-year data, approximately one-fourth of the FX transaction observations imply a risk of more than 12% of the firm's net income. The U.S. counterparts suggest a 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 4.6% of the firm's net income. And only 5 percent of the same observations imply a risk of more than 27% of the firm's net income. A large share of firms in India, South Korea, and Taiwan also appear exposed to FX transaction risk, while euro area firms appear closer to their U.S. counterparts.

Table D1. Summary Statistics: United States, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	58,777	58,777	2,080	6,191	1	3	8	56	267	1,250	10,013	31,369	83,383
Pre-Tax Income	58,777	58,772	172	787	-4,322	-498	-98	-5	6	71	871	4,070	9,829
Assets	58,777	58,777	2,619	8,759	4	6	12	62	282	1,363	12,329	41,839	156,774
Return on Assets (%)	58,777	58,772	-0.95	21.22	-120.49	-85.80	-45.66	-5.21	4.18	10.33	22.13	32.86	40.95
Profit Margin (%)	58,777	58,772	-16.98	98.13	-1,226.80	-557.80	-111.64	-5.61	3.80	10.52	25.74	42.09	51.75
Market / Book Ratio	58,722	58,722	1.95	1.45	0.42	0.61	0.79	1.11	1.48	2.20	4.87	8.18	16.93
Total Debt / Assets	58,777	51,031	0.25	0.24	0.00	0.00	0.00	0.05	0.21	0.37	0.70	1.07	1.54
Foreign Currency Debt / Assets	32,024	2,981	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.21
Foreign Sales Share	43,766	24,075	0.20	0.25	0.00	0.00	0.00	0.00	0.08	0.35	0.71	0.94	1.00
Cash / Assets	58,777	58,621	0.17	0.20	0.00	0.00	0.00	0.03	0.09	0.24	0.65	0.85	0.92
FX Transaction Income	14,080	13,681	-3	19	-237	-89	-21	-2	-0	0	9	43	130
FX Transaction Income / Assets (%)	14,080	13,681	-0.07	0.51	-7.25	-1.74	-0.76	-0.17	-0.03	0.06	0.55	1.36	3.50
FX Transaction Income / Sales (%)	14,080	13,681	-0.07	0.69	-8.64	-2.31	-0.88	-0.20	-0.03	0.07	0.64	1.91	9.80
|FX Transaction Income| / Assets (%)	14,080	13,681	0.27	0.44	0.00	0.00	0.00	0.04	0.13	0.31	1.06	2.10	7.25
|FX Transaction Income| / Sales (%)	14,080	13,681	0.33	0.61	0.00	0.00	0.00	0.05	0.14	0.36	1.26	3.04	9.80
|FX Transaction Income| / |Income| (%)	14,079	13,680	6.26	16.26	0.00	0.00	0.04	0.49	1.55	4.64	27.42	88.74	217.90

This table reports summary statistics for all firms in our sample located in the United States. Sales, income, assets, market capitalization, FX transaction income are all reported in millions of U.S. dollars. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

Table D2. Summary Statistics: Euro Area, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	20,977	20,977	2,594	7,768	2	3	9	54	212	1,122	14,127	44,662	62,536
Pre-Tax Income	20,977	20,975	160	592	-1,825	-246	-33	-0	7	54	880	3,559	6,271
Assets	20,977	20,977	3,499	11,521	5	7	13	59	225	1,195	18,786	71,262	114,074
Return on Assets (%)	20,977	20,975	2.21	12.98	-98.68	-50.60	-22.08	-0.23	4.14	8.22	17.69	28.90	35.33
Profit Margin (%)	20,977	20,975	-2.04	39.53	-601.90	-211.24	-37.49	-0.22	4.11	9.10	21.76	36.63	69.30
Market / Book Ratio	20,977	20,977	1.50	0.91	0.49	0.62	0.79	1.00	1.22	1.64	3.17	5.52	16.51
Total Debt / Assets	20,977	19,924	0.23	0.17	0.00	0.00	0.00	0.08	0.21	0.33	0.53	0.73	0.89
Foreign Currency Debt / Assets	19,926	3,427	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.20	0.29
Foreign Sales Share	14,521	12,915	0.46	0.31	0.00	0.00	0.00	0.19	0.48	0.73	0.92	1.00	1.00
Cash / Assets	20,977	20,977	0.14	0.14	0.00	0.00	0.01	0.05	0.10	0.19	0.44	0.67	0.77
FX Transaction Income	20,962	13,828	-2	15	-278	-56	-9	-0	0	0	3	24	122
FX Transaction Income / Assets (%)	20,962	13,828	-0.05	0.45	-4.76	-1.66	-0.66	-0.08	0.00	0.01	0.47	1.32	3.26
FX Transaction Income / Sales (%)	20,962	13,828	-0.06	0.82	-19.59	-2.47	-0.81	-0.08	0.00	0.01	0.56	2.27	6.99
|FX Transaction Income| / Assets (%)	20,962	13,828	0.20	0.40	0.00	0.00	0.00	0.00	0.04	0.21	0.94	1.97	4.76
|FX Transaction Income| / Sales (%)	20,962	13,828	0.27	0.77	0.00	0.00	0.00	0.00	0.04	0.24	1.25	3.30	19.59
|FX Transaction Income| / |Income| (%)	20,960	13,828	5.76	17.88	0.00	0.00	0.00	0.00	0.59	3.73	26.89	89.49	320.10

This table reports summary statistics for all firms in our sample located in the Euro Area. Sales, income, assets, market capitalization, FX transaction income are all reported in millions of euros. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

Table D3. Summary Statistics: Japan, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	65,330	65,330	192	519	1	2	4	16	41	129	830	3,084	6,333
Pre-Tax Income	65,330	65,311	8	26	-57	-11	-2	0	1	5	36	132	354
Assets	65,330	65,330	205	558	1	2	5	17	42	126	933	3,331	5,634
Return on Assets (%)	65,330	65,311	3.60	5.94	-37.72	-17.46	-5.68	1.25	3.50	6.48	12.72	19.17	24.56
Profit Margin (%)	65,330	65,311	3.75	7.48	-53.56	-22.79	-6.50	1.14	3.40	6.67	15.18	25.21	34.17
Market / Book Ratio	65,330	65,330	1.19	0.63	0.39	0.50	0.63	0.85	1.03	1.31	2.27	3.73	7.76
Total Debt / Assets	65,330	59,973	0.23	0.19	0.00	0.00	0.00	0.06	0.20	0.35	0.58	0.71	0.84
Foreign Currency Debt / Assets	36,835	720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.12
Foreign Sales Share	37,979	18,026	0.15	0.22	0.00	0.00	0.00	0.00	0.00	0.25	0.64	0.82	0.89
Cash / Assets	65,330	65,330	0.18	0.13	0.01	0.02	0.04	0.09	0.15	0.24	0.44	0.61	0.73
FX Transaction Income	65,318	29,658	-0	1	-26	-3	-1	0	0	0	0	2	15
FX Transaction Income / Assets (%)	65,318	29,658	-0.01	0.34	-4.47	-1.20	-0.44	0.00	0.00	0.00	0.37	1.03	3.06
FX Transaction Income / Sales (%)	65,318	29,658	-0.01	0.43	-5.48	-1.44	-0.50	0.00	0.00	0.00	0.42	1.31	5.08
|FX Transaction Income| / Assets (%)	65,318	29,658	0.13	0.31	0.00	0.00	0.00	0.00	0.00	0.14	0.67	1.54	4.47
|FX Transaction Income| / Sales (%)	65,318	29,658	0.16	0.40	0.00	0.00	0.00	0.00	0.00	0.14	0.79	1.93	5.48
|FX Transaction Income| / |Income| (%)	65,299	29,653	5.99	23.69	0.00	0.00	0.00	0.00	0.00	3.09	26.69	102.64	964.85

This table reports summary statistics for all firms in our sample located in Japan. Sales, income, assets, market capitalization, FX transaction income are all reported in billions of Japanese yen. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

Table D4. Summary Statistics: Taiwan, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	23,654	23,654	13,741	40,359	71	107	306	1,209	2,969	8,520	54,050	265,823	379,860
Pre-Tax Income	23,654	23,654	852	3,134	-10,450	-2,140	-440	8	154	568	3,738	18,849	36,315
Assets	23,654	23,654	17,464	49,677	262	325	614	1,691	3,950	10,524	70,822	334,296	437,967
Return on Assets (%)	23,654	23,654	4.00	9.24	-40.59	-27.34	-12.79	0.34	4.40	9.07	18.32	25.31	31.95
Profit Margin (%)	23,654	23,654	3.50	19.69	-155.45	-88.97	-26.17	0.45	5.24	11.75	26.31	43.49	67.80
Market / Book Ratio	23,654	23,654	1.38	0.75	0.45	0.62	0.74	0.94	1.15	1.55	2.85	4.61	7.42
Total Debt / Assets	23,654	20,683	0.20	0.17	0.00	0.00	0.00	0.05	0.18	0.32	0.50	0.64	0.72
Foreign Currency Debt / Assets	21,679	2,355	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.13	0.20
Foreign Sales Share	13,248	10,758	0.45	0.37	0.00	0.00	0.00	0.04	0.42	0.82	1.00	1.00	1.00
Cash / Assets	23,654	23,654	0.22	0.16	0.00	0.01	0.03	0.10	0.18	0.30	0.56	0.72	0.78
FX Transaction Income	23,651	21,812	7	114	-2,950	-308	-83	-8	0	12	120	483	1,104
FX Transaction Income / Assets (%)	23,651	21,812	-0.00	0.74	-4.17	-2.50	-1.23	-0.23	0.00	0.27	1.14	2.01	5.90
FX Transaction Income / Sales (%)	23,651	21,812	-0.04	1.20	-12.83	-3.96	-1.77	-0.31	0.00	0.34	1.53	3.01	7.59
|FX Transaction Income| / Assets (%)	23,651	21,812	0.46	0.57	0.00	0.00	0.00	0.07	0.25	0.64	1.63	2.66	5.90
|FX Transaction Income| / Sales (%)	23,651	21,812	0.66	1.00	0.00	0.00	0.00	0.09	0.32	0.84	2.36	4.79	12.83
|FX Transaction Income| / |Income| (%)	23,651	21,812	14.61	32.50	0.00	0.00	0.00	1.06	4.17	12.64	67.61	164.88	334.52

This table reports summary statistics for all firms in our sample located in Taiwan. Sales, income, assets, market capitalization, FX transaction income are all reported in millions of New Taiwan dollars. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

Table D5. Summary Statistics: South Korea, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	27,248	27,248	862	2,797	4	7	16	53	136	396	3,605	17,740	24,351
Pre-Tax Income	27,248	27,248	33	153	-953	-141	-28	-1	4	18	160	937	1,597
Assets	27,248	27,248	980	3,296	11	17	29	70	151	435	4,118	20,201	34,053
Return on Assets (%)	27,248	27,248	1.25	12.60	-110.40	-50.33	-21.62	-1.15	2.95	7.38	16.15	23.22	58.54
Profit Margin (%)	27,248	27,248	-1.36	26.37	-317.87	-127.89	-40.79	-1.35	3.24	8.27	20.88	35.49	79.60
Market / Book Ratio	27,248	27,248	1.23	0.79	0.31	0.48	0.60	0.82	1.00	1.33	2.62	4.75	8.70
Total Debt / Assets	27,248	24,952	0.24	0.19	0.00	0.00	0.00	0.07	0.23	0.38	0.57	0.68	1.53
Foreign Currency Debt / Assets	19,932	6,772	0.02	0.05	-0.00	0.00	0.00	0.00	0.00	0.01	0.14	0.27	0.38
Foreign Sales Share	11,131	8,094	0.25	0.28	0.00	0.00	0.00	0.00	0.13	0.45	0.83	0.95	1.00
Cash / Assets	27,248	27,248	0.17	0.14	0.00	0.01	0.02	0.06	0.12	0.23	0.47	0.64	0.75
FX Transaction Income	27,248	25,773	-1	23	-717	-35	-6	-0	0	0	4	29	220
FX Transaction Income / Assets (%)	27,248	25,773	-0.04	1.02	-11.64	-3.32	-1.37	-0.19	0.00	0.17	1.17	2.73	8.98
FX Transaction Income / Sales (%)	27,248	25,773	-0.05	1.41	-21.13	-4.70	-1.75	-0.23	0.00	0.21	1.53	3.42	17.95
|FX Transaction Income| / Assets (%)	27,248	25,773	0.49	0.90	0.00	0.00	0.00	0.04	0.18	0.55	1.96	4.26	11.64
|FX Transaction Income| / Sales (%)	27,248	25,773	0.63	1.27	0.00	0.00	0.00	0.05	0.22	0.67	2.55	5.43	21.13
|FX Transaction Income| / |Income| (%)	27,248	25,773	18.89	59.60	0.00	0.00	0.00	0.64	3.40	13.08	88.66	227.25	1,655.69

This table reports summary statistics for all firms in our sample located in South Korea. Sales, income, assets, market capitalization, FX transaction income are all reported in billions of Korean won. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

Table D6. Summary Statistics: India, All Firms

	Obs	NonzeroObs	Mean	StdDev	Min	Q01	Q05	Q25	Q50	Q75	Q95	Q99	Max
Sales	24,729	24,729	20,209	64,477	88	128	317	1,279	3,745	12,311	76,567	395,301	718,811
Pre-Tax Income	24,729	24,728	1,599	7,305	-17,532	-6,730	-1,043	7	145	762	7,335	47,481	78,865
Assets	24,729	24,729	28,576	98,968	243	335	517	1,613	4,536	15,098	109,821	607,037	1,262,689
Return on Assets (%)	24,729	24,728	4.72	10.78	-53.86	-31.00	-12.47	0.41	4.47	10.15	21.96	32.47	47.79
Profit Margin (%)	24,729	24,728	1.53	29.10	-274.29	-137.87	-35.33	0.50	4.80	11.32	27.63	51.40	76.21
Market / Book Ratio	24,729	24,729	1.45	1.21	0.27	0.37	0.56	0.83	1.04	1.54	3.84	6.99	10.69
Total Debt / Assets	24,729	23,470	0.31	0.25	0.00	0.00	0.00	0.12	0.29	0.45	0.72	1.21	1.82
Foreign Currency Debt / Assets	23,075	5,204	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.30	0.35
Foreign Sales Share	11,768	4,749	0.15	0.27	0.00	0.00	0.00	0.00	0.00	0.20	0.83	0.97	1.00
Cash / Assets	24,729	24,729	0.08	0.11	0.00	0.00	0.00	0.01	0.03	0.09	0.32	0.54	0.60
FX Transaction Income	24,692	17,036	-23	334	-6,462	-1,034	-152	-2	0	2	97	581	4,019
FX Transaction Income / Assets (%)	24,692	17,036	-0.03	0.74	-11.52	-2.65	-0.97	-0.05	0.00	0.06	0.86	2.08	5.61
FX Transaction Income / Sales (%)	24,692	17,036	-0.04	1.04	-15.89	-3.98	-1.22	-0.06	0.00	0.07	1.06	2.81	12.27
|FX Transaction Income| / Assets (%)	24,692	17,036	0.31	0.67	0.00	0.00	0.00	0.00	0.05	0.33	1.47	2.95	11.52
|FX Transaction Income| / Sales (%)	24,692	17,036	0.41	0.96	0.00	0.00	0.00	0.00	0.07	0.39	1.94	4.86	15.89
|FX Transaction Income| / |Income| (%)	24,691	17,035	10.71	36.44	0.00	0.00	0.00	0.00	0.80	5.76	50.23	170.63	570.56

This table reports summary statistics for all firms in our sample located in India. Sales, income, assets, market capitalization, FX transaction income are all reported in millions of Indian rupees. "Obs" denotes the number of non-missing observations for each variable, "NonzeroObs" denotes the number of non-zero observations for each variable, and columns Q01 through Q99 report 1st through 99th percentiles computed across all firm-year observations. All statistics are computed after winsorizing variables at the $(1\%, 99\%)$ level.

D.2 Aggregate variables

Figure D1 compares aggregate FX transaction income to GDP. Figure D2 presents annual aggregate foreign exchange transaction income as a fraction of aggregate corporate assets: as in the main text, where FX transaction income is scaled by firm income, there is a strong correlation between aggregate FX transaction income and changes in exchange rates.

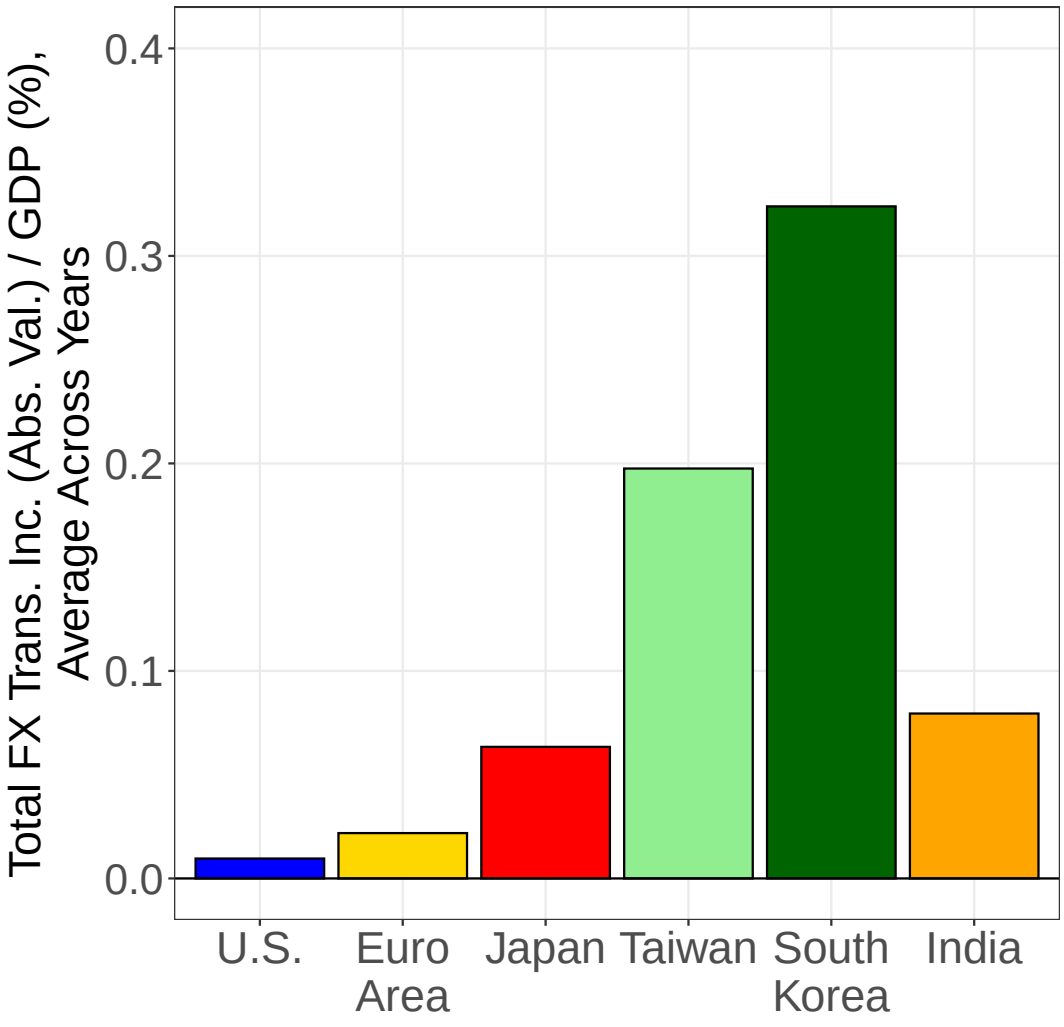
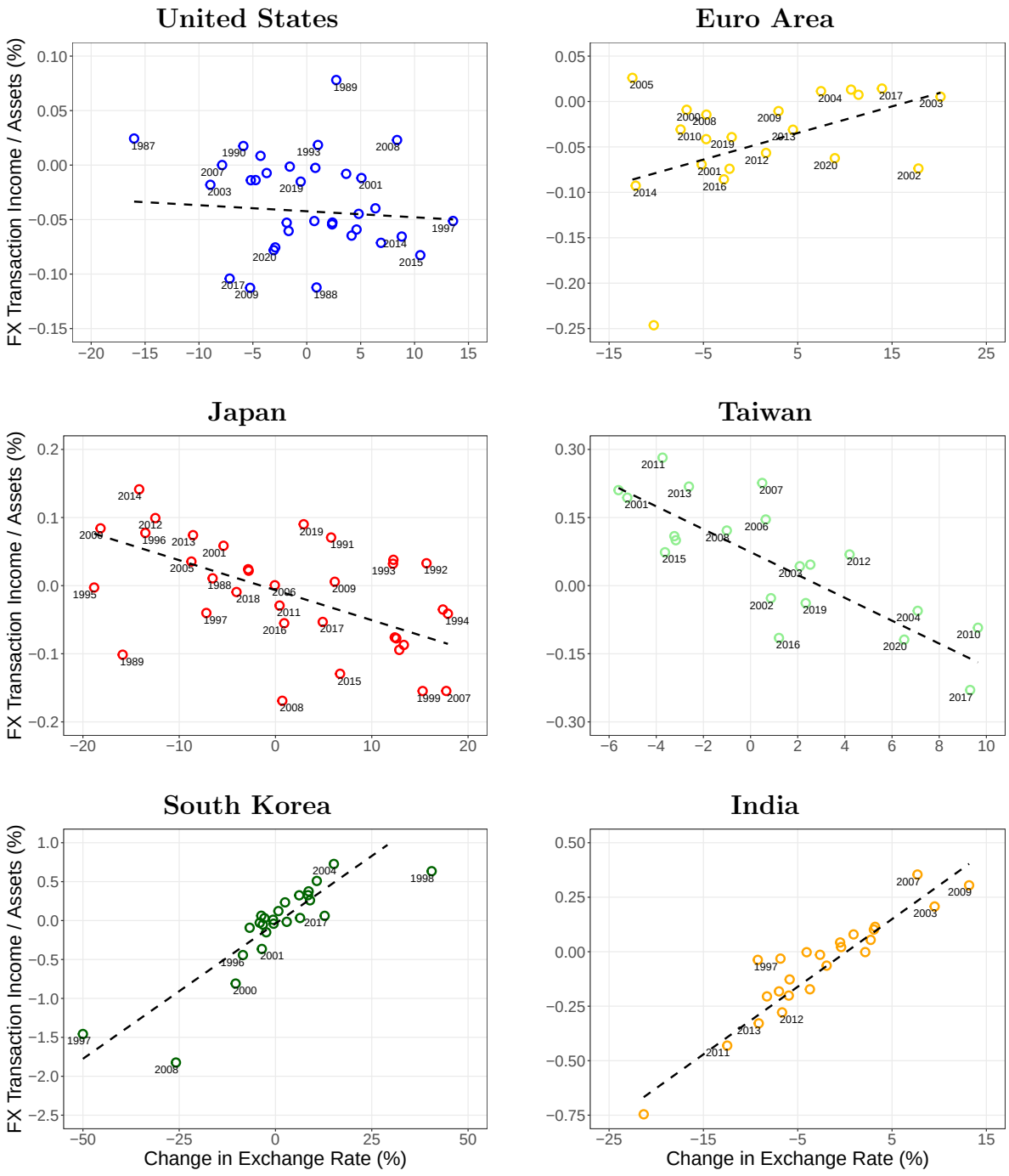


Figure D1. Average FX Transaction Income as a fraction of GDP (in absolute values)
This figure reports the average FX transaction income (in absolute values) over all country-years with at least 200 firm observations, scaled by GDP.

D.3 Examples of distributions

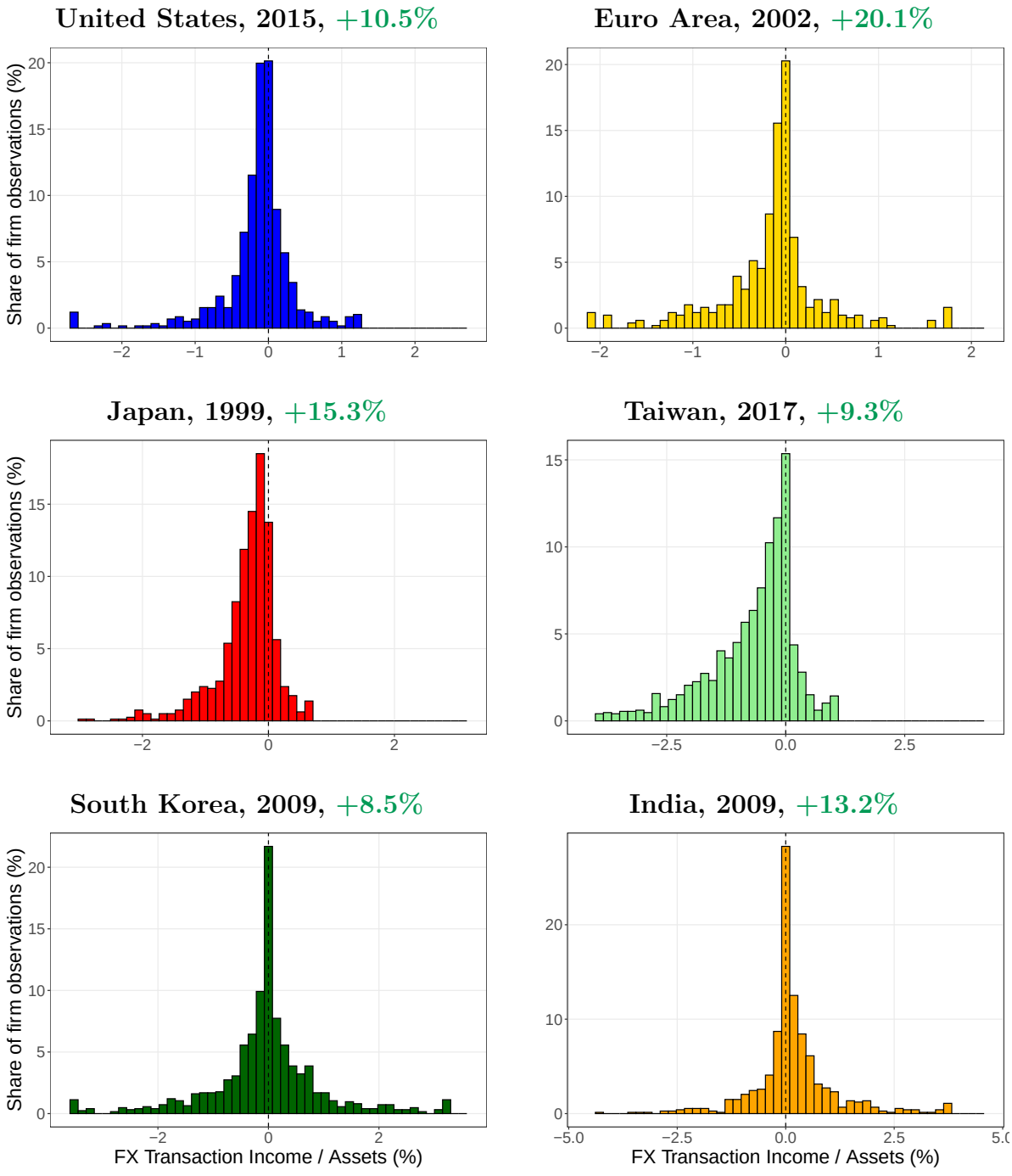
The histograms reported in Figures D3 and D4 show the cross-sectional distribution of FX transaction income relative to total firm assets. The values of aggregate FX transaction income relative to aggregate assets shown in Figure D2 are obtained by taking an asset-weighted average over this distribution. The distribution of FX transaction gains and losses across the firm size distribution can explain, for example, why the histograms reported for South Korea appear nearly symmetric while the aggregate FX transaction incomes in the same years were large in magnitude.

Figure D2. Aggregate Foreign Exchange Transaction Income (Relative to Assets) and Exchange Rates



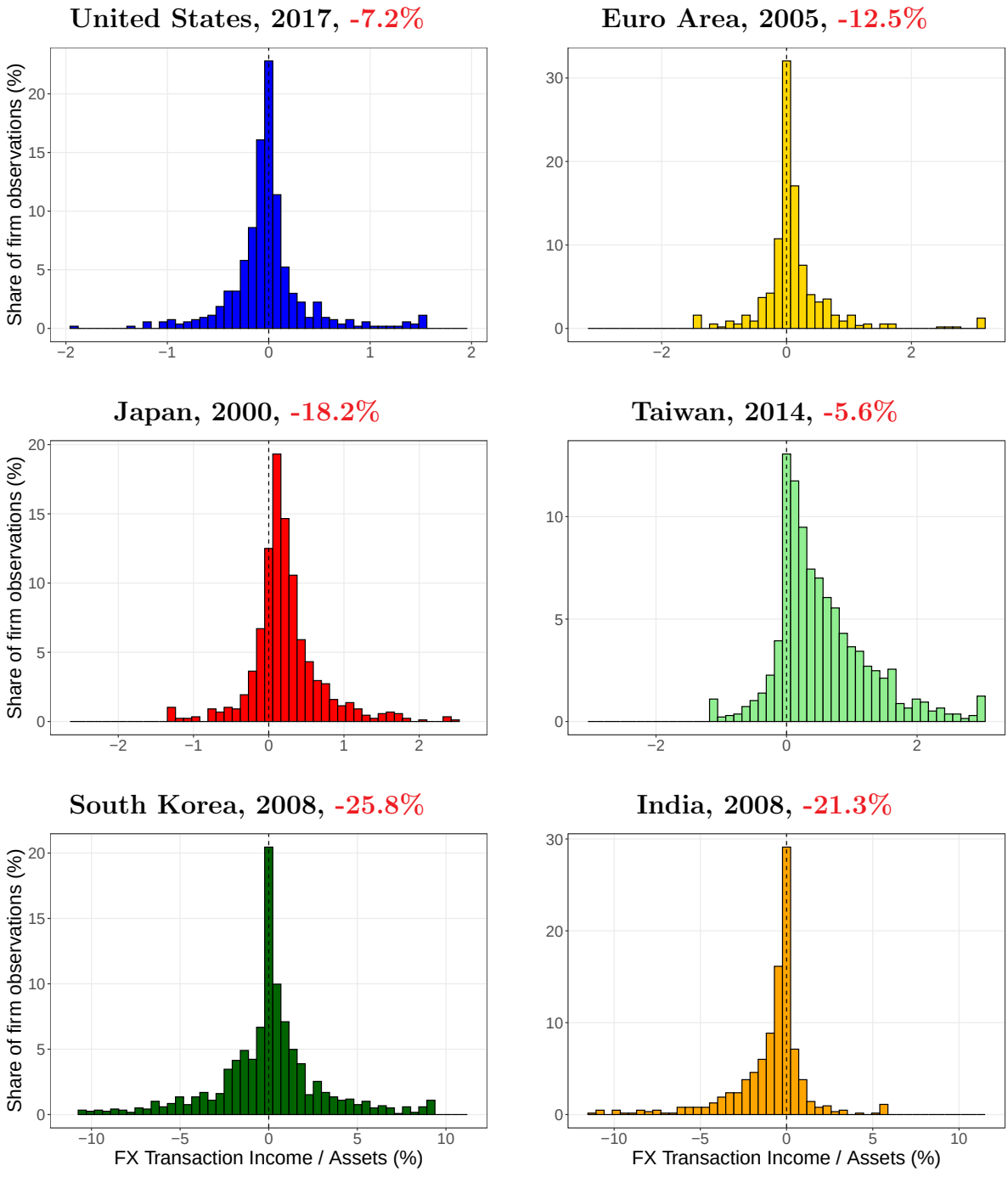
This figure presents aggregate FX transaction income in each year for the six countries and currency areas in our sample, as function of the annual change in exchange rate. Aggregate FX transaction income is the sum of FX transaction income across all firms in the sample for which a non-missing value is available in a given year. The aggregate FX transaction income is scaled by the aggregate total assets for the same set of firms. The figure includes only country-years for which at least 200 firms report non-missing FX transaction income. The exchange rate is the BIS trade-weighted U.S. dollar index for the U.S., and the corresponding bilateral exchange rate against the U.S. dollar for all other countries. Exchange rates are defined in U.S. dollars per local currency. A positive change in exchange rate indicates an appreciation of the local currency.

Figure D3. Distribution of FX Transaction Income: Local Currency Appreciations



This figure presents the distribution of FX transaction income (scaled by total assets) across firms in each country, in selected years with large local currency appreciations. The ratio of FX transaction income to total assets is winsorized at the first and 99th percentiles for each country-year. The histograms exclude firms that report zero FX transaction income.

Figure D4. Distribution of FX Transaction Income: Local Currency Depreciations



This figure presents the distribution of FX transaction income (scaled by total assets) across firms in each country, in selected years with large local currency depreciations. The ratio of FX transaction income to total assets is winsorized at the first and 99th percentiles for each country-year. The histograms exclude firms that report zero FX transaction income.

D.4 Persistence of firm-level FX transaction income

We now turn to the persistence of FX transaction income at the firm level. In levels, FX transaction income appears close to serially uncorrelated for an individual firm, as expected if these gains and losses primarily arise from serially uncorrelated changes in nominal exchange rates. However, firms' *exposure* to FX transaction risk is persistent: firms that previously reported nonzero FX transaction income are likely to do so again in the future, and the magnitude of firms' FX transaction income is strongly correlated across years.

Table D7 reports the firm-level autocorrelation of FX transaction income, in levels. Estimates in Panel A correspond to the following panel regression of FX transaction income (scaled by total firm assets) on its lagged value:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t}} = \alpha + \rho \frac{\text{FX Transaction Income}_{i,t-1}}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t} \tag{20}$$

For firms that fully or partially hedge their exposure to exchange rate risk using derivatives, their reported FX transaction income also includes a small component determined by differences in spot and forward exchange rates, as explained in Appendix B.2. Since differences between forward and spot exchange rates tend to be persistent, hedge accounting may lead to a small positive autocorrelation in reported FX transaction income for these firms.

The estimated coefficients ρ reported in Panel A of Table D7 are generally small in magnitude, and only the estimate for Japan is marginally statistically significant. Panel B adds firm fixed effects, which may help to remove any small, persistent component of some firms' FX transaction income arising from hedge accounting. The estimated coefficients in Panel B are again small in magnitude and statistically insignificant. Overall, Table D7 documents that firms' FX transaction income exhibits weak serial correlation, as would

be expected if these gains and losses arise primarily from serially uncorrelated changes in nominal exchange rates.

On the other hand, the *magnitude* of firms' FX transaction income is persistent. Panel A of Table reports estimates from a similar regression for the absolute value of firms' FX transaction income:

$$\frac{|\text{FX Transaction Income}_{i,t}|}{\text{Assets}_{i,t}} = \alpha + \rho \frac{|\text{FX Transaction Income}_{i,t-1}|}{\text{Assets}_{i,t-1}} + \varepsilon_{i,t}. \tag{21}$$

The estimated coefficients reported in Table D8 are large and statistically significant. While it is difficult to predict the sign of firms' FX transaction income, firms that previously reported large gains or losses are likely to report future gains or losses of similar magnitude. Finally, Panel B of Table D8 reports similar estimates using an indicator variable for whether the firm reports a non-zero value of FX transaction income in a given year:

$$\mathbf{1}_{\text{FX Transaction Income}_{i,t} \neq 0} = \alpha + \rho \times \mathbf{1}_{\text{FX Transaction Income}_{i,t-1} \neq 0} + \varepsilon_{i,t}. \tag{22}$$

The estimated coefficients are again large and statistically significant: firms that report *any* FX transaction gains or losses will likely do so again in the following year. Taken together, these results show that firms' exposure to FX transaction risk is persistent, both at the intensive margin (whether firms report any FX transaction gains or losses) and the extensive margin (the magnitude of these gains and losses).

Table D7. Persistence of FX Transaction Income: Levels

Panel A: no firm fixed effects

	FX Transaction Income$_t$/Assets$_t$ (basis points)					
	USA	EUR	JPN	TWN	KOR	IND
	(1)	(2)	(3)	(4)	(5)	(6)
FX Transaction Income$_{t-1}$/Assets$_{t-1}$ (basis points)	0.09	0.09	0.20*	−0.002	−0.07	0.14
	(0.07)	(0.09)	(0.10)	(0.14)	(0.08)	(0.11)
Constant	−6.96***	−4.45**	−1.16	−1.20	−4.16	−2.42
	(1.44)	(1.80)	(1.95)	(9.35)	(4.22)	(3.82)
Observations	11,250	18,132	61,085	21,015	23,630	20,926
R^2	0.01	0.01	0.04	0.0000	0.01	0.02
Note:						*p<0.1; **p<0.05; ***p<0.01

Panel B: including firm fixed effects

	FX Transaction Income$_t$/Assets$_t$ (basis points)					
	USA	EUR	JPN	TWN	KOR	IND
FX Transaction Income$_{t-1}$/Assets$_{t-1}$ (basis points)	−0.08	−0.04	0.15	−0.07	−0.11*	−0.03
	(0.07)	(0.09)	(0.11)	(0.14)	(0.07)	(0.09)
Fixed Effects			Firm			
Observations	11,250	18,132	61,085	21,015	23,630	20,926
R^2	0.20	0.15	0.08	0.09	0.08	0.20
Note:						*p<0.1; **p<0.05; ***p<0.01

Panel A reports estimates from the regression

$$\frac{FXTransactionIncome_{i,t}}{Assets_{i,t}} = \alpha + \rho \frac{FXTransactionIncome_{i,t-1}}{Assets_{i,t-1}} + \varepsilon_{i,t}$$

for the six countries in our sample. α denotes a constant.
Panel B reports estimates for a similar regression including firm fixed effects α_i:

$$\frac{FXTransactionIncome_{i,t}}{Assets_{i,t}} = \alpha + \rho \frac{FXTransactionIncome_{i,t-1}}{Assets_{i,t-1}} + \varepsilon_{i,t}$$

Standard errors are reported in parentheses and are double-clustered by firm and year.

Table D8. Persistence of FX Transaction Income: Exposure

Panel A: persistence of absolute value $|FXTransactionIncome_{i,t}|$

	$\lvert$FX Transaction Income$_t\rvert$/Assets$_t$					
	USA	EUR	JPN	TWN	KOR	IND
	(1)	(2)	(3)	(4)	(5)	(6)
$\lvert$FX Transaction Income$_{t-1}\rvert$/Assets$_{t-1}$	0.48***	0.51***	0.54***	0.39***	0.25***	0.42***
	(0.06)	(0.07)	(0.05)	(0.04)	(0.06)	(0.07)
Constant	13.18***	10.54***	6.33***	28.25***	34.94***	17.53***
	(1.16)	(0.98)	(0.71)	(3.92)	(7.87)	(2.88)
Observations	11,250	18,132	61,085	21,015	23,630	20,926
R^2	0.20	0.23	0.29	0.15	0.07	0.19
Note:						*p<0.1; **p<0.05; ***p<0.01

Panel B: persistence of indicator $1(FXTransactionIncome_{i,t} \neq 0)$

	1(FX Transaction Income$_t \neq 0$)					
	USA	EUR	JPN	TWN	KOR	IND
	(1)	(2)	(3)	(4)	(5)	(6)
1(FX Transaction Income$_{t-1} \neq 0$)	0.54***	0.80***	0.77***	0.58***	0.80***	0.73***
	(0.04)	(0.03)	(0.01)	(0.09)	(0.02)	(0.02)
Constant	0.45***	0.15***	0.12***	0.39***	0.19***	0.20***
	(0.04)	(0.02)	(0.01)	(0.09)	(0.02)	(0.02)
Observations	11,250	18,132	61,085	21,015	23,630	20,926
R^2	0.24	0.65	0.59	0.35	0.64	0.54
Note:						*p<0.1; **p<0.05; ***p<0.01

Panel A reports estimates from the regression

$$\frac{|FXTransactionIncome_{i,t}|}{Assets_{i,t}} = \alpha + \rho \frac{|FXTransactionIncome_{i,t-1}|}{Assets_{i,t-1}} + \varepsilon_{i,t}$$

for the six countries in our sample. $|FXTransactionIncome_{i,t}|$ denotes the absolute value of FX transaction income for firm i in year t. α denotes a constant. Panel B reports estimates from the regression

$$1(FXTransactionIncome_{i,t} \neq 0) = \alpha + \rho \times 1(FXTransactionIncome_{i,t-1} \neq 0) + \varepsilon_{i,t}$$

Here $1(FXTransactionIncome_{i,t} \neq 0)$ denotes an indicator variable taking the value 1 if firm i reports a non-zero value for FX transaction income in year t, and 0 if the firm reports a (non-missing) zero value for FX transactionn income. Standard errors are reported in parentheses and are double-clustered by firm and year.

D.5 Determinants of FX transaction income

Tables D9 and D10 consider robustness checks in the study of the determinants of FX transaction income (cf. Table 1 in the main text), either replacing foreign currency debt by total debt or adding foreign sales shares to our benchmark specification.

Table D9. Determinants of Firms' Exposure to FX Transaction Risk: Full Sample without Foreign Currency Debt

	FX Transaction Income$_t$/Assets$_{t-1}$ (basis points)						
	USA	EUR	JPN	TWN	KOR	IND	Pooled
Exchange rate change Δs_t (%)	-0.61^{**}	-0.45^{***}	-0.56^{***}	-4.80^{***}	-1.15^{**}	1.63^{**}	-0.71^{***}
	(0.28)	(0.13)	(0.09)	(0.35)	(0.56)	(0.67)	(0.13)
$\Delta s_t \times$Industry Net Exports / Output	0.55	-0.56	-4.19^{***}	-13.50^{***}	-7.13^{**}	-2.66	-7.05^{***}
	(1.36)	(0.75)	(0.57)	(1.02)	(2.61)	(1.70)	(1.11)
$\Delta s_t \times$Total Debt$_{t-1}$/Assets$_{t-1}$	-1.88^{*}	-0.23	0.67^{***}	4.49^{**}	7.42^{***}	2.45^{***}	3.42^{***}
	(1.11)	(0.44)	(0.24)	(1.96)	(2.33)	(0.68)	(0.77)
$\Delta s_t \times$Cash$_{t-1}$/Assets$_{t-1}$ (std.)	-0.52^{***}	-0.37^{***}	-0.07	-2.49^{***}	-0.93^{***}	-0.14	-0.32^{***}
	(0.18)	(0.10)	(0.05)	(0.54)	(0.19)	(0.14)	(0.08)
$\Delta s_t \times$Net Trade Credit$_{t-1}$/Assets$_{t-1}$ (std.)	-0.20	-0.20^{**}	-0.01	-1.91^{***}	-0.73^{***}	-0.63^{**}	-0.18^{***}
	(0.16)	(0.08)	(0.03)	(0.19)	(0.21)	(0.30)	(0.07)
Fixed Effects				Firm			
Observations	11,940	17,992	59,843	20,913	23,487	19,723	153,898
R^2	0.22	0.16	0.15	0.38	0.13	0.24	0.15
Note:							*p<0.1; **p<0.05; ***p<0.01

This table reports the sensitivity of FX transaction income to changes in exchange rates, obtained from the following panel regression:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t}} = \alpha_i + \beta \Delta s_t + \Gamma' \left(\Delta s_t \times X_{i,t-1}\right) + \varepsilon_{i,t},$$

where the dependent variable is converted to basis points (i.e. the original ratio is multiplied by 10^4), Δs_t denotes the change in the exchange rate in percentage points, with a positive value indicating an appreciation of the local currency, α_i denotes firm fixed effects, and the vector $X_{i,t}$ corresponds to the firm characteristics: total debt, industry-level net exports (as a fraction of gross output), the ratio of cash to assets, and the ratio of net trade credit to assets. The last two controls are standardized to have zero mean and unit standard deviation in each country. The sample consists of firms with non-missing values for FX transaction income and other firm characteristics. Standard errors are reported in parentheses and are double-clustered by firm and year.

Table D10. Determinants of Firms' Exposure to FX Transaction Risk: Subsample with Foreign Sales Share

	FX Transaction Income$_t$/Assets$_{t-1}$ (basis points)						
	USA	EUR	JPN	TWN	KOR	IND	Pooled
Exchange rate change Δs_t (%)	-1.07^{***}	-0.29^{***}	-0.47^{***}	-3.29^{***}	-0.70^{*}	2.07^{***}	0.20
	(0.33)	(0.09)	(0.07)	(0.35)	(0.39)	(0.39)	(0.23)
$\Delta s_t \times$Industry Net Exports / Output	-0.04	-0.16	-2.95^{***}	-9.43^{***}	-7.66^{***}	-3.24	-7.97^{***}
	(1.97)	(0.72)	(0.63)	(1.62)	(2.40)	(2.24)	(1.07)
$\Delta s_t \times$Foreign Currency Debt$_{t-1}$/Assets$_{t-1}$	2.17	5.13^{*}	19.43^{***}	50.89^{***}	65.44^{***}	18.89^{***}	26.86^{***}
	(4.79)	(2.46)	(6.39)	(6.56)	(10.40)	(3.75)	(3.73)
$\Delta s_t \times$Cash$_{t-1}$/Assets$_{t-1}$ (std.)	-0.16	-0.34^{***}	-0.33^{***}	-3.00^{***}	-1.53^{***}	-0.39^{*}	-0.61^{***}
	(0.18)	(0.09)	(0.07)	(0.42)	(0.22)	(0.21)	(0.13)
$\Delta s_t \times$Net Trade Credit$_{t-1}$/Assets$_{t-1}$ (std.)	-0.07	-0.15^{*}	-0.02	-1.89^{***}	-1.40^{***}	-0.65^{**}	-0.26^{***}
	(0.22)	(0.08)	(0.06)	(0.29)	(0.45)	(0.26)	(0.08)
$\Delta s_t \times$Foreign Sales Share$_{t-1}$	0.27	-0.76^{**}	-4.37^{***}	-3.67^{***}	-8.88^{***}	1.32	-2.37^{***}
	(0.78)	(0.34)	(0.49)	(0.93)	(1.62)	(2.21)	(0.52)
Fixed Effects				Firm			
Observations	6,742	12,061	20,725	11,078	7,419	9,773	67,798
R^2	0.27	0.20	0.31	0.44	0.35	0.30	0.26
Note:							*p<0.1; **p<0.05; ***p<0.01

This table reports the sensitivity of FX transaction income to changes in exchange rates, obtained from the following panel regression:

$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t}} = \alpha_i + \beta \Delta s_t + \Gamma' \left(\Delta s_t \times X_{i,t}\right) + \varepsilon_{i,t},$$

where the dependent variable is converted to basis points (i.e. the original ratio is multiplied by 10^4), Δs_t denotes the change in the exchange rate in percentage points, with a positive value indicating an appreciation of the local currency, α_i denotes firm fixed effects, and the vector $X_{i,t}$ corresponds to the firm characteristics: foreign currency debt, the share of foreign sales (between 0 and 1), industry-level net exports (as a fraction of gross output), the ratio of cash to assets, and the ratio of net trade credit to assets. The last two controls are standardized to have zero mean and unit standard deviation in each country. The sample consists of firms with non-missing values for FX transaction income and other firm characteristics. Standard errors are reported in parentheses and are double-clustered by firm and year.

D.6 FX transaction income passthrough to pre-tax profits

In the main text, we ignore corporate taxes to assess the passthrough of FX transaction income to pre-tax profits. FX transaction income is generally treated as taxable income (even if the FX transaction gains are losses have not yet been realized), thus the presence of corporate taxes mechanically reduces the passthrough of FX transaction income to post-tax income. To measure this passthrough to post-tax income, we estimate a similar regression to Equation (4), but replacing the firm's pre-tax income with its ordinary income, which deducts corporate taxes paid.[38] Table D11 reports the estimated passthrough coefficients for ordinary (post-tax) income. We again obtain positive and statistically significant coefficient estimates, although they are smaller in magnitude than the estimated passthrough coefficients for pre-tax income due to the effect of corporate taxes. FX transaction gains and losses thus have a large effect on firms' final profits, even after accounting for the potential effects of operational hedging, offsetting effects of exchange rate movements on future sales, and corporate taxes.

[38] In the Compustat Global Annual Fundamentals file, the income before extraordinary items variable (item code `ib`) contains fewer non-missing observations than the two net income variables (item codes `nicon` for consolidated net income, and `ninc` for non-consolidated net income).

Table D11. FX Transaction Income and Firms' Post-Tax Profits

	Ordinary Income$_t$/Assets$_{t-1}$						
	USA	EUR	JPN	TWN	KOR	IND	Pooled
FX Trans. Income$_t$/Assets$_{t-1}$	0.84***	0.80***	0.47***	0.77***	0.59***	0.67***	0.64***
	(0.25)	(0.26)	(0.11)	(0.12)	(0.07)	(0.08)	(0.05)
Fixed Effects	Firm, Country-Industry-Year						
Observations	8,822	13,503	53,459	16,596	17,743	14,845	124,968
R^2	0.72	0.63	0.46	0.62	0.51	0.65	0.61
Note:							*p<0.1; **p<0.05; ***p<0.01

This table reports estimates from the regression

$$\frac{OrdinaryIncome_{i,t}}{Assets_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \beta \frac{FXTransactionIncome_{i,t}}{Assets_{i,t-1}} + \varepsilon_{i,t}$$

for the six countries in our sample. α_i denotes firm fixed effects, and $\theta_{Industry(i),t}$ denotes industry-year fixed effects (based on the World Input-Output Table industry classification). The sample consists of firm-year observations (i,t) for which firm i is continuously present in the sample from years $t-1$ to $t+2$, for consistency with the longer-horizon regression estimates reported in Figure 8. Standard errors are reported in parentheses and are double-clustered by firm and year.

D.7 Local effect of exchange rate on pre-tax profits

As a robustness check, we sort firms based on their contemporaneous FX transaction income (instead of their lagged values in the main text). Our estimates reported in Table D12 show that exchange rate fluctuations are associated with large income differences across firms with different exposures to FX transaction risk. Following a 10% appreciation of the local currency, firms in the top FX exposure quartile report income which exceeds that of comparable firms in the lowest FX exposure quartile by amounts varying from $10 \times 3.96 = 39.6$ basis points, i.e., 0.4% of total firm assets in Japan to $10 \times 21.16 = 211.6$ basis points, i.e., 2.1% in Taiwan. For comparison, the median value of the dependent variable across firm-year observations in all six countries is 4%. The estimated interaction coefficients are all positive and – with the exception of the U.S. – monotonically increasing across quartiles.[39]

[39]The variance of pre-tax income is larger for our U.S. sample of firms compared to the other countries, and the magnitude of firms' FX transaction income is relatively small as shown in Figure 4.

Table D12. Exchange Rates and Firm Profits, Sorting on Contemporaneous FX Transaction Income

	Pretax Income$_t$/Assets$_{t-1}$ (basis points)					
	USA	EUR	JPN	TWN	KOR	IND
Δ Exchange Rate (%) $\times$ 1(2nd FX exposure quartile)	14.38***	4.71***	2.19**	7.71	2.93*	3.26*
	(4.68)	(1.62)	(0.99)	(5.33)	(1.49)	(1.84)
Δ Exchange Rate (%) $\times$ 1(3rd FX exposure quartile)	11.36**	9.22***	3.41***	18.15***	7.77***	10.71***
	(4.69)	(1.68)	(1.05)	(4.64)	(2.15)	(2.27)
Δ Exchange Rate (%) $\times$ 1(4th FX exposure quartile)	18.51***	12.74***	3.96***	21.16***	14.49***	15.14***
	(4.93)	(3.20)	(0.96)	(5.06)	(2.60)	(2.84)
Fixed Effects	Firm, Industry-Year					
Lagged Controls	Log Assets, Cash / Assets, Leverage, Market-to-Book					
Observations	12,029	12,359	28,349	19,433	22,343	14,741
R^2	0.75	0.71	0.60	0.66	0.55	0.70
Note:						*p<0.1; **p<0.05; ***p<0.01

This table reports estimates from the regression

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Industry(i),t} + \Delta s_t \times \sum_{k=2}^{4} \lambda_k 1(\text{FX exposure quartile}_{i,t} = k) + \Gamma' X_{i,t-1} + \varepsilon_{i,t}$$

for the six countries in our sample. The sample consists of firm-year observations (i,t) with non-missing and non-zero FX transaction income in year t. The dependent variable is converted to basis points (i.e. the original ratio is multiplied by 10^4). Δs_t denotes the change in the exchange rate in percentage points, with a positive value indicating an appreciation of the local currency. α_i denotes firm fixed effects, and $\theta_{Industry(i),t}$ denotes industry-year fixed effects (based on the World Input-Output Table industry classification). FX exposure quartile$_{i,t} \in \{1,2,3,4\}$ denotes the FX exposure quartile i is assigned in year t, based on the value of the ratio FX Transaction Income$_{i,t}$/Assets$_{i,t-1}$ and the sign of the exchange rate change Δs_t as described in Section 5. The set of lagged firm-level control variables $X_{i,t-1}$ includes log total assets, the ratio of cash to total assets, total leverage, and the market-to-book ratio for the firm's assets. Standard errors are reported in parentheses and are double-clustered by firm and year.

D.8 FX Transaction Income and Other Investment Measures

Table D13 report two-stage least square estimates of the response of several measures of firm-level investment, using the same specification as in Table 5 in the main text.

- The change in total long-term assets (defined as non-current assets, i.e. total assets minus current assets) is our most comprehensive measure of investment, reflecting investment in both tangible and intangible assets. The response for this measure of investment one year after the shock is 16 cents for every dollar of FX transaction income.

- The change in property, plant and equipment (net of depreciation) includes only firms' investment in tangible fixed assets. The response for this measure of investment one year after the shock drops from 16 cents to 12 cents.

- Our third measure of investment - capital expenditures minus proceeds from the sale of fixed assets - is constructed using information from the statement of cash flows. This measure is available for a more limited set of firm-year observations in our sample (in particular, cash flow statement information is not available for firms in Japan before fiscal year 1999). The response of investment one year after the shock is the same as obtained with PPE.

Table D13. FX Transaction Income and Other Investment Measures: Non-Cumulative

	Δ Long-Term Assets	Δ PPE	CAPX - Sale of PPE
	Horizon $h = 0$, non-cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	0.13*	0.11*	−0.02
(passthrough-adjusted)	(0.07)	(0.06)	(0.06)
	Horizon $h = 1$, non-cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	0.16**	0.12**	0.12***
(passthrough-adjusted)	(0.06)	(0.05)	(0.04)
	Horizon $h = 2$, non-cumulative		
FX Trans. Income$_t$/Assets$_{t-1}$	−0.01	−0.02	0.02
(passthrough-adjusted)	(0.08)	(0.05)	(0.04)
Fixed Effects	Firm, Country-Industry-Year		
Observations	124,063	124,063	105,702
Note:			*p<0.1; **p<0.05; ***p<0.01

This table reports two-stage least squares estimates of the relationship between FX transaction income and other firm investment outcomes. In the first stage, we estimate a pooled regression of pre-tax income on contemporaneous FX transaction income with country-specific coefficients:

$$\frac{\text{Pre-tax Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \delta_{Country(i)} \frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + u_{i,t}$$

where α_i denotes firm fixed effects and $\theta_{Country(i),Industry(i),t}$ denotes country-industry-year fixed effects (based on the World Input-Output Table industry classification). The set of lagged firm-level control variables $X_{i,t-1}$ includes the ratio of ordinary (post-tax) income to total assets, log total assets, the ratio of cash to total assets, total leverage, and the market-to-book ratio for the firm's assets; the coefficients $\Gamma_{Country(i)}$ for these controls are also country-specific. In the second stage, we estimate a pooled regression of a selected firm outcome $Y_{i,t+h}$ (where $h \in \{0, 1, 2\}$) on the fitted values from the first stage regression and the same set of fixed effects and lagged firm-level control variables:

$$\frac{Y_{i,t+h}}{\text{Assets}_{i,t-1}} = \alpha_i + \theta_{Country(i),Industry(i),t} + \beta_h \frac{\widehat{\text{Pre-tax Income}}_{i,t}}{\text{Assets}_{i,t-1}} + \Gamma'_{Country(i)} X_{i,t-1} + \varepsilon_{i,t+h}$$

Each column presents estimates for a different firm outcome $Y_{i,t+h}$. "Δ Long-Term Assets" denotes the change in non-current assets (total assets minus current assets) from the end of year $t+h-1$ to the end of year $t+h$. "Δ PPE" denotes the change in property, plant and equipment (net of depreciation) from the end of year $t+h-1$ to the end of year $t+h$. "CAPX - Sale of PPE" denotes capital expenditures minus proceeds from the sale of fixed assets in year $t+h$. The sample consists of firm-year observations (i,t) with non-missing FX transaction income in years t through $t+2$. Capital expenditures (reported in the statement of cash flows) are available for fewer firms in our sample; in this column, we further restrict the sample to firm-year observations (i,t) with non-missing capital expenditures in years t through $t+2$. Standard errors are reported in parentheses and are double-clustered by firm and country-year.