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 this mechanism: 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. This finding indicates that many firms do not fully hedge financially the exchange rate risk that arises when selling goods or purchasing intermediate inputs abroad in foreign currency, when these transactions involve a delay between invoicing and payment.

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 transac-

tion 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' valuation 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

[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 appear disconnected from many real macroeconomic variables in developed countries. The puzzle remains to this day, although recent papers successfully link dollar exchange rates to aggregate capital flows (Kalemli-Ozcan and Varela, 2019, Camanho, Hau, and Rey, 2021, 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, 2020); (ii) the location choices of multinational firms (Goldberg and Kolstad, 1995); and (iii) the demand for skill labor (Maurin, Thesmar, and Thoenig, 2003). 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 preva-

[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), Niepmann and Schmidt-Eisenlohr (2019), Kohn, Leibovici, and Szkup (2020), Verner and Gyongyosi (2020), Salomao and Varela (2021), Kalemli-Ozcan, Liu, and Shim (2021), Keller (2021), Bengura, Matsumoto, and Safie (2022), Blanco, Drenik and Zaratiegui (2022), and Gyongyosi, Rariga and Verner (2022) 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.

lence of the U.S. dollar as the invoicing currency in international trade (Goldberg and Tille, 2009, Gopinath, 2016, Boz, Gopinath and Plagborg-Moller, 2017, 2019, Gopinath and Stein, 2018, Ito et al., 2018, and Boz et al., 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 (Lyonnet, Martin and Mejean, 2016, Bartram, 2019, and Berthou et al., 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

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, 2021) 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.

positions as of December 1997 from their Form 10-K SEC filings (more precisely, the "Footnotes to Financial Statements") and found that, under some assumptions, the estimated amounts of interest rate, currency, and commodity price risks hedged by large firms are modest relative to their sizes.

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.

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 re-

ceivables, 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

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

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 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 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 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

[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 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).

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 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.

[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.

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 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

[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.

U.S. dollars per foreign currency: an increase thus corresponds to an appreciation of the local currency.

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. Scaled by the total operating income reported by the same firms in the same year, aggregate FX

[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.

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 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.

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. 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] Even if some firms benefit from a local

[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.

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. 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

[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).

lagged firm characteristics that are potentially informative about firms' exposure to FX transaction risk. In firm-level regressions, FX transaction income is scaled by total assets instead of operating income to avoid biasing results with zero or very small values of the denominator. We focus on the role of foreign currency debt and international trade, 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.[15] Table 1 reports estimates of Equation (1) for the subsample of firm-year observations where foreign currency debt is available in

[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 has been extended to it by its 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.

[15]In the Appendix, Section C.4 describes the World Input-Output Database (WIOD) and our procedure for mapping NAICS codes reported in the Compustat Fundamentals files to the 56 WIOD industries.

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' 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.[16]

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).[17]

[16]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. 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.

[17]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

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 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 provides 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

remain negative and statistically significant for most countries, but are generally smaller in magnitude.

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 aggre-

gates, we build an asset-weighted, characteristic-specific loading in each country.[18] Recall that, at the aggregate level, local currency appreciation brings aggregate FX transaction 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

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

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

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 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 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, 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.[19] To check, we estimate a dynamic version of Equation (4), using *future* profits at

[19]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.

an horizon of h years ahead:

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

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

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.

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, such a firm reports a positive FX transaction income. Intuitively, by sorting firms on their FX transaction income when the yen appreciates, one recovers a cross-section of FX exposure (in this example, due to different levels of exports), from less exposed to more exposed firms. Likewise, when the yen depreciates, the Japanese firm in our example records a negative FX transaction income. Across firms, the larger the exports, the more negative the FX transaction income. By bunching together firms with the largest FX transaction income when the yen appreciates and the lowest FX transaction income when the yen depreciates, we group firms with the largest exports. 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 gains to those that tend to report losses 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. 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 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:

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

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.[20]

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 significant. Similar results obtain with the changes in the firms' property, plant and equipment (PPE, net of depreciation) and capital expenditures (net

[20] This decomposition describes all the possible use of cash flows and connects to the definition of FX transaction income. 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

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

of the sales in PPE) reported in Appendix Tables **??** and 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 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 (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 ad-

ditional 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.[21] 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 firm profits, and its signal of firms' exposure to FX shocks.

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.

[21] 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.

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 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.

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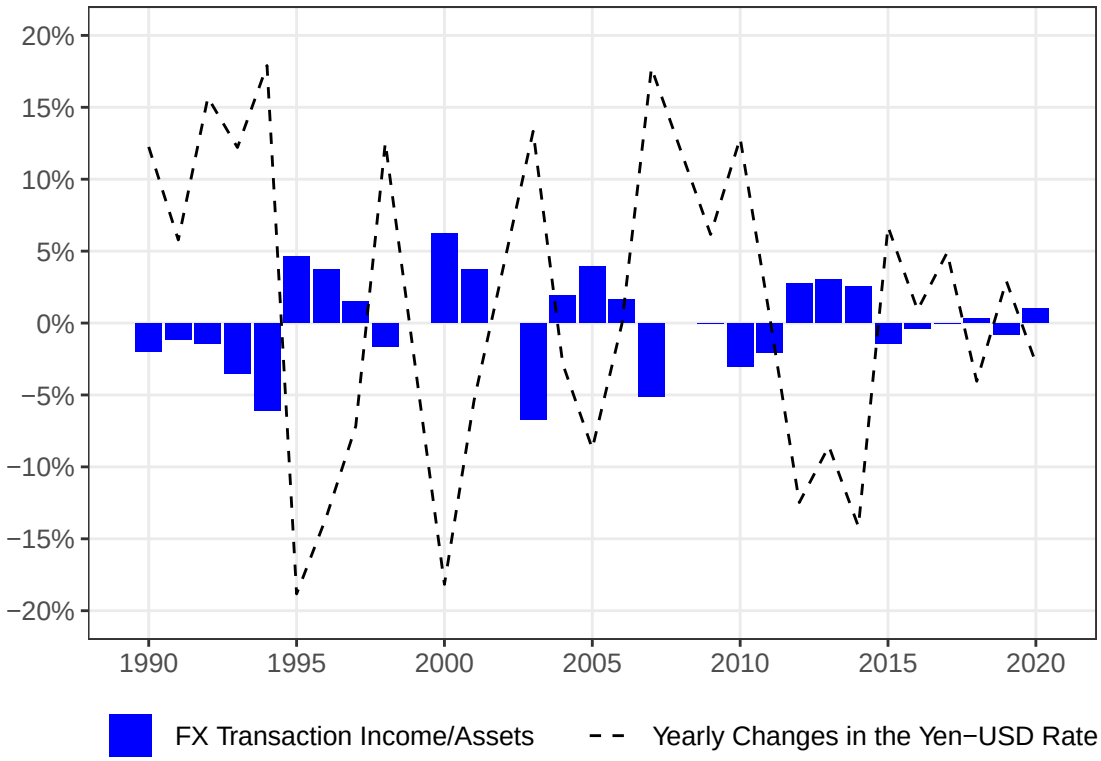
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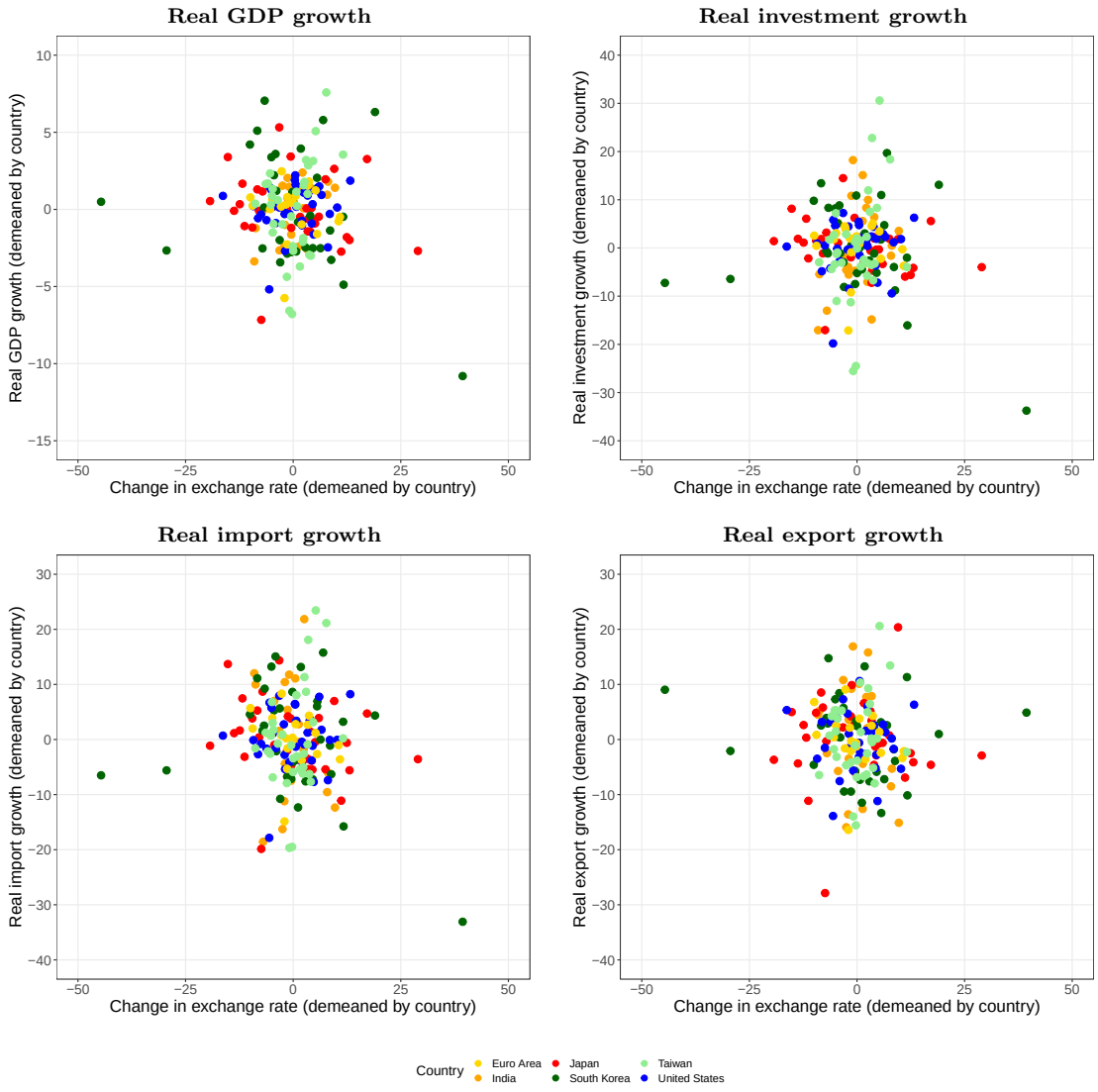
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Figure 1. Foreign Transaction Income: the Example of Nintendo Co.



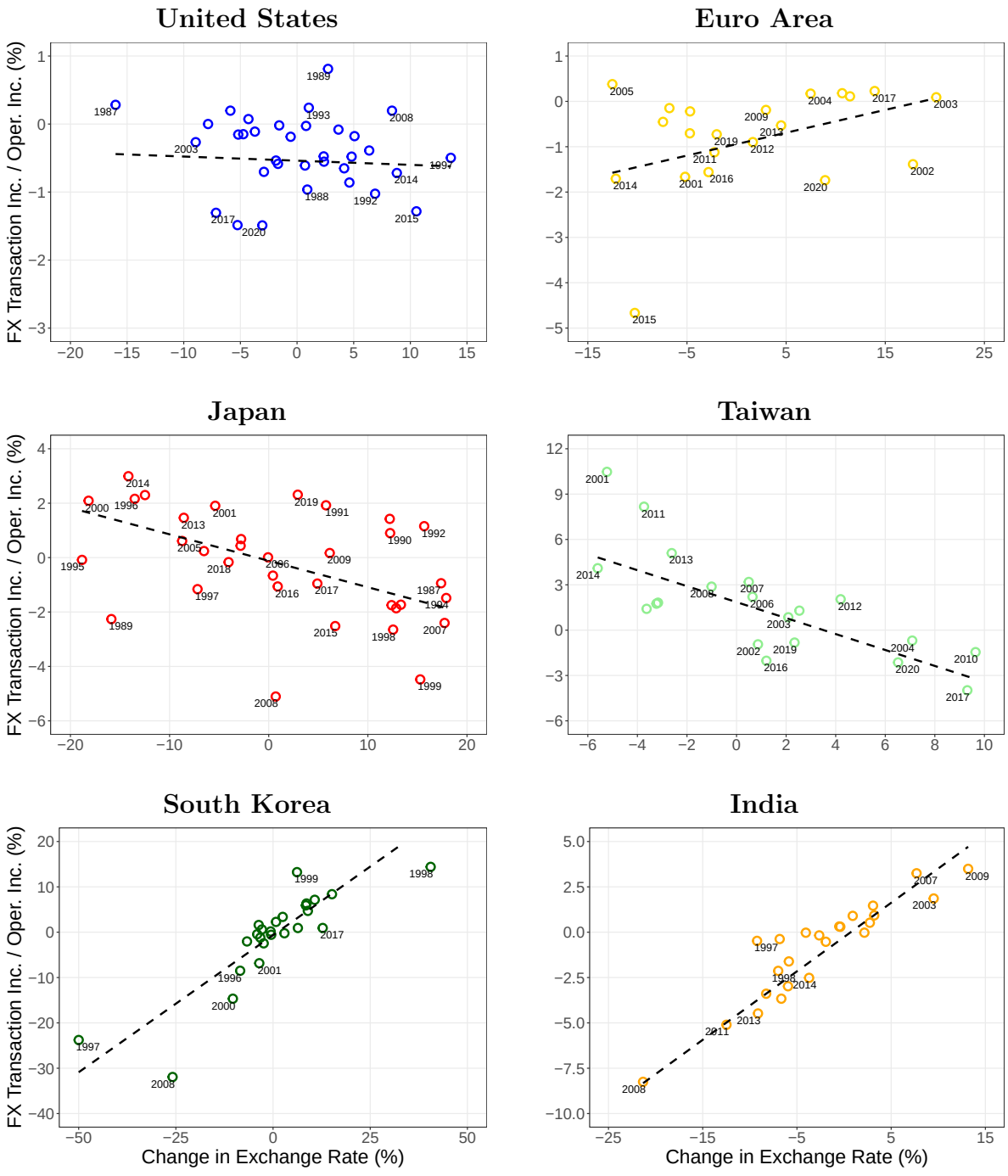
The figure above presents the FX transaction income (scaled by total assets) reported in Nintendo's consolidated statements of income. The dashed line represents the yearly change in the exchange rate defined in U.S. dollars per yen, such that a positive change corresponds to an appreciation of the yen.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



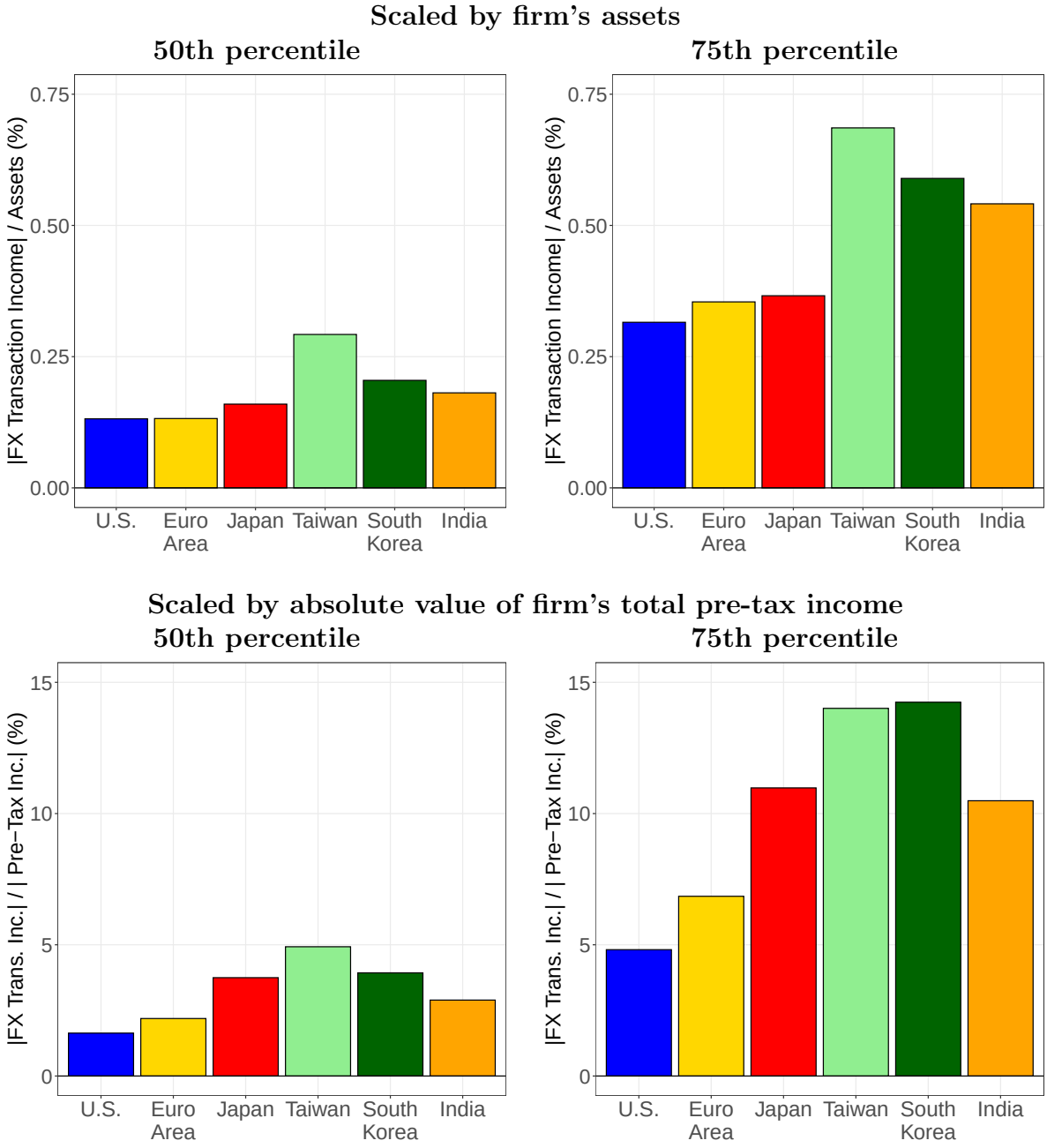
The figure above reports the annual changes in the nominal exchange rates of the euro area, India, Japan, South Korea, Taiwan, and the United States over the 1987–2020 period (on the horizontal axis) against the real GDP growth, real investment growth, real import and export growth. For the U.S., the 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



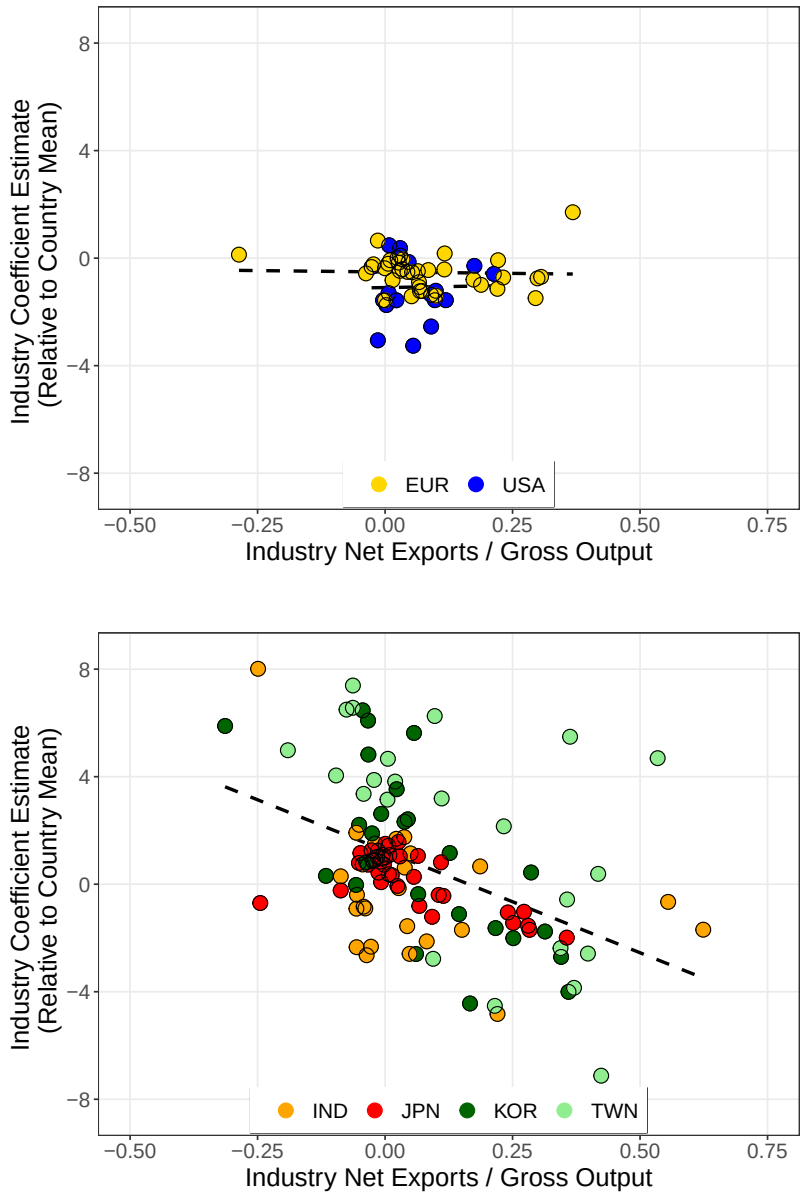
This figure presents aggregate FX transaction income in each year for the six countries and currency areas in our sample, as function of the annual change in exchange rate. Aggregate FX transaction income is the sum of FX transaction income across all firms in the sample for which a non-missing value 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

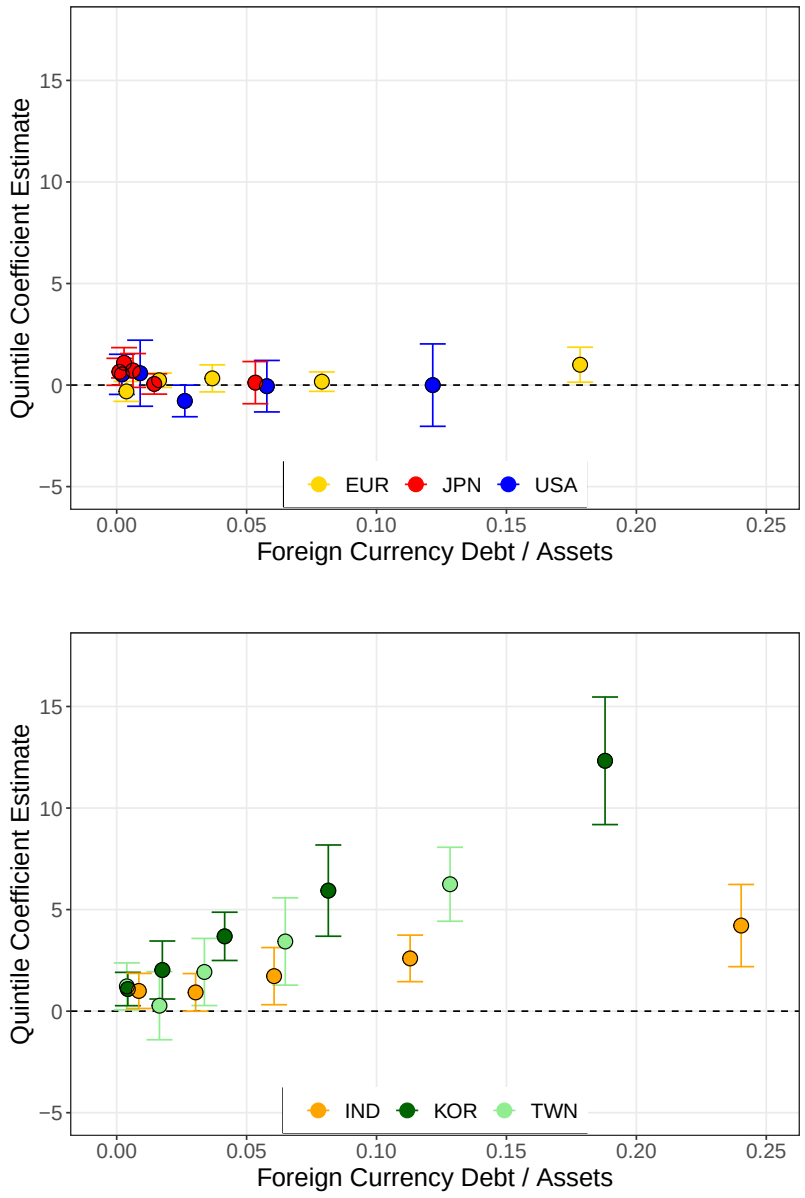


This figure presents, across industries, the estimated FX transaction income sensitivity to exchange rates, as function of the share of net exports in gross output in the corresponding industry. In each country, the FX transaction income sensitivity to exchange rates of industry j, denoted β_j, is estimated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

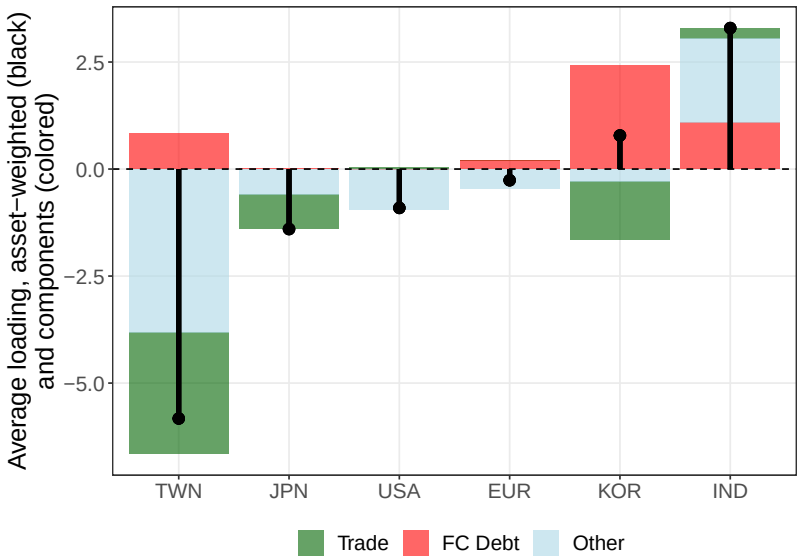


This figure presents the estimated FX transaction income sensitivity to exchange rates, as function of the average levels of foreign currency debt (relative to total assets). In each country and each year, firms are sorted by their amounts of foreign currency debt outstanding (relative to total assets) 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:

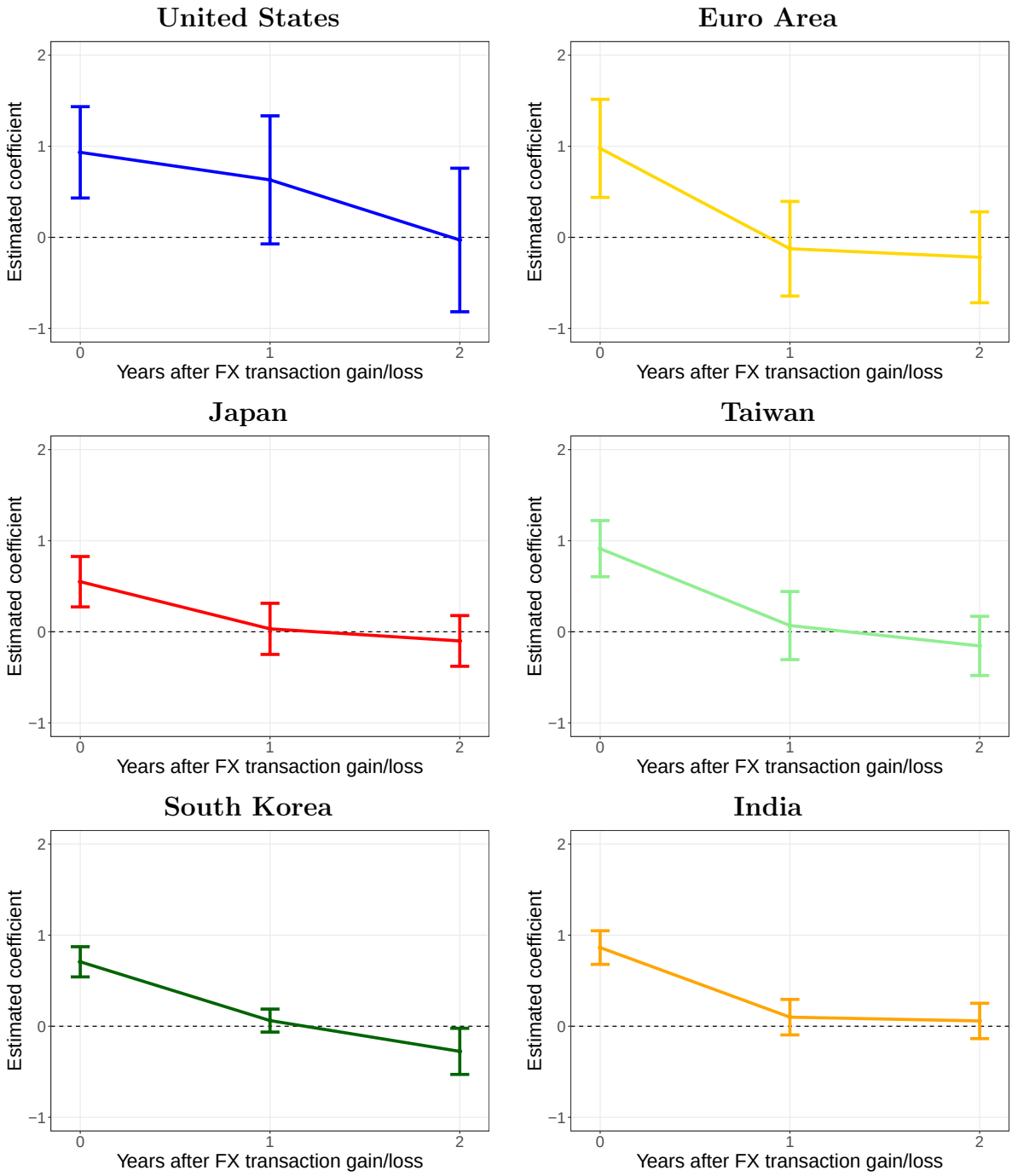
$$\frac{\text{FX Transaction Income}_{i,t}}{\text{Assets}_{i,t-1}} = \alpha_i + \beta \times \Delta s_{c,t} + \sum_{k=1}^{K} \gamma_k \times X_{i,k,t-1} \times \Delta s_{c,t} + \varepsilon_{i,t},$$

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.