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Dollar Exchange Rate Volatility and Productivity Growth in Emerging Markets: Evidence from Firm Level Data.

Kodjovi M. Eklou

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WORKING PAPER

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Dollar Exchange Rate volatility and Productivity Growth in Emerging Markets: Evidence from Firm Level Data

Prepared by Kodjovi Eklou*

Authorized for distribution by Lamin Leigh
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ABSTRACT: This paper examines the impact of Dollar exchange rate volatility on firm productivity in Emerging Markets economies (EMs). Using firm level data covering 16 EMs over the period 1998 -2019, the paper shows that dollar exchange rate volatility reduces firm productivity growth. Exploring channels, it finds that the results are driven by countries with low level of financial development, high dollar invoicing, high bilateral trade with the US, high collective bargaining coverage and open capital account. Exploring the role of policy, it finds that Foreign Exchange Interventions (FXI) dampen this impact on firm productivity. Further, exploiting firm level data, the paper shows that dollar exchange rate volatility operates also through the financial friction channel, reducing contemporaneous investments, especially at firms with low liquidity buffers and weak balance sheet (high leverage). The role of financial frictions is confirmed through the finding that younger firms, more likely to face financial constraints, are also found to be more vulnerable to dollar exchange rate volatility. In addition, we also find evidence of a large and persistent effect on firms with highly irreversible investment, lending support for the real option channel of uncertainty on the dollar exchange rate. These findings are robust to a battery of tests, including controlling for uncertainty, financial crises and using an instrumental variable strategy exploiting US monetary policy shocks as an exogenous source of variation in dollar exchange rate volatility.

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Author's E-Mail Address: keklou@imf.org

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WORKING PAPERS

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¹ "The author(s) would like to thank" footnote, as applicable.

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Introduction

The exchange rate plays an important role in Emerging Market economies (EMs) for different reasons including i) the influence of the exchange rate on demand in small open economies which tends to be large, ii) the exchange rate often constitutes a key variable for private sector expectations about inflation, and iii) exchange rate fluctuations produce large balance sheet effects when households and firms have foreign currency assets and liabilities (BIS, 2008). Further, the dominant currency paradigm (Gopinath et al, 2020) suggests a central role for the USD in international transactions including in EMs. In addition, the dollar also affects credit conditions as the Bank for International Settlements (2014) estimates that globally, around 80 percent of bank trade credit is denominated in US dollars. Finally, fluctuations in USD have been shown to impact EMs not only through the trade channels but also through financial channels, with real macroeconomic implications that could go in opposite directions (see for instance Avdjiev et al, 2019).

In this paper going beyond just exchange rate depreciation or appreciation, I ask the following research question: Do dollar exchange rate volatility have implications for productivity growth in EMs? If yes, what are the channels? In other words, the focus here is on uncertainty regarding the dollar exchange rate. Our starting point is the theoretical framework developed by Aghion et al (2009) where exchange rate volatility induced by both real and financial aggregate shocks, affect the growth performance of credit-constrained firms. They argue that in presence of wages rigidities to exchange rate movements (that is wages cannot be adjusted to variations in the nominal exchange rate), following an appreciation, the earnings of firms decrease and consequently their ability to borrow to face idiosyncratic liquidity shocks and thus innovate in the long run.¹ At the same time while depreciations have the opposite effects, the negative effect of exchange rate appreciations will not be fully offset because of the existence of credit constraint. This mechanism implies that the impact of exchange rate volatility would disproportionately affect firms that are financially constrained or with high liquidity needs, especially in countries with a low level of financial development.

Using firm level data from Orbis, this paper examines the impact of dollar exchange rate volatility on 16 EMs over the period 1998-2019. We begin by providing empirical evidence for the average effect of dollar exchange rate volatility on firm level productivity and Investment. The results show that dollar exchange rate volatility shocks, contemporaneously reduce investment (lead to a delay in investment) while reducing productivity with a one-year lag, and this effect is short-lived. The paper then undertakes an analysis of the potential channels with two dimensions including cross-country and firm level heterogeneities. First, regarding cross-country heterogeneities, we explore the role of financial development following Aghion et al (2009), the well-known

¹ The borrowing capacity of firms in this model depends on their current earnings and with fixed wage costs in local currency, firms exporting are unable to fully pass-through cost changes to importing partners when the exchange rate fluctuates. Exchange rate fluctuations could also affect firm leverage, especially foreign currency denominated debt, with appreciations increasing the net worth of firms holding local currency assets which can then borrow more, while the opposite is true for depreciations (See Kalemli-Ozcan et al, 2021). However, the focus in this paper is on the volatility of exchange rate rather than depreciations or appreciations alone.

trade channel through the role of dependence on bilateral trade with the US, the role of dollar invoicing motivated by the related literature (see for instance Gopinath et al, 2020; Boz et al, 2022 and, Berthou et al, 2022) but also the role of wage setting institutions such as collective bargaining given the importance of wage rigidity in the framework of Aghion et al (2009) and finally the role of capital account openness (see for instance Cavallino, 2019 on the role of capital flows in affecting exchange rate movements).

The findings on the cross-country heterogeneities are as follows. The effect of exchange rate volatility on productivity is magnified in EMs with a low level of financial development, signaling the role of financial constraint, and in countries with high proportion of workers covered by collective bargaining agreement suggesting an important role for wage rigidities. These first two results are consistent with Aghion et al (2009). Further, we also find supportive evidence for the trade channel as we find that trade exposure to the US amplifies the impact of dollar exchange rate volatility. Next, we also find an important role for dollar invoicing and capital account openness.² Finally, we also show that Foreign Exchange Interventions, by leaning against excessive volatility in exchange rates (see for instance Cavallino, 2019), could mitigate this negative impact on productivity.

Firm level heterogeneities are then explored to analyze the role of liquidity, balance sheet weakness (leverage) but also investment irreversibility in mediating these effects on investment. Consistently with the liquidity channel identified in Aghion et al (2009) as well as our cross-country finding on the role of financial development, we find that dollar exchange rate volatility disproportionately affects firms with high liquidity needs.³ In addition, firms with weak balance sheets, that is highly leveraged, which could also face significant financial constraint for new investments and or incentivize shareholders to decide on new investments (see for instance Myers, 1977; Li et al, 2020) are more affected by the dollar exchange rate volatility. Next, the financial friction channel is corroborated by the finding that younger firms, also more subject to financial constraints (see Cloyne et al, 2023) are more vulnerable to dollar exchange rate uncertainty. Finally, following Husted et al. (2020), the paper explicitly tests the role of the 'real options' channel of uncertainty (Bertola and Caballero, 1994 and, Bloom, 2009) by conditioning the impact of dollar exchange rate volatility on the level of irreversibility of investment. The results show strong evidence for the 'real options' channel as firms with highly irreversible investment see larger and more persistent delay in investments following a dollar exchange rate volatility shock. Overall, our findings suggest the relevance of both the trade and the financial friction channels of the dollar exchange rate volatility with the implication that uncertainty on the dollar exchange rate plays an importance role in EMs.

² See Lakdawala et al (2021) who find that US monetary policy uncertainty spillover to bond yields in EMs, in particular in countries with open capital account, through a flight to safety mechanism as investors pull capital out of countries that are perceived to be risky.

³ See also Kalemli-Ozcan et al. (2016) who show that illiquidity is the main source of financial constraint that hinders firm investment.

Our baseline empirical strategy relied on the local projection framework (Jordá, 2005) while controlling for financial crises as well as measures of uncertainty and exploiting various sources of heterogeneity (across countries and firms). We finally complement this framework with an instrumental variable approach. We instrument country level dollar exchange rate volatility by exogenous US monetary policy shocks and their interaction with country's average level of dollar invoicing in imports. This approach allows for a heterogeneous response across countries and draws from the large literature on spillovers from US monetary policy shocks to EMs (see for instance Rey, 2016; and Miranda-Agrippino and Rey, 2020). Further, countries with high dollar invoicing are also shown to experience greater dollar exchange rate pass-through to import prices (Boz et al., 2022), and monetary policy in the dominant currency country have strong spillovers to the rest of the world (Gopinath et al, 2020). The results show qualitatively consistent but larger impact of dollar exchange rate volatility compared to the baseline approach.

This paper is the first to the best of our knowledge to investigate the impact of dollar exchange rate volatility for productivity growth in EMs and using firm level data. It is closely related to Aghion et al (2009) and makes several contributions to this seminal paper.⁴ First, based on the role of USD as a dominant currency (see for instance Gopinath et al, 2020; Boz et al, 2022 and, Berthou et al, 2022) and the balance sheet effects of the dollar exchange rate (see Avdjiev et al, 2019), we investigate the role of dollar exchange rate volatility rather than effective exchange rate as done in Aghion et al (2009). Second, in addition, to the role of financial development at the country level, we provide evidence also for the role of dollar invoicing, the dependency on trade with the US, collective bargaining coverage (suggestive role of wage rigidities – highlighted in the theoretical framework in Aghion et al, 2009 but not tested empirically), the role of capital account openness and the mitigating role of foreign exchange interventions. Third, we use firm level data to explicitly test the liquidity channel. Fourth, the focus in this paper is on the implication of short-term volatility in the dollar exchange rate volatility, while Aghion et al (2009) focused on long-term volatility (over 5-year period). This paper shows that short-term dollar exchange rate volatility could have implication for productivity growth, and thus suggests implications for aggregate volatility. Finally, we exploit US monetary policy shocks to identify an exogenous source of variation in the dollar exchange rate volatility.

The paper is also related to the literature on the spillovers from US monetary policy, in particular, those using firm level data (see for instance Cloyne et al, 2023; Arbatli et al, 2022; Li et al., 2020; Di Giovanni et al, 2022). In addition to complementing this literature by looking at implications for productivity growth, the paper also shows that US monetary policy shocks could have spillover effects to emerging markets through the effect on the second moment of dollar exchange rate compared to the traditional exchange rate channel through the first moment (depreciations and appreciations). It makes the same contribution regarding the volatility of the exchange rate to the literature on the effect of exchange rate fluctuations, in particular works with an emphasis on the financial channel (see for instance Avdjiev et al, 2019; Kalemli-Ozcan et al, 2021). The paper also

⁴ Hsu et al (2022) also show that currency volatility significantly reduces both innovation output measured as patents and inputs measured as R&D spendings at the firm level.

relates to recent work by Lakdawala et al (2021) showing that spillovers from US monetary policy uncertainty to global bond yields are larger compared to those from the first moment, that is, surprise changes in the expected US policy rates.

Finally, the paper also contributes to the recent literature on the implications of dollar invoicing (see for instance, Gopinath et al, 2020; Boz et al, 2022 and, Berthou et al, 2022). It provides evidence for dollar invoicing amplifying the transmission of US monetary policy to exchange rate volatility with an impact on productivity and suggests a role for a financial channel of dollar invoicing. While Berthou et al (2022) examined the role of dollar invoicing in mediating financial shocks through hedging costs in periods of tension in the foreign exchange market, inducing a reduction in exports, the emphasis in this paper is on financial friction channel of dollar exchange rate volatility and implication for productivity growth.

The rest of the paper is organized as follows. Section I discusses the data. Section II is dedicated to the empirical analysis including, the identification strategy, the results and different robustness checks. Finally, section III concludes.

I. Data

To explore the impact of dollar exchange rate volatility on productivity in EMs, we use both cross-country and firm level data for 16 emerging markets over the period 1998 - 2019. The dataset is an unbalanced panel data of firms across countries. Table A1 in Appendix shows the summary statistics.

Firm level data.

The firm level data comes from Orbis, provided by Bureau van Dijk. A major advantage of this database is that it includes both listed and unlisted firms. The sample includes all non-financial firms. Our measure of productivity is the firm level Total Factor Productivity, taken from Díez et al (2021). TFP estimates are obtained through the methodology developed by Akerberg et al (2015) and employing the gross output approach with cost of goods sold and tangible fixed assets as inputs. Further, countries are pooled within a given 2-digit NACE industry level classification. However, given potential methodological and data issues related in measuring TFP, we also use labor productivity (real value added per employee) in our robustness checks.

In addition to TFP, we use other firm level variables. Following Husted et al (2020), we compute investment rate as the ratio of capital expenditure over lagged total assets.⁵ Further, we calculate two measures of liquidity ratio including the current ratio and the quick ratio. The current ratio is obtained as ratio between current assets

⁵ Capital expenditure is measured as the sum of the change in tangible fixed assets and depreciation and amortization. We use an alternative measure of investment in robustness check focusing on intangible assets (the ratio is obtained as the change in intangibles asset over lagged total assets).

and current liabilities while the quick ratio is obtained cash and cash equivalent over current liabilities. These two measures are proxies for the ability of a firm to repay its current liabilities (obligations payable within the coming year) as they come due. All else being equal, a lower ratio implies that a firm will have more challenge meeting its financial obligations. Other firm level variables include firm age, total assets and leverage ratio defined as total debt over the Earnings Before Interest, Taxes, Depreciation and Amortization (EDITDA) (see for instance Ebeke and Eklou, 2017). Investment irreversibility is measured following Husted et al (2020) as the share of tangible fixed assets in lagged total assets. Firm level data have been winsorized at 5 percent to mitigate the influence of outliers.

Cross-Country data

Our main country level data is the dollar exchange rate volatility. We constructed two measures of yearly dollar exchange rate volatility. We follow an approach similar to Aghion et al (2009) and Krol (2014), and use the standard deviation of the log difference of monthly bilateral USD exchange rate (local currency units per USD) from IMF International Finance Statistics to calculate yearly volatility.⁶ For robustness check, we also computed an alternative measure of exchange rate volatility using the so-called canonical univariate Generalized Autoregressive Conditional Heteroskedasticity - GARCH (1,1) model following (Hansen and Lunde, 2005) based on monthly data of the first difference of the bilateral exchange rate. We ran the GARCH (1,1) model for each country using monthly data and we take the average standard deviation over the year. The two measures of exchange rate volatility are highly correlated (coefficient of correlation of 0.94).

Given that previous literature (Krol, 2014, Balcilar et al, 2016; and, Kido, 2016, Bartsch, 2019) has investigated the role of uncertainty as a determinant of exchange rate volatility, we control for country-specific uncertainty taking data from the World Uncertainty Index (Ahir et al, 2022). Further, we control for the output gap taken from the IMF World Economic Outlook to capture the cyclical position of the economy, trade openness measured as the share of total trade (exports and imports) in country's GDP, CPI inflation rate, the logarithm of real GDP per capita to account for country income level from the World Development Indicators (WDI) of the World Bank. We also use data on capital account openness from Chinn-Ito Database (Chinn and Ito, 2008), two proxies for the level of financial development from the WDI (domestic credit to private sector as share of GDP and the stock market capitalization as share of GDP).

Next, given our focus on dollar exchange rate, we use data on USD invoicing (share of export and import invoiced in USD) as well as bilateral trade (share of export to the US and import from the US as share of total exports and imports respectively) from Boz et al (2022). In addition, we use data on Foreign Exchange Intervention from Adler et al (2021). We use monthly series to calculate total FXI, summing over the calendar year which is then expressed in percent of yearly GDP. We also use data on the share of employees covered

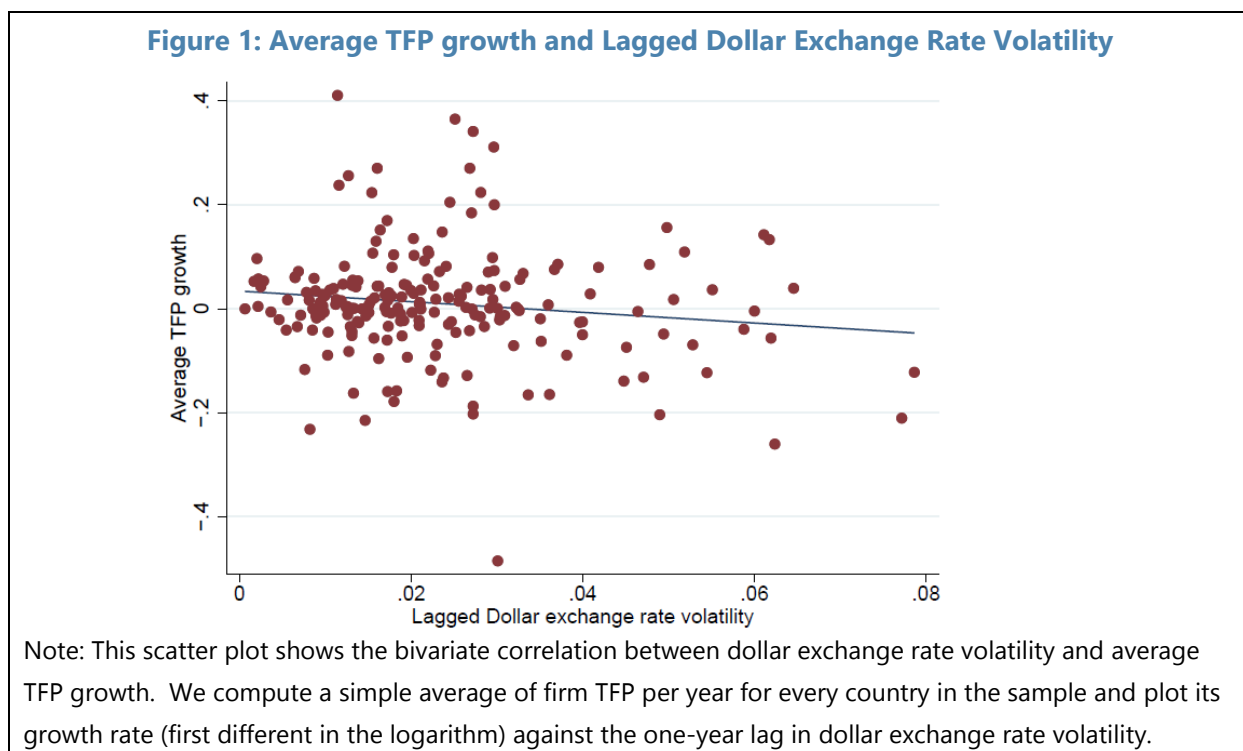
⁶ Aghion et al (2009) used the annual log differences in the effective real exchange rate and calculated the standard deviation over five years. Our focus in this paper is on short-term volatility in the dollar exchange rate.

by one or more collective agreements, from the International Labour Organization (ILO) and data financial crises including banking, currency and debt crises from Nguyen et al (2022).

Time-series Data

We use two-time series variables in our empirical analysis, including the VIX index and US monetary policy shocks. The VIX index, is taken from the Chicago Board Options Exchange (CBOE) as a proxy for macroeconomic uncertainty (Bloom, 2009) or financial uncertainty in the US (Charles et al, 2018). Finally, we use data on US monetary policy shock from Nakamura and Steinsson (2018). We aggregate the monthly shock series into annual shocks following Holm et al (2021). We complemented original series from 1998-1999 with updated series from 2000-2019 by Acosta (2022) and Acosta and Saia (2020). Figure A4 in the appendix shows the monetary policy shock series.

Figure 1 below shows a simple bivariate correlation between TFP growth and dollar exchange rate volatility. It depicts a negative and statistically significant correlation (-1.02) between average TFP growth and lagged dollar exchange rate volatility in the sample. In the empirical analysis we will investigate further this relationship taking into account potential confounders or covariates.



II. Dollar Exchange Rate Volatility and Productivity Growth: Empirical Analysis

A. Empirical Strategy

The empirical strategy to estimate the impact of dollar exchange rate volatility consists in five steps. In the first step, we estimate the average effect of exchange rate volatility on firm productivity using the local projection approach (Jordá, 2005). We estimate the following equation:

$$Y_{ft+h} - Y_{ft-1} = \theta^h \sigma_{ct}^{ER} + \beta_1^h X_{ft} + \beta_2^h Z_{ct} + \beta_3^h vix_t + \mu_f + \mu_{cs} + \xi_{ft+h} \quad (1)$$

Where Y is the logarithm of TFP of firm f in year t , σ_{ct}^{ER} is the bilateral dollar exchange rate volatility in country c in year t , X is a set of firm level controls including the logarithm of total assets, leverage ratio and the age of the firm; Z is a set of country level controls including the CPI inflation rate, output gap, the logarithm of real GDP per capita, trade openness, country-specific uncertainty index and financial crises; and the VIX index (vix); μ_f are firm fixed effects to account for time-invariant unobservable firm characteristics, μ_{cs} are country-sector fixed effects. Following Cloyne et al. (2023), We do not include other time or sector-time fixed effects as we want to interpret these coefficients as group specific impulse response functions (see specifications in equations 2, 3 and 4 below for group specifics), including any general equilibrium effects. Having firm level observations, the exchange rate volatility, measured at the country level is a common shock that is not identified in the presence of year fixed effects. Further we have included the VIX following related literature, which is solely time-varying and a common shock to all firms in all countries. Using year fixed effects implies that we do not have any variation left. Country-sector fixed effects are however included.

Second, we expand (1) by exploring the role of various channels as captured by cross-country heterogeneities and discussed earlier. We follow the semi-parametric approach of Cloyne et al. (2023) providing a flexible way to estimate the impact of dollar exchange rate volatility without any assumption about the functional form. We estimate the following equation:

$$Y_{ft+h} - Y_{ft-1} = \sum_{j=1}^J \theta^h \times \mathcal{T}[Z_c \in J] \sigma_{ct}^{ER} + \beta_1^h X_{ft} + \beta_2^h Z_{ct} + \beta_3^h vix_t + \mu_f + \mu_{cs} + \xi_{ft+h} \quad (2)$$

Where \mathcal{T} is an indicator function which equals 1 if country c 's average characteristic Z_c falls below or above the sample median. J denotes a specific group. Country with an average of a given characteristic above sample median are in the "high" group while those below are in the "low" group. These cross-country characteristics include the level of financial development, dollar invoicing, bilateral trade with the US and collective bargaining coverage. Note that we do not include the group dummy among regressors as we have firm fixed effects and

country-sector fixed effects that account for this in the specification. The remaining variables retain the same definition.

Exploring the role of financial development is directly related to the financial constraint channel highlighted by Aghion et al (2009) and discussed earlier. Dollar invoicing could amplify the vulnerability of firm's performance to dollar exchange rate volatility either through changes in input costs (imports) or through prices of output (exports). Boz et al., (2022) find that countries invoicing more in dollars tend to experience greater dollar exchange rate pass-through to their import prices and higher sensitivity of their trade volumes to fluctuations in these exchange rates. In addition, Berthou et al (2022) finds that the export performance of French firms in countries where imports are frequently invoiced in USD were vulnerable to rise in hedging cost following the liquidity squeeze during the euro area debt crisis in the second half of 2011. Further, countries that have larger share of their trade flows with the US will see their firms more exposed to dollar exchange rate volatility (standard trade channel). Wage rigidity plays an important role in the model developed by Aghion et al (2009), as it prevents firms from adjusting wage payment to variations in exchange rates, leading to a fluctuation in firm's earning. We use the share of employees covered by one or more collective agreements, to proxy the degree of wage rigidity or the tendency of wage setting institutions to lead to a downward wage rigidity preventing firms to unilaterally adjust wages.

Third, to explore the role of other cross-country characteristics such as the openness of the capital account and policy intervention such as FXI, we estimate a variant of equation (2) where we include an interaction term with the volatility in exchange rate to explore these nonlinearities. We estimate the following equation:

$$Y_{ft+h} - Y_{ft-1} = \theta^h \sigma_{ct}^{ER} + \delta^h \sigma_{ct}^{ER} \times Z_{ct-1} + \beta_1^h X_{ft} + \beta_2^h Z_{ct-1} + \beta_3^h vix_t + \mu_f + \mu_{cs} + \xi_{ft+h} \quad (3)$$

In this specification, we obtain the conditional impact of exchange rate volatility as $\theta^h + \delta^h \times Z_{ct-1}$. Exchange rate volatility may impact more countries that have an open capital account on the back of potentially induced volatility of capital flows. This specification allows policy to vary, and the lag would allow to reduce bias due to reverse causality as countries can either impose capital flow measures or intervene during a given episode of volatility. We explore the role of FXI as EMs central banks do intervene to smooth exchange rate movements. Recent research has shown that FXI can be effective in reducing exchange rate volatility (see for instance Daude et al, 2016)

Fourth, in order to explore channels at the firm level, we investigate the impact of exchange rate volatility on Investment and explicitly through the liquidity channel and others potential channels including the role of 'real options' theory for uncertainty through the irreversibility degree of investment (Husted et al, 2020) and the role of the strength in firm balance sheet captured by the size of leverage, given that highly leveraged firms could face significant financial constraint (Li et al, 2020). We estimate the following equation:

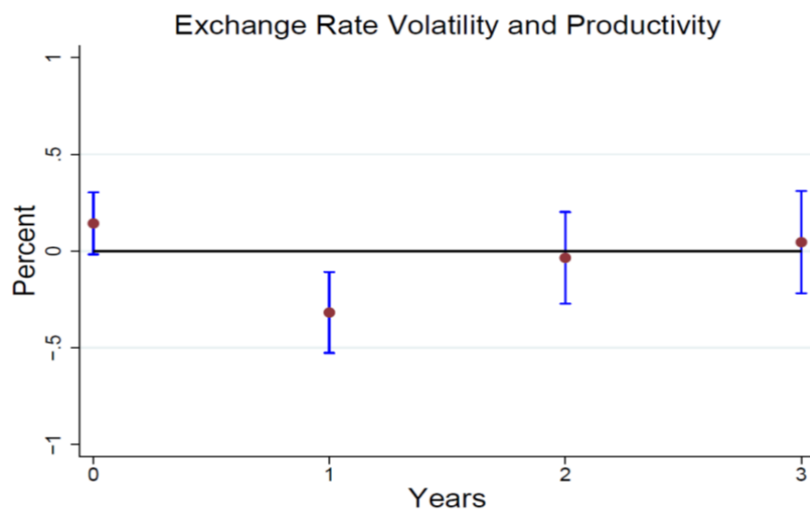
$$I_{ft+h} - I_{ft-1} = \sum_{j=1}^J \theta^h \times \mathcal{T}[X_{ft-1} \in J] \sigma_{ct}^{ER} + \sum_{j=1}^J \alpha^h \times \mathcal{T}[X_{ft-1} \in J] + \beta_1^h X_{ft} + \beta_2^h Z_{ct} + \beta_3^h vix_t + \mu_f + \mu_{cs} + \xi_{ft+h} \quad (4)$$

Where, I_{ft} is the logarithm of the investment ratio while other variables retain the same definition. In this specification, if the firm's characteristic in the year preceding the exchange rate volatility shock, X_{ft-1} falls above the 75th percentile, the firm is classified as part of the "high" group while if it falls below the 25th percentile, the firm is classified as part of the "low" group. α^h captures the effect of the lagged group, which vary across time. Aghion et al (2009) highlight that exchange rate volatility could affect investment and thus innovation and productivity especially in firms with high liquidity needs.

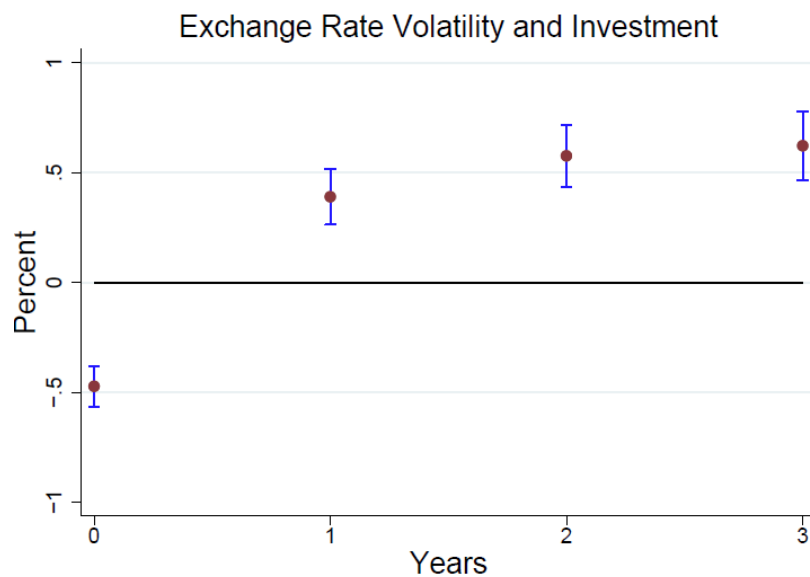
Finally, after being agnostic about the drivers of the dollar exchange rate volatility albeit accounting for its potential determinants such as uncertainty, the cyclical position of the economy, the VIX index and financial crises, we exploit an exogenous source of variation. Following the literature on the spillovers from US monetary policy to EMs (see for instance Rey, 2016; Li et al, 2020; and Miranda-Agrippino and Rey, 2020), we exploit the exogeneity of US monetary policy shocks from EMs' perspective and the fact that countries with high dollar invoicing are also shown to experience greater dollar exchange rate pass-through to import prices (Boz et al., 2022), and monetary policy in the dominant currency country have strong spillovers to the rest of the world (Gopinath et al, 2020). We instrument therefore the exchange rate volatility by the US monetary policy shock and its interaction with the country average dollar invoicing. We therefore allow for a heterogeneous response to US monetary policy shocks based on the average size of dollar invoicing.

B. Baseline Results

Figure 2 shows the average TFP response to a 0.01 standard deviation in dollar exchange rate. We find that dollar exchange rate volatility reduces TFP with one-year delay by about 0.3 percent. Our finding is consistent with the two-periods theoretical framework of Aghion et al (2009) where firms face a liquidity shock at the end of the first period and must decide whether to cover it (depending on their ability to do so) in order to survive and thereby innovating in the second period. Consistently, Figure 3 shows that dollar exchange rate volatility affects investment decisions contemporaneously, reducing investment by 0.5 percent. The finding in Figure 3 is similar to previous finding on how volatility could induce a delay in investment in EMs (see for instance Li et al, 2020). Figure 2 and Figure 3 together suggest that, by affecting current year investment, exchange rate volatility reduce future productivity. Overall, the baseline findings suggest a short-lived average impact of exchange rate volatility on productivity growth.

Figure 2: Average Effect of Dollar Exchange Rate Volatility on Productivity

Note: This Figure shows results from Equation (1). 90 percent confidence bars with robust standard errors are shown. The impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure 3: Average Effect of Dollar Exchange Rate Volatility on Investment

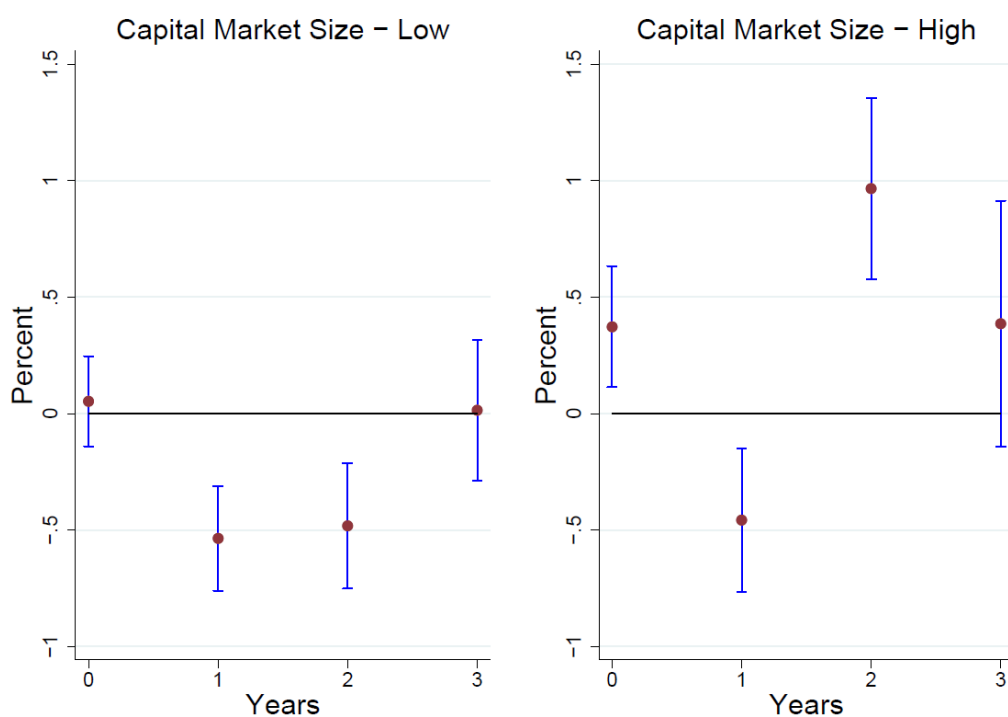
Note: This Figure shows results from specification in Equation (1) for Investment. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

C. Exploring Channels

Cross-country Heterogeneity

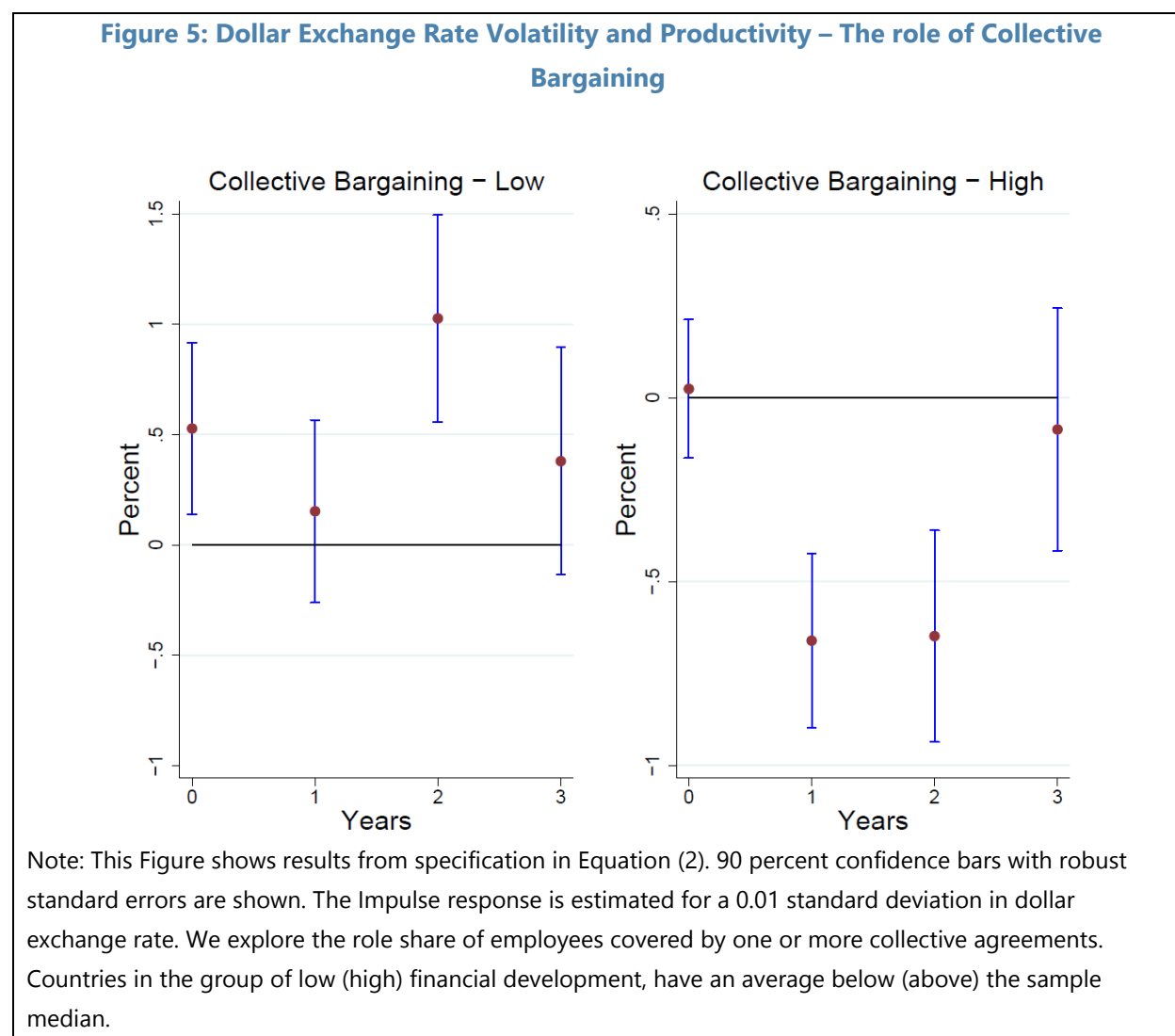
In this section, we explore different channels as discussed previously, exploiting cross-country variation following the specification in Equation (2) and (3) in Figures 4-7. Figure 4 shows that, consistently with Aghion et al. (2009), exchange rate volatility affects disproportionately firms in countries with low financial development. More specifically, Figure 4 shows that dollar exchange rate volatility has a persistent effect on productivity growth in countries with low a level of financial development. However, firms in countries with highly developed financial system, recover quickly after a year, as they would be less financially constrained. This finding validates the financial channel as previously discussed.

Figure 4: Dollar Exchange Rate Volatility and Productivity – The role of Financial Development



Note: This Figure shows results from specification in Equation (2). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. Financial Development is measured as the size of market capitalization in share of GDP. Countries in the group of low (high) financial development, have an average below (above) the sample median.

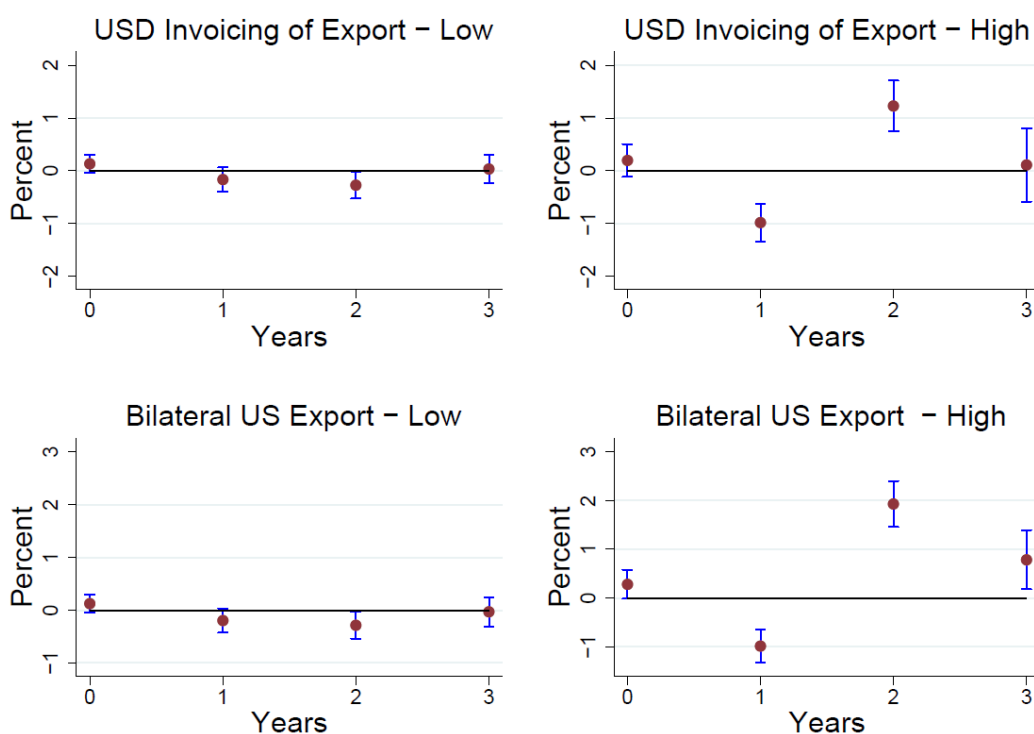
Figure 5 explores the role of collective bargaining coverage, as a proxy for wage rigidity which is at the center of the theoretical framework presented in Aghion et al (2009). Consistently with the theoretical argument previously discussed, we find that the effect of dollar exchange rate volatility on firm productivity is larger and more persistent in countries with high collective bargaining coverage compared to the baseline estimates and there is no negative and statistically significant effect for countries with low collective bargaining coverage.



Next, we explore the importance of the trade channel by testing for the role of dependence on trade with the US as well as dollar invoicing in trade. Figure 6 shows as expected that the impact of dollar exchange rate volatility on firm productivity is large (twice the baseline estimated effect) in countries with high share of export to the US and with high share of dollar invoicing of exports. Finally Figure 7, shows, that the productivity of firms operating in countries with open capital account tend to be disproportionately affected by dollar exchange

rate volatility and in a persistent manner compared to the average baseline impact.⁷ Further, it shows that FXI could mitigate the impact of exchange rate volatility on firm productivity.⁸ This finding is consistent with Li et al (2020) who found that high foreign reserves could help as buffer for corporate investment following changes in US monetary policy.⁹

Figure 6: Dollar Exchange Rate Volatility and Productivity – The role of Bilateral Trade with the US and USD Invoicing



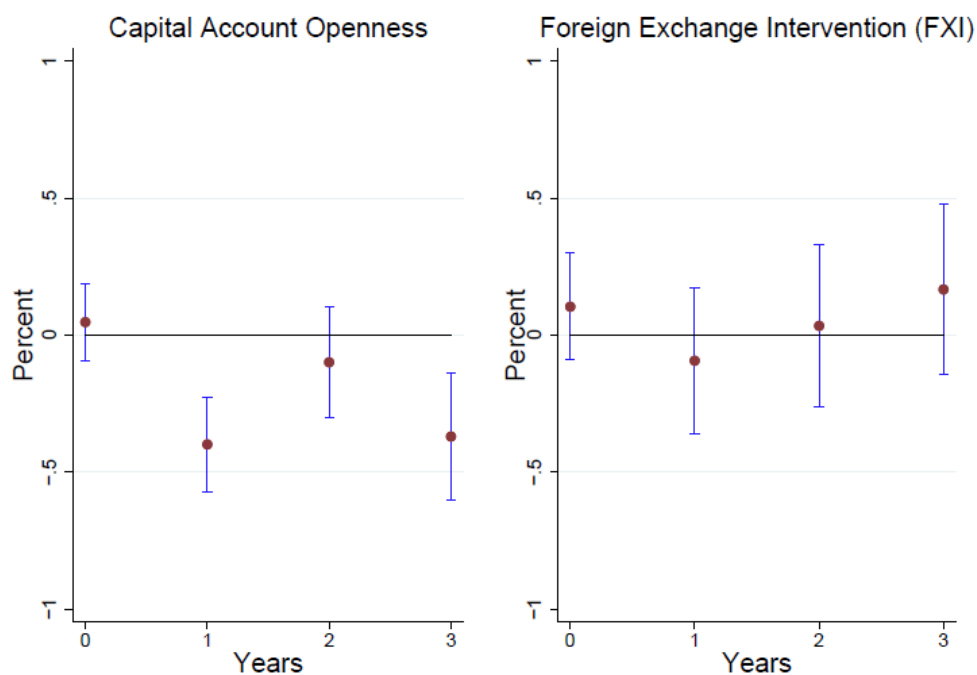
Note: This Figure shows results from specification in Equation (2). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. We explore the role share of the share of exports invoiced in USD (top panel) and the share of exports to US in total export (bottom panel). Countries in the group of low (high) USD invoicing or Export share to US, have an average below (above) the sample median.

⁷ See for instance Lakdawala et al (2021) who shows that capital account openness amplifies the transmission of US monetary policy uncertainty to bond yields in EMs.

⁸ We do not investigate the role of bilateral exchange rate regime with the US as most of the country-years in the sample are with floating arrangement vis-à-vis the USD except for China (2000-2005: conventional peg, 2006-2007: crawling peg), Malaysia (2000- 2004: conventional peg) and Russia (2008-2013: other managed). We use data on both de jure and IMF de facto exchange rate regime from Harms et al (2021).

⁹ See also for instance Cavallino, 2019 on the impact of capital flows in affecting exchange rate movements and the role of Foreign Exchange Intervention in leaning against the wind.

Figure 7: Dollar Exchange Rate Volatility and Productivity – The role of capital account Openness and FXI

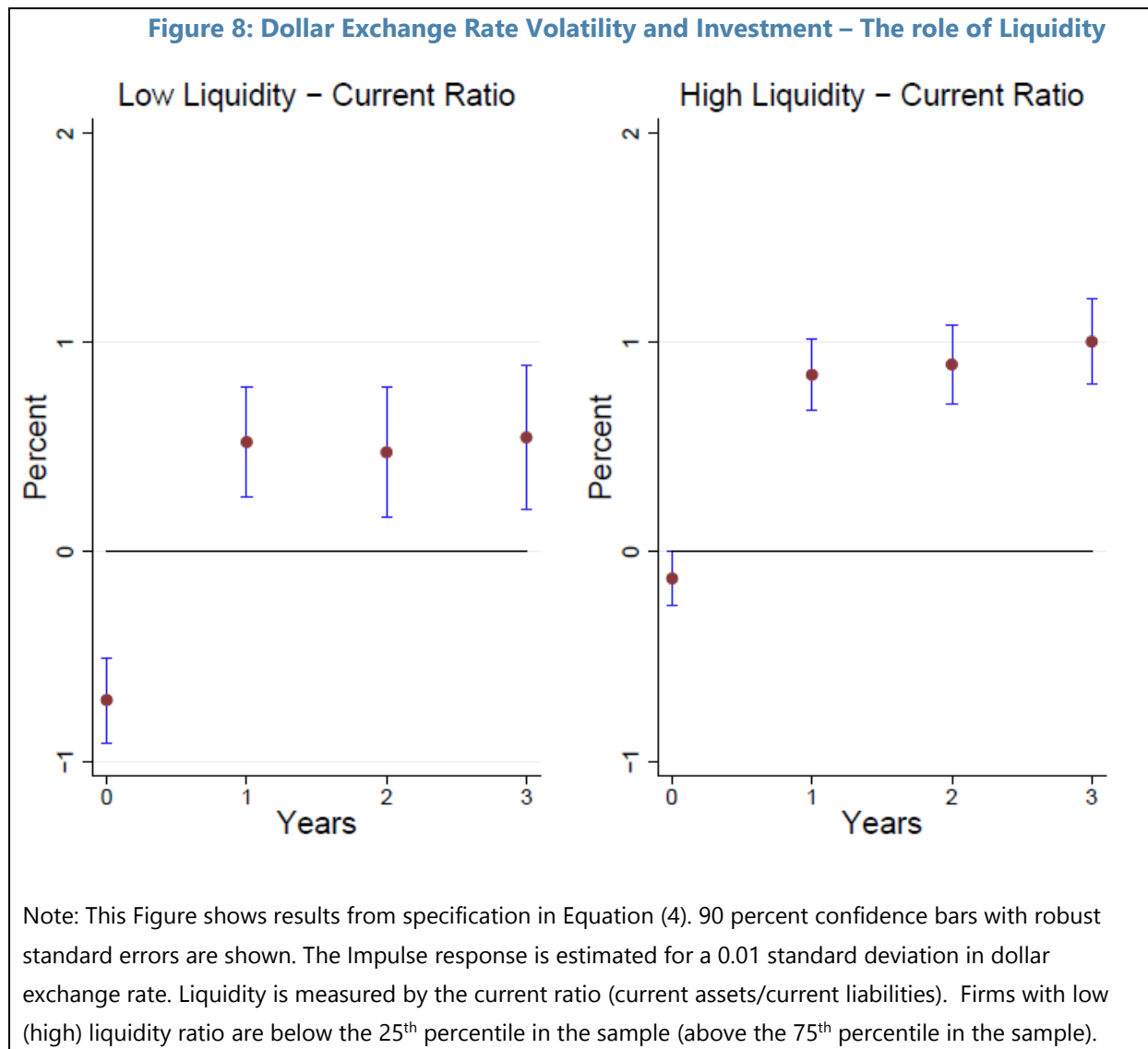


Note: This Figure shows results from specification in Equation (3). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. We calculate the impact of dollar exchange rate volatility conditional on Chinn-Ito dummy (=1 if capital account is open) and on a 1 percent point of GDP in FXI.

Firm Level Heterogeneity

Now we turn to a more granular approach by exploring firm level heterogeneity based on specification in Equation (4). Figure 8 shows that similarly to the baseline finding in Figure 2, dollar exchange rate volatility reduces contemporaneously investment but mainly in firms with a low liquidity level. This is again, consistent with the mechanism of the financial friction channel identified in Aghion et al (2009) as discussed previously. Further, consistently with the balance sheet effects of the dollar exchange rate (Avdjiev et al., 2019), Figure 9 shows that highly leveraged firms tend to be disproportionately affected by the dollar exchange rate volatility. This finding is also consistent with Li et al (2020) who find that firms with weak balance sheet tend to delay their investment following changes in U.S. monetary policy and financial-market volatility. Highly leveraged firms could face significant financial constraint for new investments and or incentivize shareholders to decide on new

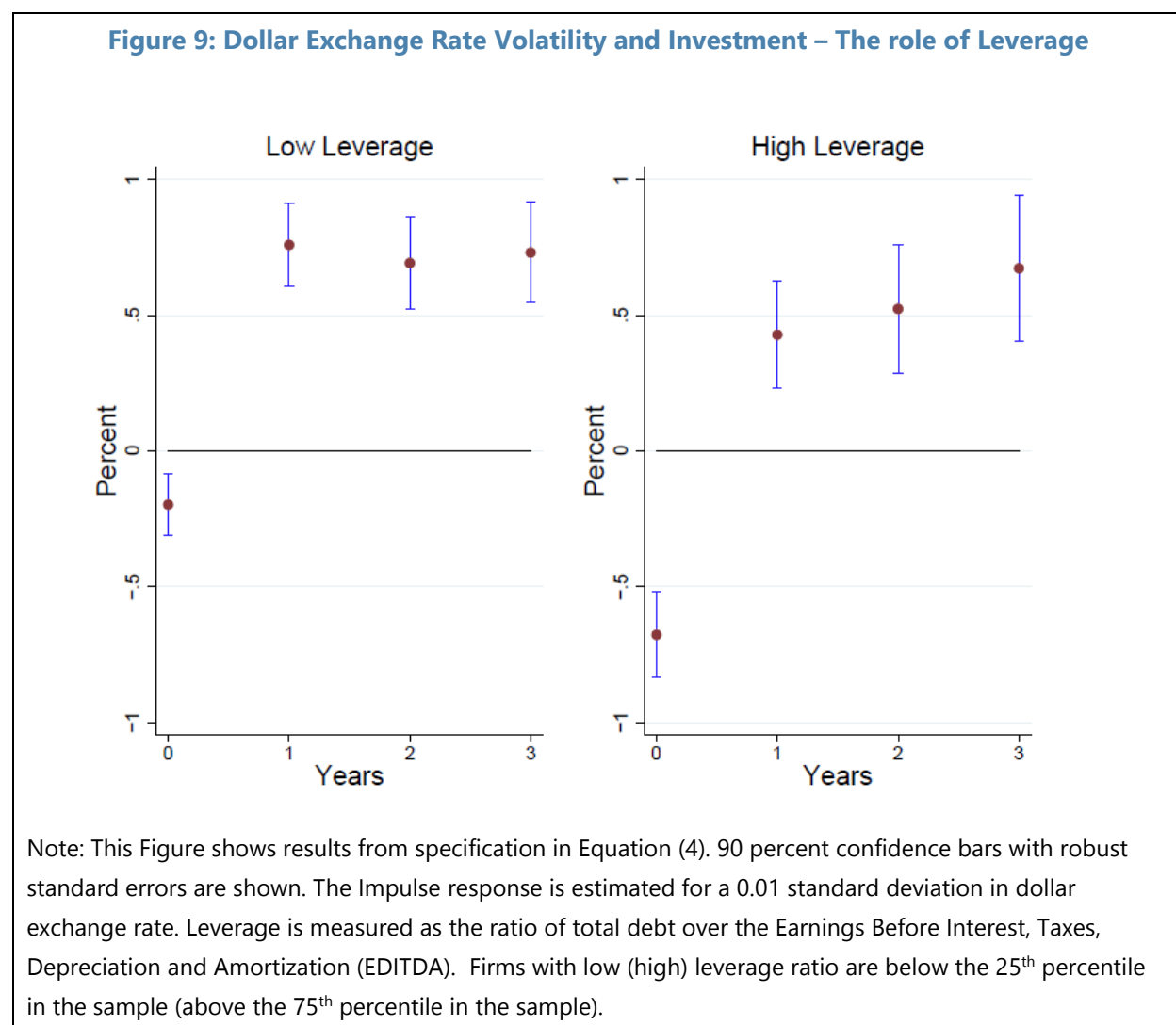
investments (see for instance Myers, 1977; Li et al, 2020) and thus are more affected by the dollar exchange rate volatility.¹⁰



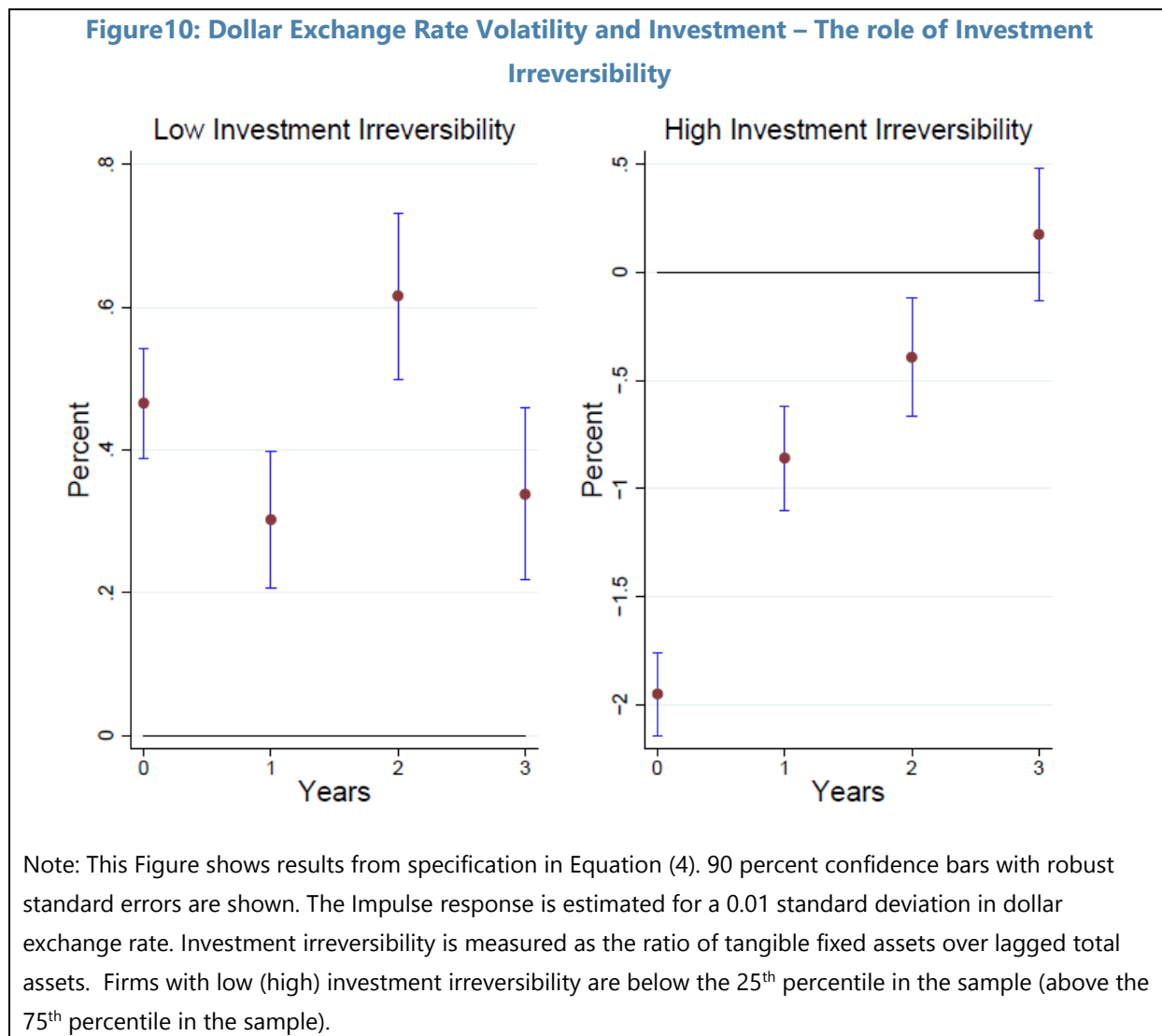
Next, following Husted et al (2020) we explore the role of the `real options` channel of uncertainty (Bertola and Caballero, 1994 and, Bloom, 2009), an additional channel through which exchange rate volatility could affect firms' investments (and productivity as shown here). In our previous empirical analysis, we have estimated an impact of dollar exchange rate volatility after controlling for country-specific level of uncertainty as well as the VIX index. Figure 10 depicts suggestive evidence that the `real options` uncertainty is a compelling channel

¹⁰ Although we do not have data to explore potential currency composition on the asset and liability sides of firms balance sheet, this channel is likely to be in play independently of the currency composition given that high leverage will plausibly be an impediment for firms access to new credit especially in context of uncertainty on financial conditions.

through which dollar exchange rate volatility affects productivity and investment as discussed in this paper. Indeed, it shows that there is a large and persistent negative impact of dollar exchange rate volatility on Investment in firms with highly irreversible investment, as captured by the ratio of tangible fixed asset in total asset. The finding on the role of irreversibility of investment is reinforced by result showing that, once we define investment focusing on intangible assets, we do not find any negative impact.¹¹

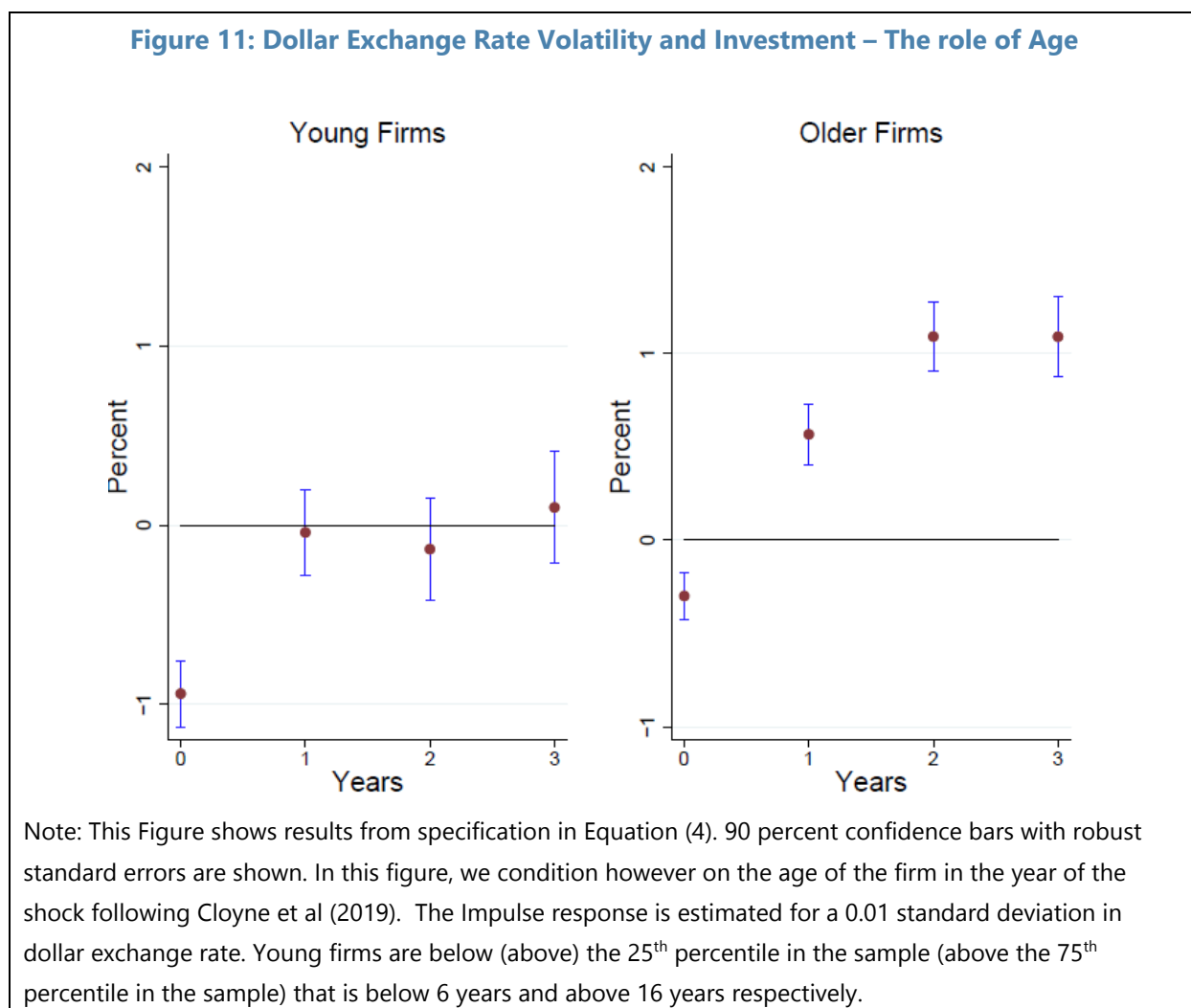


¹¹ See Table A9 in Appendix. This finding can also be reconciled with recent evidence that liquidity creation by banks contributes to growth mainly by boosting tangible investments (Beck et al, 2022) with no impact on intangible investment. Hsu et al (2022) show that foreign exchange volatility lowers firm-level R&D expenditure in intangible investment, through financial friction channel. However, consistently with Beck et al (2022) and the role of liquidity highlighted here, our sample includes EMs, where tangible assets play a more important role compared to advanced economies (with highly intangible investments - mostly included in Hsu et al., 2022). Nevertheless, Hsu et al (2022) find that firms that face high financial constraint and higher foreign debt are disproportionately affected (similarly to the results in this paper) while the impact is mitigated by hedging.



Finally, Cloyne et al (2023) introduced the concept of corporate age as an exogenous proxy for the degree of firm financial constraint. The intuition is similar to the micro-economic literature using the age of the household head as a proxy for access to credit markets, given that younger households are more likely to face tighter financial conditions because of lower income and lower credit history and thus credit score. They find in the United States and the United Kingdom that the investment of young firms is more sensitive to monetary policy tightening. They consider three groups of firm ages 'younger' (below fifteen years), 'middle-aged' (between fifteen and fifty years) and 'older' (more than fifty years).

In the sample of EMs at hand, firms are relatively young, aged between two and twenty-five years. We consider two age groups 'young' (below the 25th percentile of the age distribution, that is, below 6 years) and 'older' (above 16 years old or the 75th percentile of the age distribution). We use equation (4) to study the heterogeneity of the impact of the dollar exchange rate volatility depending on the age of the firm at the time of the shock. Given that the identification of firms by age is not sensitive to decisions about what defines the degree of liquidity of firms or a highly leveraged firms, dimensions discussed previously, it provides compelling evidence to the role of financial constraint as the key mechanism or channel of the impact of dollar exchange rate volatility. Figure 11 shows that young firms are more likely to delay investments in response to a dollar exchange rate volatility shock compared to older firms. Further, it shows that older firms recover more quickly from the shock consistent with the mechanism. Dollar exchange rate volatility can be seen therefore as a proxy for uncertainty about financial conditions. Our results are also consistent with Shousha (2019) who find that dollar appreciations lead to declines in GDP, investment and credit to private sector in EMs mainly through financial conditions.



D. Robustness Check

Now we undertake a series of robustness tests including using a different measure of exchange rate volatility, using an instrumental variable approach as discussed in the empirical strategy section, but also a different measure of financial development (domestic credit to private sector - see Figure A5 in the Appendix), a different measure of bilateral trade and dollar invoicing (imports - Figure A6 in the Appendix - see Gopinath et al (2020) who show that the share of imports invoiced in dollars strengthens and amplifies dollar exchange rate pass-through), and a different measure of firm liquidity (quick ratio - see Figure A7 in the Appendix).

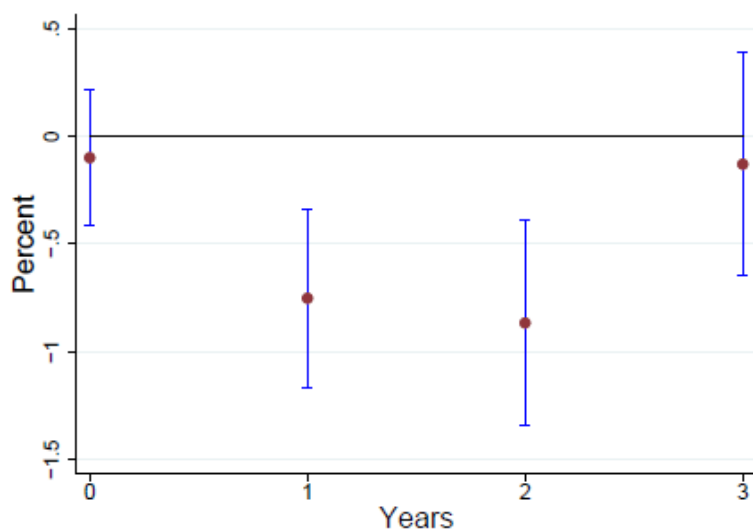
First, as discussed in the data section, we employ a different measure of exchange rate volatility using a GARCH (1, 1) approach (Hansen and Lunde, 2005). Figure 12 shows the related results which are very similar finding to our baseline albeit with a larger and a more persistent impact (see Figure A8 in Appendix for investment results). Second, in Figure 13, we show estimates using the instrumental variable approach, where we exploit exogenous variation from US monetary policy shock and allowing for heterogeneous response across countries based on their average magnitude of dollar invoicing of imports. Figure 13 shows very similar results to the baseline but with a larger impact. This finding that our results can be plausibly interpreted as causal.

We undertook other robustness tests as shown in Figure A8-A16 in the Appendix including the focus on the sub-sample of firms operating in the manufacturing sector which may be more suited for a production function approach of productivity, a different measure of productivity (labor productivity in Figure A11), redefining investment based on intangible assets, an instrumental variable estimate of the baseline finding for investment and, based on exchange rate volatility obtained from the GARCH (1,1) model, instrumental variable estimates for both TFP and investment but also the role of dollar invoicing. Our results show robust and very similar patterns to our baseline estimates.

Finally, we consider a specification (1) for both investment and productivity where we include the change in the bilateral exchange rate among the controls. This allows to isolate the effect of the dollar exchange rate volatility from the effect of changes in exchange rate (appreciation or depreciation). Our results (see Figure A17 in the Appendix) show a larger and more persistent effect of dollar exchange rate volatility compared to the baseline specification both for productivity and investment.¹³

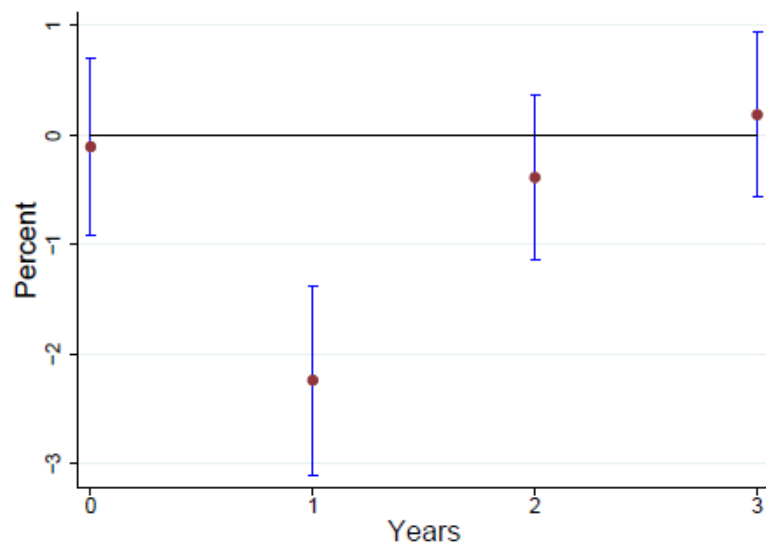
¹³ We also find consistently with the money growth model developed by Aghion et al. (2009) that depreciations (by increasing firms earning in local currency and thus their ability to borrow) have a (small) positive impact on productivity growth – results are available upon request. These findings offer an additional robustness check to show that results are driven by uncertainty on dollar exchange rate rather than the change in the first moment. These are also similar to the finding by Lakdawala et al (2021) who find that spillovers from US monetary policy uncertainty to global bond yields are larger compared to those from the first moment.

Figure 12: Dollar Exchange Rate Volatility and Productivity – Exchange Rate volatility Measured using GARCH (1,1)



Note: This Figure shows results from specification in Equation (1) measuring exchange rate volatility from a GARCH (1,1) model. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure 13: Dollar Exchange Rate Volatility and Productivity – Instrumental Variable Estimate



Note: This Figure shows results from an Instrumental variable approach. We use US monetary policy shock from Nakamura and Steinsson (2018) and its interaction with country-specific average of share of imports invoiced in USD. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

III. Conclusion

This paper uses firm level data covering 16 Emerging Market (EMs) economies over the period 1998-2019 to examine the consequences of dollar exchange rate volatility for productivity growth. The paper uncovers a delayed and short-lived negative effect of exchange rate volatility on productivity growth in EMs.

Exploring cross-country heterogeneity, the paper shows that dollar exchange rate volatility severely impacts firm productivity growth in EMs with low level of financial development, high dollar invoicing, high bilateral trade with the US and open capital account. In addition, it shows that Foreign Exchange Interventions (FXI) policies could dampen this impact on firm productivity in EMs. A deeper look at the data, exploiting firm level heterogeneities shows that dollar exchange rate volatility operates through the financial friction channel, causing firms (especially those with low liquidity buffers and a weak balance sheet) to delay their investment. These results are corroborated using age as an exogenous proxy for the degree of financial constraint at the firm level, as younger firms are found to be more vulnerable to dollar exchange rate volatility in EMs. In addition, uncertainty about the dollar exchange rate operates also through the real option channel as the paper provides evidence for a large and persistent effect on firms with highly irreversible investment. These findings are robust to a battery of tests, including controlling for uncertainty and using an instrumental variable strategy based on using US monetary policy shocks as exogenous source of variation in dollar exchange rate volatility.

Overall, our findings suggest the relevance of both the trade and the financial friction channels of the dollar exchange rate volatility with the implication that uncertainty regarding the dollar exchange rate plays an importance role in EMs. This paper is the first to the best of our knowledge to provide evidence of the effect of dollar exchange rate volatility on productivity growth in EMs. An important policy implication of our findings is that prolonged periods of dollar exchange rate volatility could have important spillover effects on the productivity growth in EMs causing a drag on growth in these countries. It shows therefore that not only the level but also the second moment of the dollar exchange rate, uncertainty about financial conditions, matters. However, it is important to highlight that the findings in the paper should not be construed as suggestive that EMs would be better off with fixed or managed exchange rate regimes. No single exchange rate regime is right for all countries or at all times (Frankel, 1999). Fixed or managed regimes have other drawbacks such as the loss of monetary policy autonomy and the inability to use the exchange rate as a shock absorber. The results for instance point to the role of enhancing financial development, reducing financial vulnerabilities but also policy interventions to smooth excessive volatility. Further, there is also room for the development of hedging instruments to help manage such volatility.

Appendix.

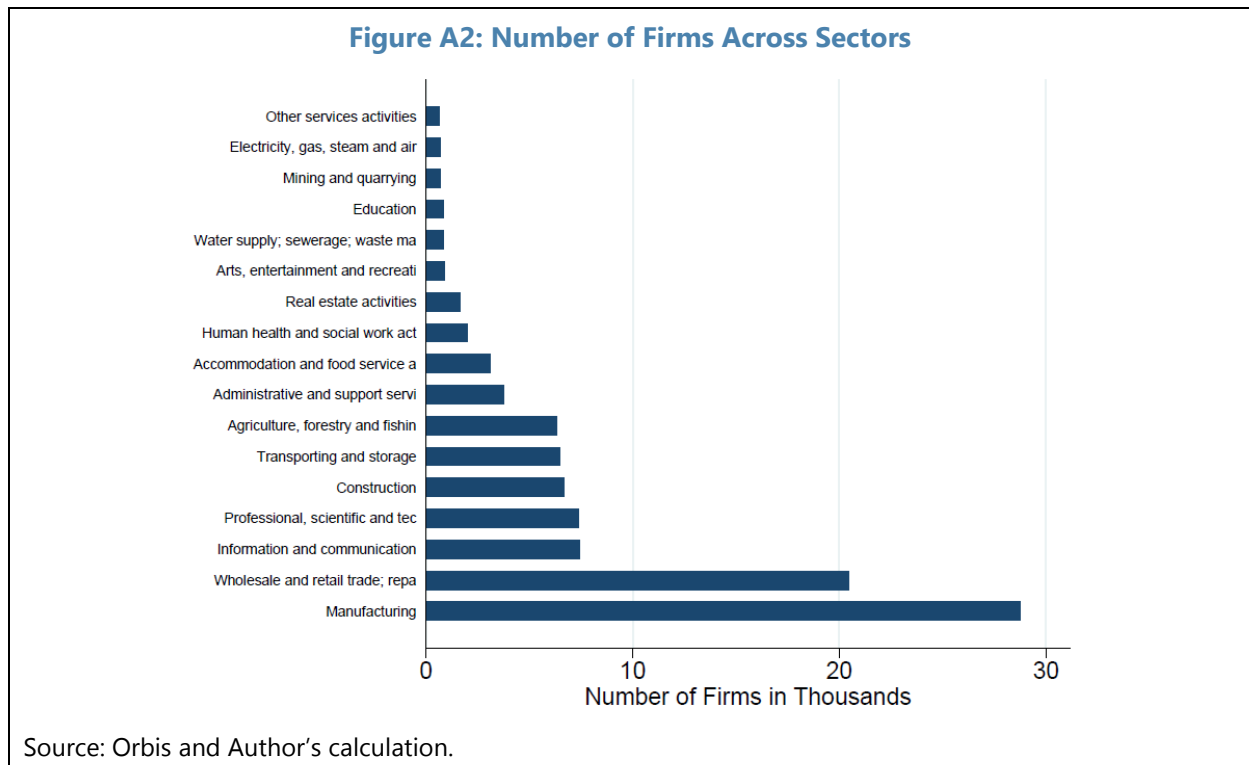
Table A1- Summary Statistics

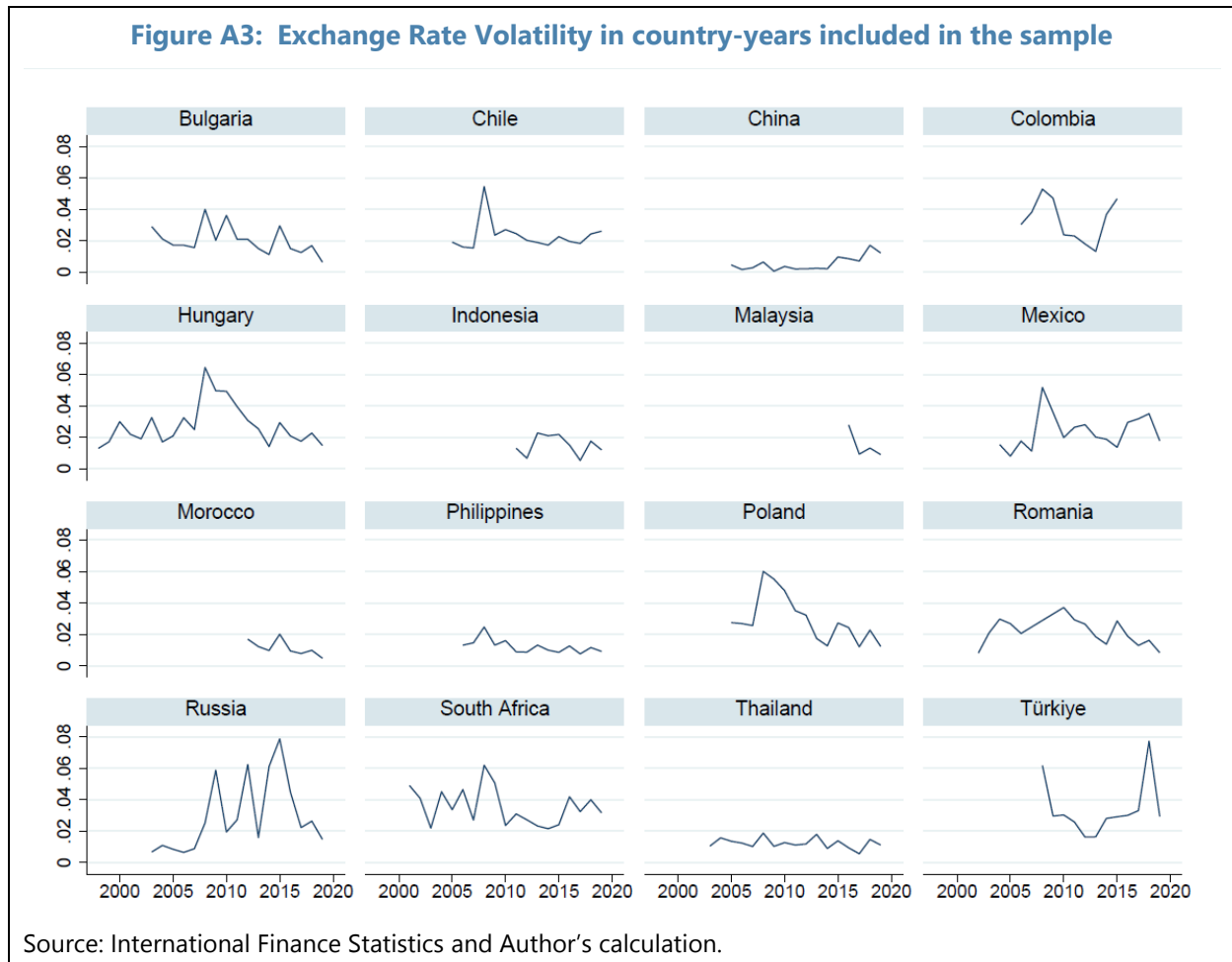
Variables	Obs	Mean	Std. dev.	Min	Max
Firm Level					
Log (TFP)	349,303	1.859	0.796	0.58	3.05
Log Labor Productivity	127,395	9.620	0.961	7.70	11.17
Log (Total Assets)	349,303	13.685	2.283	9.54	17.28
Leverage Ratio	349,303	1.088	1.965	0	7.30
Age	349,303	11.488	6.971	2	25
Investment Ratio	348,090	0.118	0.173	0.002	0.76
Current Ratio	348,394	3.269	4.833	0.306	23.945
Quick Ratio	340,912	1.010	1.842	0.002	7.333
Tangible fixed asset / Total asset (Investment Irreversibility)	349,303	0.301	0.285	0	0.941
Investment Ratio (Intangible)	144,664	-0.001	0.005	-0.130	0.007
Country Level					
Dollar Exchange Rate volatility	225	0.023	0.014	0.001	0.079
Dollar Exchange Rate volatility - GARCH (1,1)	225	0.030	0.009	0.021	0.082
Output Gap	225	-0.040	1.906	-6.934	6.589
Log Real GDP per capita	225	8.862	0.475	7.673	9.619
Uncertainty Index	225	0.224	0.191	0	1.343
CPI inflation rate	225	4.452	3.578	-1.545	22.540
Trade Openness	225	79.792	35.580	34.265	168.341
Financial crises	225	0.076	0.265	0	1
Capital Account Openness	225	0.528	0.298	0.164	1
Domestic Credit to Private sector (percent of GDP)	225	56.747	31.751	10.090	165.390
Market capitalization (percent of GDP)	207	63.574	58.365	5.403	322.711
FXI (percent of GDP)	223	1.309	3.349	-8.021	11.020
Dollar Invoicing (percent of Exports)	194	56.025	31.137	9.470	99.530
Dollar Invoicing (percent of Imports)	165	51.735	26.237	16.100	90.980
Share of Export to US in total Exports	194	8.144	8.175	1.308	43.125
Share of Imports from US in total Imports	194	7.083	6.654	0.679	29.199
Collective Bargaining Coverage (percent)	128	17.891	16.214	0.4	97.1

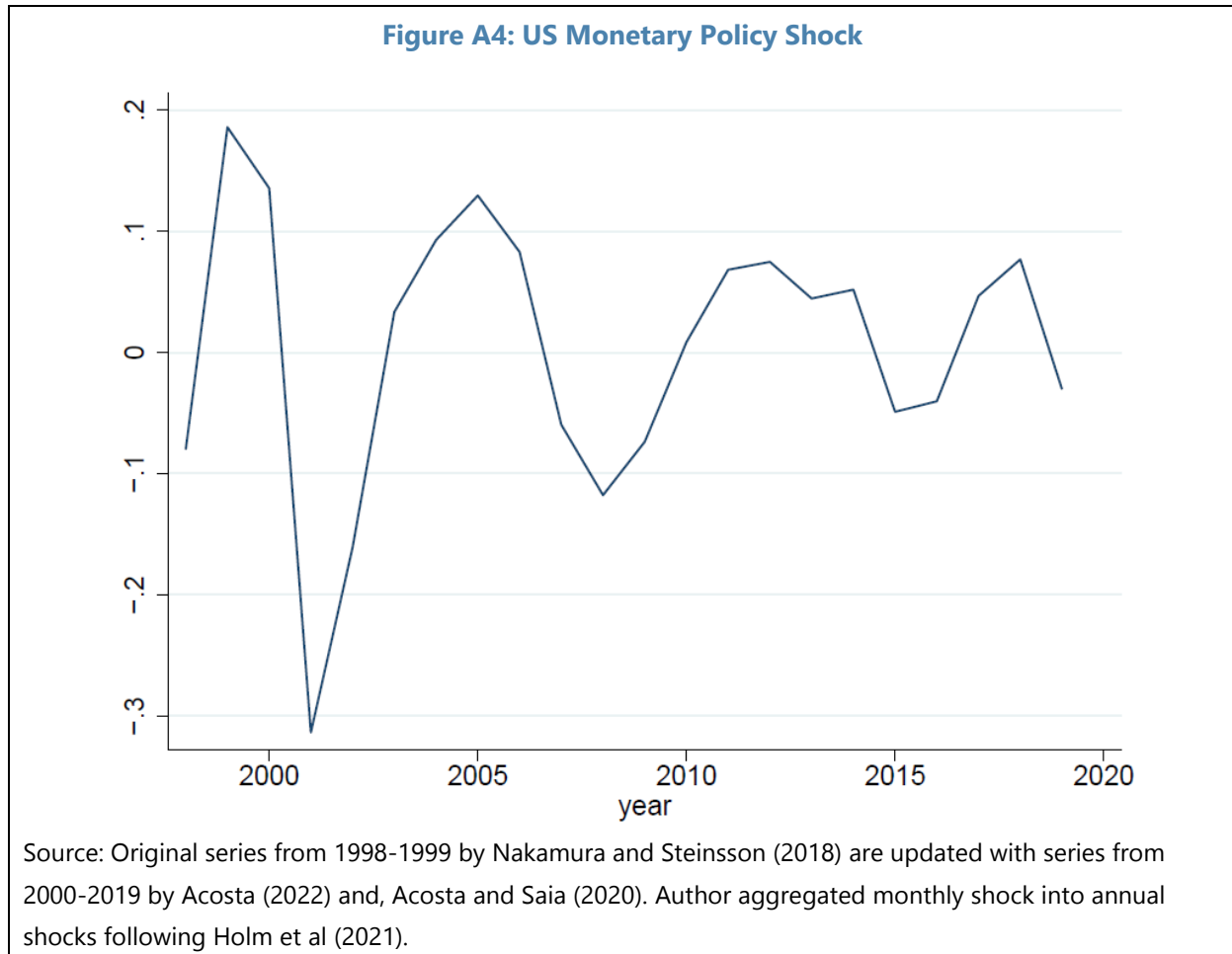
Countries in the sample: Bulgaria, Chile, China, Colombia, Hungary, Indonesia, Malaysia, Mexico, Morocco, Philippines, Poland, Romania, Russia, South Africa, Thailand, Türkiye.

Table A2 – Data Source

Firm Level	
Log (TFP)	Díez et al (2021) based on Orbis
Log Labor Productivity	Real value added per employee from Orbis
Log(Total Assets)	Orbis
Leverage Ratio	Total Debt/EBITDA - Orbis
Age	Orbis
Investment Ratio	capital expenditure/ lagged total assets - Orbis
Current Ratio	Orbis
Quick Ratio	Orbis
Investment Irreversibility	Tangible fixed asset / Total asset - Orbis
Investment Ratio (Intangible)	change in intangibles / lagged total assets - Orbis
Country Level	
Dollar Exchange Rate volatility	Monthly data on local currency per USD - IMF International Finance Statistics
Dollar Exchange Rate volatility - GARCH(1,1)	Monthly data on local currency per USD - IMF International Finance Statistics
Output Gap	IMF World Economic Outlook
Log Real GDP per capita	World Development Indicators
Uncertainty Index	Ahir et al. (2022)
CPI inflation rate	World Development Indicators
Trade Openness	World Development Indicators
Financial crises	Nguyen et al (2022)
Capital Account Openness	Chinn and Ito, 2008
Domestic Credit to Private sector (percent of GDP)	World Development Indicators
Market capitalization (percent of GDP)	World Development Indicators
FXI (percent of GDP)	Adler et al (2021)
Dollar Invoicing (percent of Exports)	Boz et al (2022)
Dollar Invoicing (percent of Imports)	Boz et al (2022)
Share of Export to US in total Exports	Boz et al (2022)
Share of Imports to US in total Imports	Boz et al (2022)
Collective Bargaining Coverage	International Labour Organization







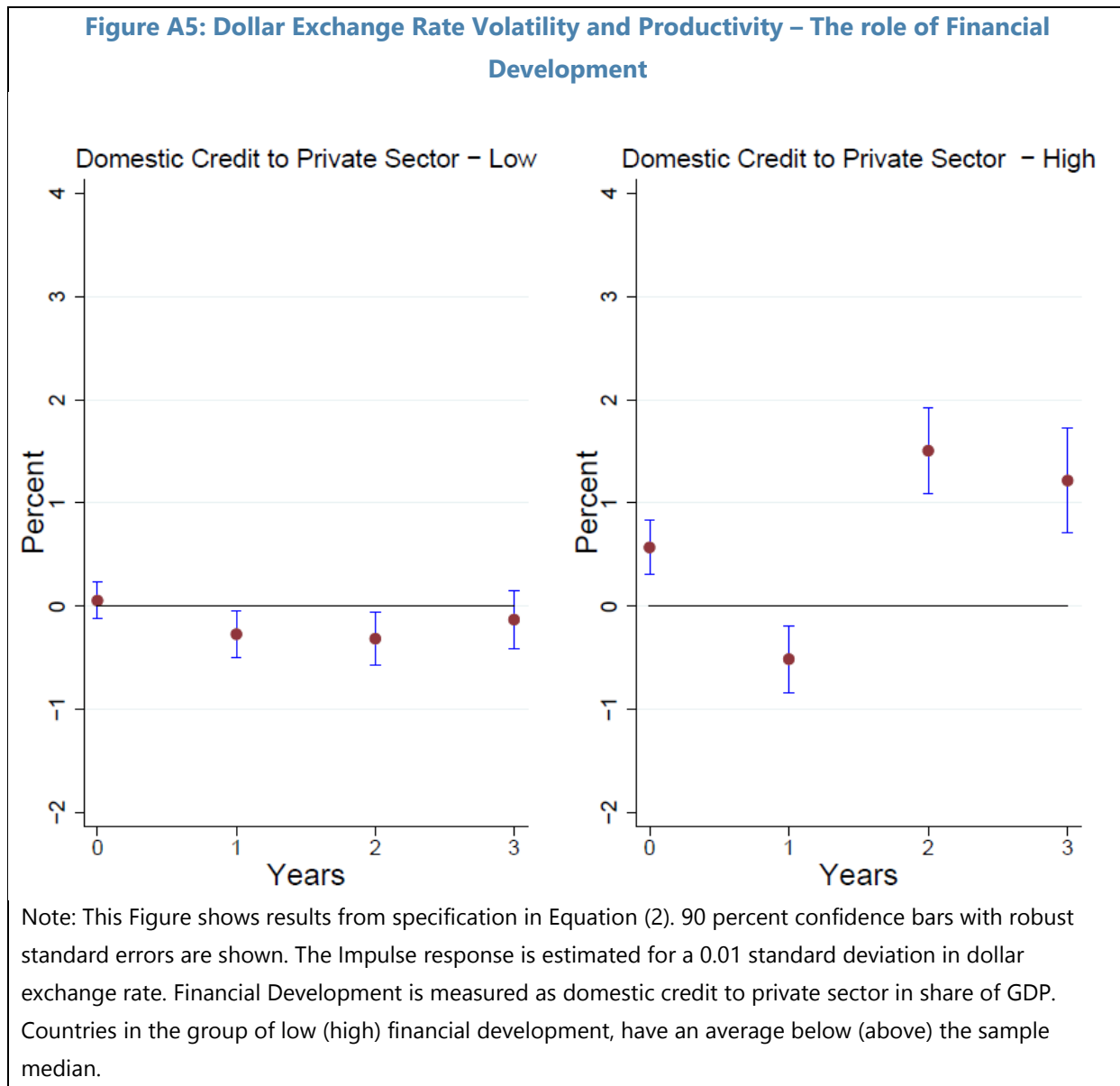
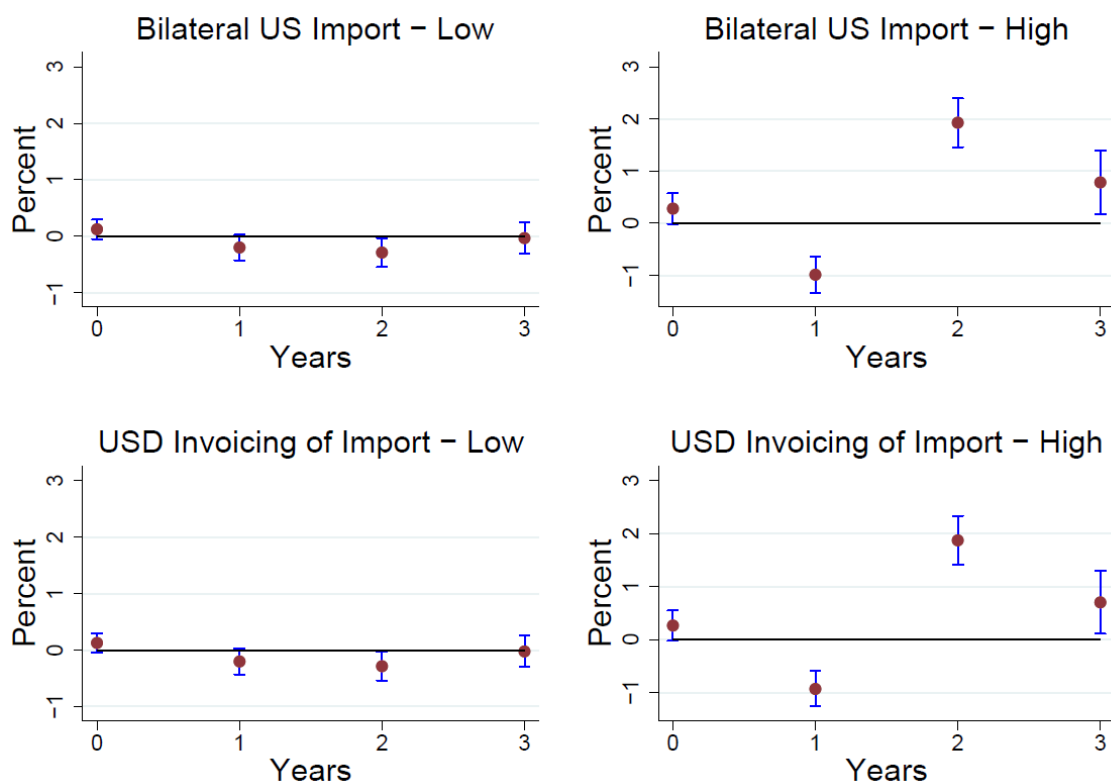
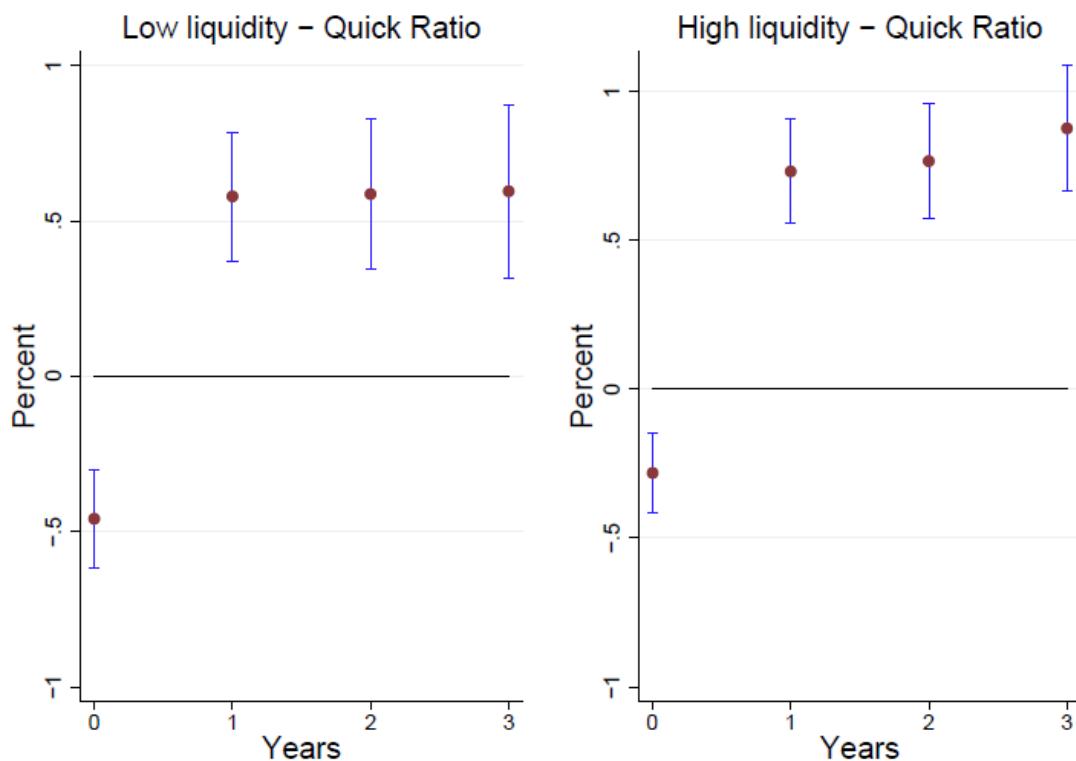


Figure A6: Dollar Exchange Rate Volatility and Productivity – The role of Bilateral Trade with the US and USD Invoicing

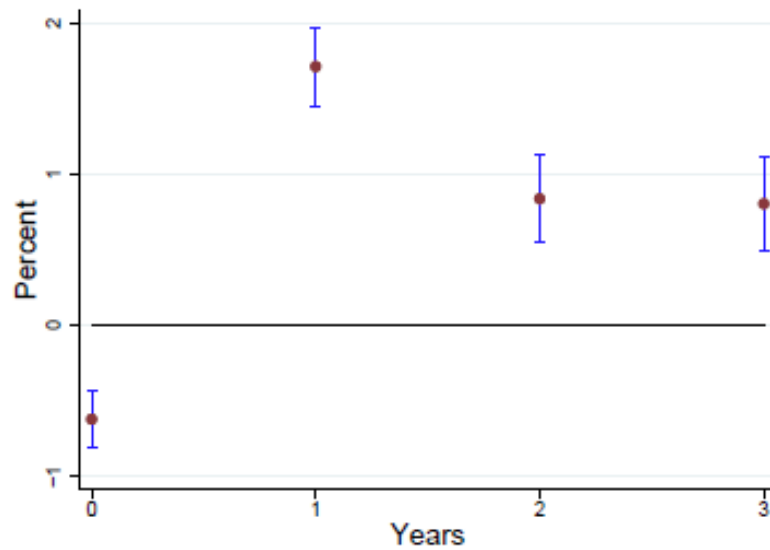


Note: This Figure shows results from specification in Equation (2). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. We explore the role of the share of imports from US in total import (top panel) and the share of imports invoiced in USD (bottom panel). Countries in the group of low (high) USD invoicing or Export share to US, have an average below (above) the sample median.

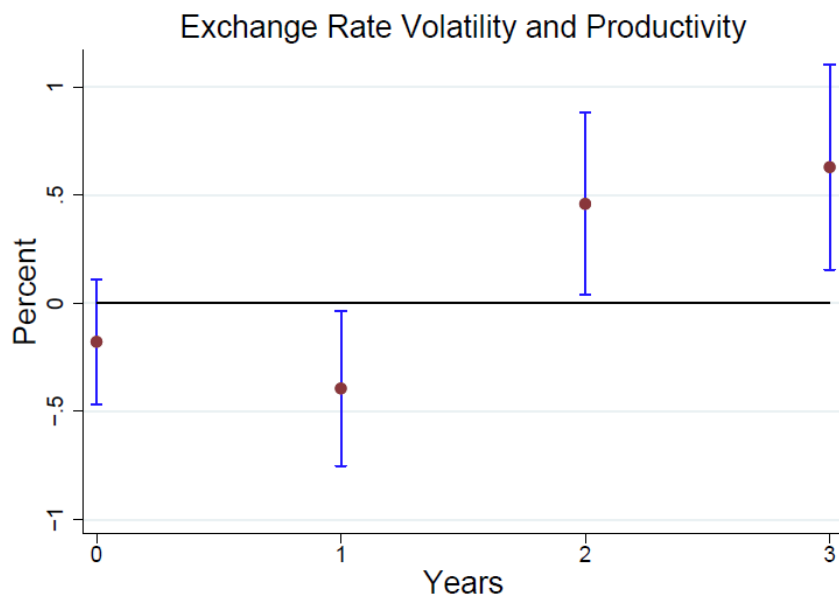
Figure A7: Dollar Exchange Rate Volatility and Investment – The role of Liquidity

Note: This Figure shows results from specification in Equation (4). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. Liquidity is measured by the quick ratio (cash and cash equivalent/current liabilities). Firms with low (high) liquidity ratio are below the 25th percentile in the sample (above the 75th percentile in the sample).

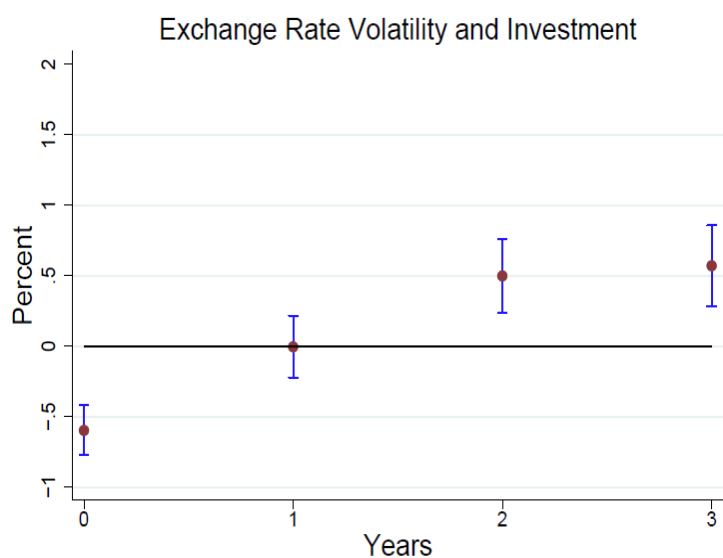
Figure A8: Dollar Exchange Rate Volatility and Investment - Exchange Rate volatility Measured using GARCH (1,1)



Note: This Figure shows results from specification in Equation (1) for Investment, measuring exchange rate volatility from a GARCH (1,1) model. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A9: Dollar Exchange Rate Volatility and Productivity – Only Manufacturing Firms

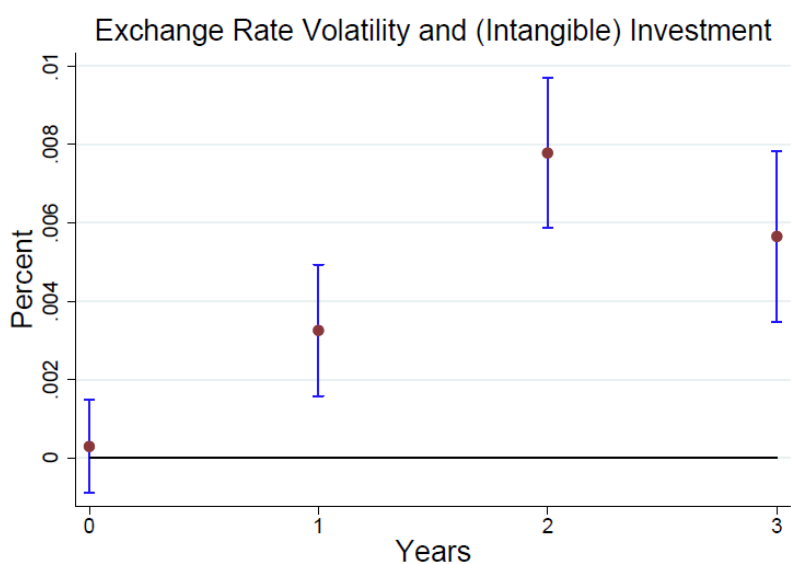
Note: This Figure shows results from Equation (1). 90 percent confidence bars with robust standard errors are shown. The impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A10: Dollar Exchange Rate Volatility and Investment – Only Manufacturing Firms

Note: This Figure shows results from specification in Equation (1) for Investment. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

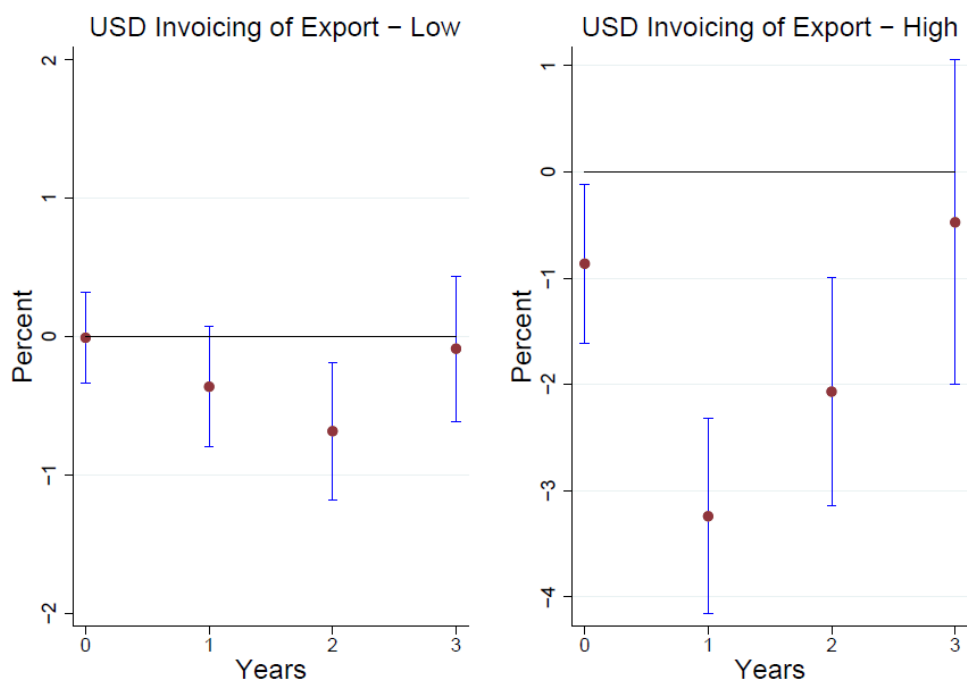
Figure A11: Dollar Exchange Rate Volatility and Labor Productivity

Note: This Figure shows results from Equation (1). 90 percent confidence bars with robust standard errors are shown. The impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A12: Dollar Exchange Rate Volatility and Intangible Investment

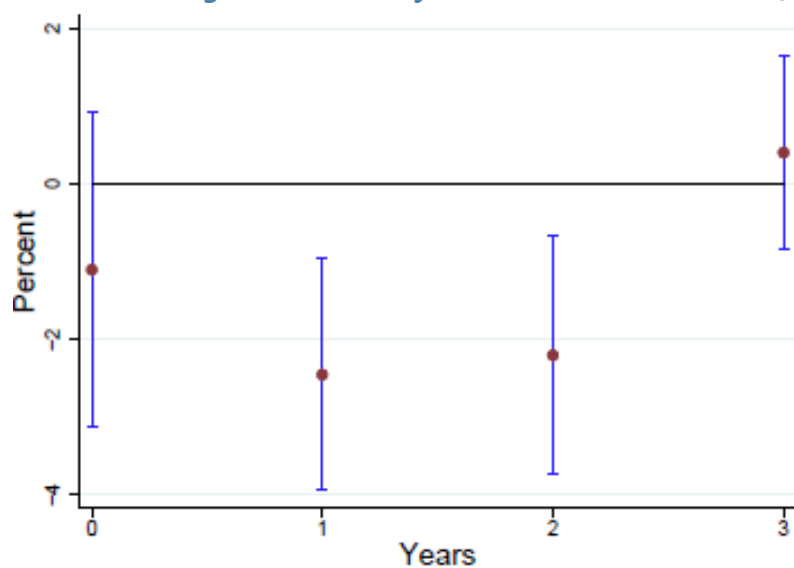
Note: This Figure shows results from specification in Equation (1) for investment in intangible assets. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A13: Dollar Exchange Rate Volatility and Productivity – The role of USD Invoicing using Exchange Rate Volatility Measured from a GARCH (1,1) Model

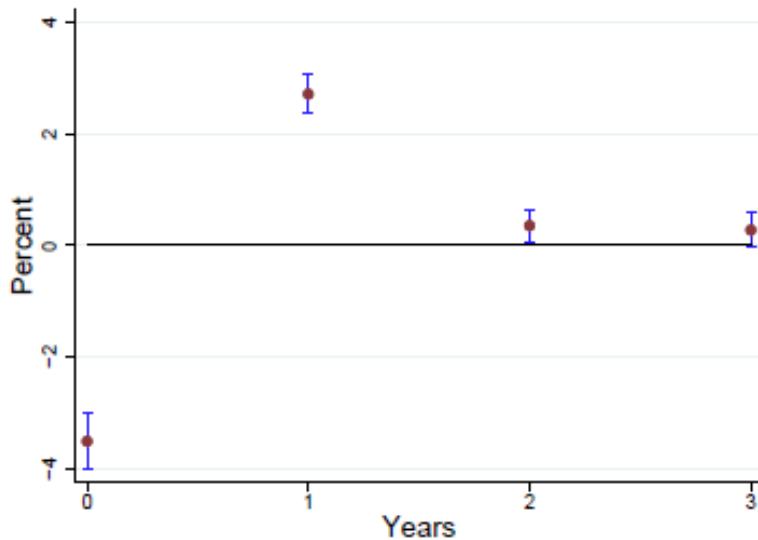


Note: This Figure shows results from measuring exchange rate volatility from a GARCH (1,1). 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate. Countries in the group of low (high) USD invoicing or Export share to US, have an average below (above) the sample median.

Figure A14: Dollar Exchange Rate Volatility and Productivity – Instrumental Variable Estimate and Exchange Rate Volatility Measured from a GARCH (1,1) Model

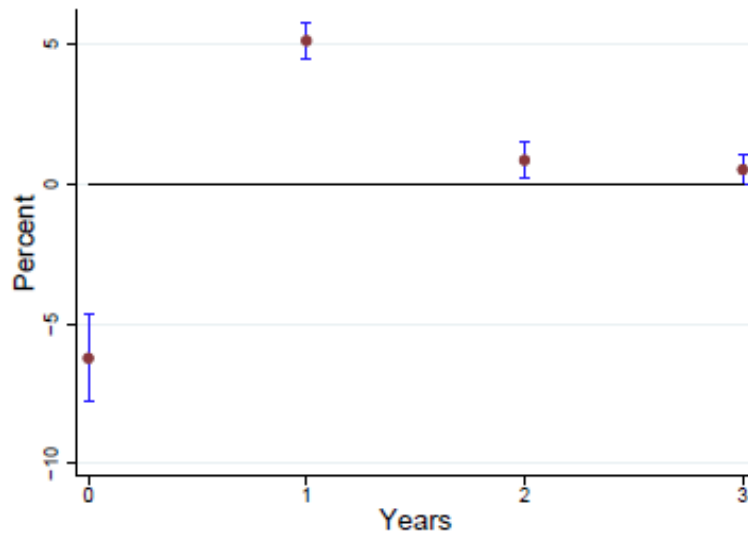


Note: This Figure shows results from measuring exchange rate volatility from a GARCH (1,1) model and using an instrumental variable approach. We use US monetary policy shock from Nakamura and Steinsson (2018) and its interaction with country-specific average of share of imports invoiced in USD. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A15: Dollar Exchange Rate Volatility and Investment – Instrumental Variable Estimate

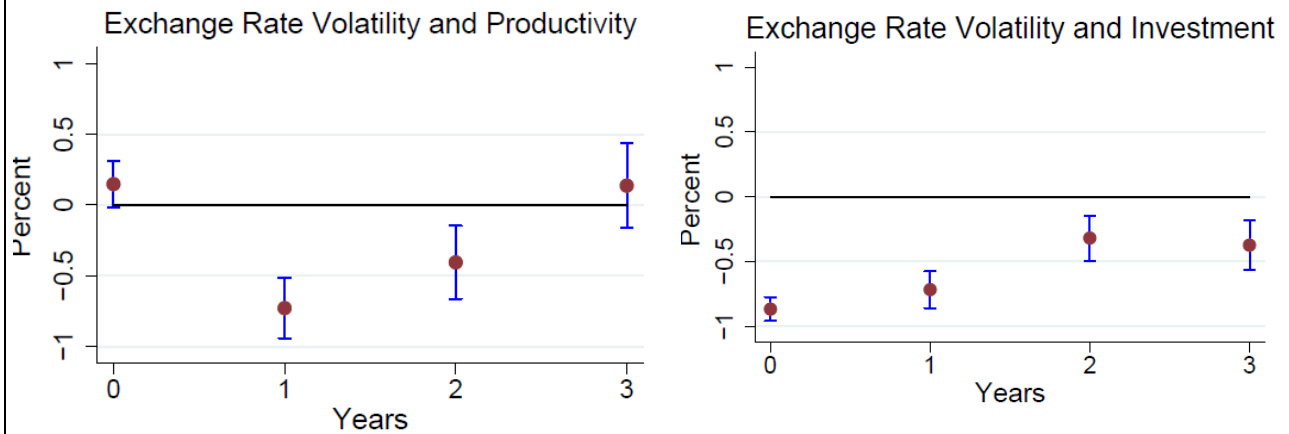
Note: This Figure shows results from using an instrumental variable approach. We use US monetary policy shock from Nakamura and Steinsson (2018) and its interaction with country-specific average of share of imports invoiced in USD. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A16: Dollar Exchange Rate Volatility and Investment – Instrumental Variable Estimate and Exchange Rate Volatility Measured from a GARCH (1,1) Model



Note: This Figure shows results from measuring exchange rate volatility from a GARCH (1,1) model and using an instrumental variable approach. We use US monetary policy shock from Nakamura and Steinsson (2018) and its interaction with country-specific average of share of imports invoiced in USD. 90 percent confidence bars with robust standard errors are shown. The Impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

Figure A17 -Horse race between Dollar Exchange Rate Volatility and Changes in the Dollar Exchange Rate



Note: This Figure shows results from Equation (1) incorporating the change in the log of dollar exchange rate among controls. 90 percent confidence bars with robust standard errors are shown. The impulse response is estimated for a 0.01 standard deviation in dollar exchange rate.

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