Dollar Invoicing and the Global Financial Cycle

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Abstract

I study the dynamic relation between dollar invoicing in exports, dollar borrowing, and the global financial cycle. I document a positive co-movement between dollar invoicing in exports and firms' dollar borrowing, and also a positive link between dollar borrowing and the VIX. I write down a model consistent with these correlations: during global financial downturns when the VIX is high and dollar liquidity is tight, firms increase dollar invoicing to secure dollar revenues, facilitating dollar borrowing with these revenues as collateral. The model shows that an endogenous increase in dollar invoicing amplifies the responsiveness of dollar borrowing to positive risk shocks (or safety shocks), affecting responses in variables like UIP premium, exchange rates, and foreign asset holdings. Empirical evidence from a comparison between Turkey and Thailand supports these insights.

JEL Codes: E32, E44, E52, F14, F31, G01

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1 Introduction

Recent literature in international macroeconomics has studied the choice of invoicing currencies in global markets, as demonstrated by works such as Goldberg and Tille (2008), Gopinath (2016), and Gopinath et al. (2020). This exploration departs from the conventional open economy framework. Building on Engel (2006)'s seminal work, macroeconomic research has provided both theoretical and empirical analyses of the endogenous choice of invoicing currency in international trade pricing, including studies by Gopinath et al. (2010), Amiti et al. (2020), and Mukhin (2020). In particular, Gopinath and Stein (2019) argue for a significant role of firms' borrowing decisions in invoicing currency choice. However, the existing literature remains silent on the dynamic variations in firms' invoicing currency preferences over time. In this paper, I empirically document time-varying trends in dollar invoicing shares influenced by global risk factors and provide a theoretical explanation for these dynamics.

The purpose of this paper is to gain insight into the dynamics related to currency choices for invoicing and borrowing, and to explore their roles in the propagation of shocks and policy effects. I first provide empirical observations about fluctuations in dollar invoicing and borrowing shares. Then, I present a theoretical model to elucidate the underlying mechanisms behind these observations. I begin with a baseline model that illustrates how a global risk shock increases the inclination of emerging market (EM) exporters to borrow in dollars instead of their own currency. Here, the global risk shock is an external shock in global uncertainty, which I refer to as a "safety shock" following Kekre and Lenel (2021) throughout the paper.[1] This, in turn, leads to an increased share of dollar invoicing in exports, because exporters seek to secure more dollar revenues that can be used as collateral to increase their dollar borrowing. I further extend the model to explore the dynamic responses of macro variables such as exchange rates, foreign asset accumulations, and outputs, to a positive safety shock. I examine policy implications by relaxing several assumptions made in the baseline model, which is supported by empirical evidence comparing Turkey and Thailand.

Based on newly provided data on invoicing currency from Boz et al. (2020), I present two key empirical findings. First, for non-U.S. countries, there is a positive co-movement between dollar invoicing shares in exports and dollar borrowing shares over time.[2] Second,

[1]The term "safety shock" is borrowed from Kekre and Lenel (2021), where it is defined as an exogenous shock in the demand for saving in dollars. I interpret the positive safety shock as a positive global risk shock, given the increased demand for safe dollar claims during global financial downturns.

[2]Based on Amiti et al. (2020)'s finding that invoicing currency choice is significantly affected by exporters' characteristics rather than importers', I focus solely on invoicing shares in exports.

dollar borrowing shares are positively correlated with the VIX (Volatility Index). This indicates that during a global financial downturn, firms tend to borrow more in dollars. These empirical facts can be linked to the findings by di Giovanni et al. (2021), Kalemli-Ozcan et al. (2020), and Kalemli-Ozcan and Varela (2022), which present co-movements among firms' foreign currency borrowing, the UIP (Uncovered Interest Parity) premium, and the VIX. Notably, di Giovanni et al. (2021) show a positive co-movement between the shares of foreign currency loans and the VIX using Turkish data. With the country-level data on invoicing currency choices in exports, I add empirical facts that establish a connection between dollar invoicing decisions, firms' dollar borrowing choices, and the global financial cycle.

I propose the following mechanism to link these observations: When the VIX increases, the expected return on the home currency relative to the dollar (the UIP premium) rises, reducing the relative cost of dollar borrowing. This shift occurs because heightened global uncertainty leads to an increased global demand for saving in dollars, driven by a higher non-pecuniary values associated with holding safe dollar claims. As a result, firms are incentivized to increase their dollar borrowing. However, firms are often constrained in their ability to borrow in dollars due to their exposure to exchange rate risk. Lenders frequently require dollar-denominated collateral for dollar borrowing, motivating exporters to increase the share of dollar invoicing in their exports, thus securing more dollar revenue (as discussed in Gopinath and Stein (2019)). Consequently, both the shares of invoicing and borrowing in dollars tend to increase during global financial downturns. I present a regression analysis that establishes a close link between dollar invoicing and dollar borrowing, even when controlling for the VIX and the UIP premium in each country.[3]

To formalize this mechanism, I introduce a baseline model that incorporates the endogenous shares of dollar invoicing and dollar borrowing by firms. This model extends the framework developed by Gopinath and Stein (2019) into a dynamic setup, integrating elements from Kekre and Lenel (2021) related to the "non-pecuniary" values associated with saving in dollars. The model consists of two countries: the U.S. and an EM. In this model, risk-averse depositors in the EM, who both consume and save, make choices regarding the currency in which they save — choosing between the dollar and the EM currency. These depositors have a preference for holding safe dollar claims, indicating a non-pecuniary value associated with saving in dollars. Initially, they save in dollars by lending to domestic firm-

[3]The purpose of the regression analysis is not to establish causality but rather to demonstrate close relationships among the variables.

bank coalitions, which are also exporters. However, if EM firms cannot produce enough safe dollar claims to meet the demand for dollar savings from EM depositors, these depositors will seek out the foreign market and opt to save in safe dollar assets in the U.S. The U.S. depositors save exclusively in dollars.

Exporters use the received deposits to finance their production by investing in capital. In my model, U.S. exporters exclusively receive payments in dollars when they sell their final goods. On the other hand, EM exporters choose the currency in which they invoice their exports. They decide on the share of dollar invoicing, while the remaining portion is invoiced in their home currency. This is because EM exporters are constrained when it comes to borrowing in dollars, primarily due to the risk associated with exchange rate fluctuations if all their revenues are denominated in the EM currency. To overcome this constraint and access dollar borrowing, EM exporters secure dollar-denominated revenues, often by increasing the share of dollar invoicing in their exports, thereby providing the necessary dollar collateral.

Suppose there is an exogenous increase in the non-pecuniary value of safe dollar claims, referred to as the "safety shock". This leads to an increase in the demand for saving in dollars, resulting in decreased returns for dollar saving. It means that the EM currency offers a higher risk premium, represented by an increase in the UIP premium. When the UIP premium rises, EM exporters seek to increase the share of dollar borrowing due to the reduced cost of borrowing in dollars. Assume that the dollar invoicing share remains fixed at a constant level. While the cost of dollar borrowing decreases, allowing EM exporters to increase their dollar share of borrowing, they are unable to secure additional dollar collateral. Then, they cannot meet the heightened demand for safe dollar claims from EM depositors. In response, EM depositors turn to U.S. safe dollar assets, lending to U.S. firm-bank coalitions. This action leads to an increased accumulation of foreign assets by the EM, boosting the demand for the dollar. As a result, the dollar appreciates, and the EM's exports increase.[4]

Now, let's consider a case in which EM firms can endogenously choose the currency for invoicing. In response to the safety shock, exporters opt to increase the share of dollar invoicing to secure more dollar revenues. This strategic move enables them to borrow more in dollars, which, in turn, allows EM depositors to hold safe dollar claims more in domestic markets. Therefore, depositors are less inclined to transfer their savings to the U.S., resulting in a reduced share of foreign asset accumulation for the EM.[5] As a result, the impact of

[4]In the baseline model, it is assumed that the price elasticity of exports is 1, so the dollar's appreciation results in an increase in the EM's home-currency invoiced exports.

[5]In this model, it is not possible for EM exporters to exclusively invoice all their exports in dollars and

the safety shock on dollar appreciation is dampened. The model highlights the role of endogeneity in the invoicing currency choice for exports in amplifying the response of EM firms' dollar borrowing while mitigating the appreciation of the dollar when faced with a positive increase in the non-pecuniary value of saving in dollars. By increasing the share of dollar invoicing, EM exporters can secure more dollars for collateral to supply more safe dollar claims. This, in turn, bolsters the domestic asset market for safe dollar claims, reducing the need for depositors to seek savings outside the country. Therefore, the increase in EM's foreign asset accumulation and the appreciation of the dollar are both attenuated.

I verify this mechanism with an extended model, relaxing several assumptions in the baseline by adding consumption dynamics, labor, and monetary policy. The model, calibrated to Turkey, revalidates the mechanism described above. It shows that an endogenous increase in the share of dollar invoicing in exports further amplifies dollar borrowing of exporters and dampens the responses of other macro variables, when there is a positive safety shock. In addition, I find that these amplifying/dampening effects also occur in response to U.S. and domestic monetary shocks. An exogenous increase in the U.S. interest rate through U.S. monetary tightening raises the UIP premium due to the EM monetary authority's response to control inflation caused by higher import prices. This, in turn, makes dollar borrowing relatively cheaper. When EM exporters can endogenously adjust the share of dollar invoicing in their exports, they further increase their borrowing in dollars, dampening the responses of the UIP premium and the exchange rate, similar to the safety shock case. The same logic applies to an EM monetary shock, where an additional increase in dollar borrowing share, driven by the increased share of dollar invoicing, prompts depositors to reduce foreign asset holdings further, amplifying the responses of the exchange rate and output.

To assess whether this theoretical insight finds support in real-world data, I conduct a comparison of the responses of Turkey and Thailand to external shocks. These two countries are selected for analysis because Turkey experiences high volatility in dollar invoicing shares in exports, indicating frequent changes in firms' invoicing currency choices. In contrast, Thailand maintains a relatively stable share of dollar invoicing, reflecting a country with a low variation in dollar invoicing shares. Examining the impulse responses of macro variables to a positive safety shock, I observe that Turkey's dollar borrowing share actually increases more than that of Thailand, while the responses of other variables are less pronounced in Turkey. A positive safety shock is proxied by an exogenous increase in the VIX, and the dynamic

fully satisfy the domestic depositor's demand for saving in dollars due to the associated costs of dollar invoicing. The cost of dollar invoicing is assumed to be substantial enough to ensure that the EM's foreign asset accumulation remains positive.

responses are obtained through a local projection method. Through this analysis, I confirm the role of invoicing currency choice in either dampening or amplifying the responses of EMs to external shocks, as elucidated in the theoretical framework. This empirical evidence aligns with the theoretical predictions and underscores the significance of invoicing currency decisions in shaping EMs' responses to external shocks.

In sum, this paper primarily focuses on how exporters determine their invoicing currency choices in response to the global financial cycle. By connecting Gopinath and Stein (2019) and Kekre and Lenel (2021), I unveil a crucial mechanism that connects the decision to borrow in dollars with the choice of invoicing currencies, particularly in relation to global risk. This linkage allows for an examination of how shocks spread and the impact of policies in EMs, which can be either amplified or mitigated due to the endogenous response of invoicing currency decisions. Given empirical support for the substantial role of invoicing currency choice in shock propagation, it becomes important to consider this factor when making policy decisions and conducing macroeconomic studies. Understanding the dynamics of invoicing currency choices is essential for policymakers and researchers, as it plays a significant role in shaping economic outcomes during periods of global financial uncertainty.

Related Literature

Recent papers have emphasized the important role of invoicing currency choices in open economies. Goldberg and Tille (2008), Gopinath (2016), Gopinath et al. (2020), and Boz et al. (2020) highlight the significance of the U.S. dollar as a dominant unit of account. In particular, Gopinath et al. (2020) introduce a novel open-economy framework that incorporates the Dominant Currency Paradigm (DCP), shedding light on exchange rate pass-through as a consequence of price stickiness. Zhang (2020) studies the role of invoicing currencies in transmitting U.S. monetary policy, while Barbiero (2020) investigates firms' currency mismatches arising from disparities in the invoicing currencies of their exports and imports. However, these papers primarily examine the impact of various invoicing currencies based on observed currency shares within their respective contexts.

A few papers have explored the endogenous choice of invoicing currency in international trade. Building on the seminal work of Engel (2006), which suggests a connection between currency choice and a firm's pricing decisions, Gopinath et al. (2010) provide a model that accounts for the endogenous invoicing currency choice in a dynamic environment. Mukhin (2020) extends these currency choice models to real-world data, finding that firm-specific characteristics, such as import intensity and size, play important roles in determining the invoicing currency. Empirically, papers, including Amiti et al. (2020) and Javadekar et al. (2021), have matched firm-level invoicing currency data with firm-level characteristics to examine firms' endogenous currency invoicing choices. However, these studies have largely remained silent regarding the dynamics and variations in invoicing behaviors over time. My contribution to this literature lies in investigating the cyclical co-movements of dollar invoicing choices with dollar borrowing shares, while also presenting a model that offers insights into how invoicing and borrowing decisions are dynamically linked.

The idea of connecting real and financial outcomes to assess the significance of the U.S. dollar as an invoicing currency was first suggested by Gopinath and Stein (2019). Their work introduces a feedback loop between dollar invoicing and the demand for safe dollar assets. As the share of dollar invoicing in international trade increases, domestic importers pay more of their expenses in dollars. This, in turn, leads to a heightened demand for safe dollar assets, resulting in an increase in the safety premium. This increased privilege encourages firms to borrow in dollars, and consequently, they choose to invoice more of their exports in dollars, as it ensures dollar revenues in the following period. However, the starting point of this feedback loop is not clearly defined in the work of Gopinath and Stein (2019). In my paper, I propose the global financial cycle as one of the potential factors that drive firms' decisions regarding invoicing currency and borrowing. Specifically, firms' dollar borrowing shares increase because the cost of dollar borrowing becomes more attractive when importers are obligated to pay more for their imports in dollars. I suggest that the UIP condition is violated due to an increase in the non-pecuniary value of safe dollar claims, particularly during global financial downturns. This links firms' choices for invoicing and borrowing currencies to the global risk cycle.

By presenting the effects of a shock in the demand for safe dollar claims while considering endogenous invoicing currency choices, I contribute to the broader literature that examines convenience yields (Engel (2016), Engel and Wu (2020), Jiang et al. (2020), Jiang et al. (2021), and Valchev (2020)). Notably, I connect the insights of Gopinath and Stein (2019) with the work of Kekre and Lenel (2021), which investigates the consequences of time-varying demand for safe dollar assets. In particular, Kekre and Lenel (2021) quantifies the impacts of safety shocks, considering heterogeneity in risk-bearing capacity to study the transmission of monetary and fiscal policies globally. It's important to note that in the framework of Kekre and Lenel (2021), all domestically produced goods are invoiced in the domestic currency. By endogenizing the choice of invoicing currency, I illustrate how the effects of a safety shock can be mitigated or amplified.

In addition to studying the role of endogenous invoicing currency decisions in the propagation of shocks related to convenience yields, I contribute to the literature on the policy implications of invoicing currency. I provide insights into how policy impacts are amplified or dampened as the choice of invoicing currency endogenously responds to policy shocks. Recently, the international macro literature has emphasized the importance of invoicing currency for the dynamics of the economy, especially concerning exchange rates and terms of trade. Gopinath et al. (2020) and Boz et al. (2020) focus on the impacts of policy shocks when exports are invoiced in dollars rather than in the home currency in small open countries. Meanwhile, Corsetti and Pesenti (2007), Devereux and Engel (2003), and Egorov and Mukhin (2023) provide analyses of the importance of invoicing currency in studying international policy spillovers and optimal exchange rate policies. Adding to this literature, I focus on the role of *endogenous* changes in the share of dollar invoicing in studying the response to policy shocks, rather than solely focusing on the role of different currencies as the currencies of pricing.

Layout

The rest of this paper proceeds as follows. Section 2 provides the empirical observations that serve as the foundation of this paper. Section 3 introduces a baseline model, while Section 4 provides analytical insights derived from this model. Section 5 extends the model and studies dynamic responses, and Section 6 concludes.

2 Empirical Analysis

As indicated in recent papers (Gopinath (2016), Boz et al. (2020)), invoicing currency decisions are relatively stable over time. A specific currency in invoicing tends to maintain its dominance and is not frequently displaced by others. However, I observe common patterns in the cyclical movements of invoicing currencies across various countries using data related to country-level invoicing currencies and corporate borrowing. I present two prominent empirical observations. First, dollar invoicing shares in exports co-move positively with dollar borrowing shares. Second, there exists a positive correlation between the shares of borrowing in dollars and the VIX. Based on these observations, I propose a hypothesis suggesting that exporters' decisions to borrow in dollars may function as a key mechanism linking the global financial cycle and the choice of invoicing currency. To provide further empirical support

Table 1: An Example of Valuation Effects

	Dollar-invoiced	Yen-invoiced
Value in invoicing currency	\$1M	¥100M
¥100 = \$1		
Value in \$	\$1M	\$1M
Share of \$ invoicing	50%	50%
¥120 = \$1		
Value in \$	\$1M	\$0.83M
Share of \$ invoicing	54.5%	45.5%

for this proposed mechanism, I conduct panel regression analyses, which provide additional support for the suggested hypothesis.

2.1 Data

Based on an analysis of newly introduced data on invoicing currency presented in Boz et al. (2020), I examine the dynamics of invoicing choices over time. The dataset provides country-level information about the annual shares of exports invoiced in various currencies.[6] The dataset includes periodic values for each country, but some values are missing due to data discontinuity. For example, the dollar invoicing data for Croatia spans from 2000 to 2018, with gaps in 2015 and 2017. To focus on the time-varying and cyclical movements of invoicing shares, I limit my analysis to 21 countries that possess time series data longer than 12 years without any missing values.[7]

Due to the absence of an international standard for the exact definition of trade invoicing shares, there are certain challenges in interpreting the data. In some cases, the measurement of invoicing currency shares relies on the choice of payment or settlement currency in Boz et al. (2020). For instance, the calculation of dollar invoicing shares in South Korea involves the use of settlement currency, whereas invoicing currency is directly applied in the case of Japan. However, survey evidence suggests that, in general, invoicing and settlement

[6] I focus exclusively on shares of invoicing currency in exports, assuming that these decisions are made by exporters. This assumption aligns with previous studies by Engel (2006), Gopinath et al. (2010), and Amiti et al. (2020), who explore the endogenous invoicing currency choices of exporters. Empirically, Amiti et al. (2020) provide evidence suggesting that invoicing currency choices primarily depend on exporters' characteristics rather than importers'.

[7] My sample countries include Australia, Belgium, Brazil, Chile, Colombia, Czech Republic, France, Germany, Greece, Indonesia, Italy, Japan, Luxembourg, New Zealand, Norway, Portugal, Russia, South Korea, Spain, Thailand, and Türkiye. This list consists of countries with time series data spanning at least 10 periods of de-trended data after merging with borrowing data from the BIS Global Liquidity Indicators.

currencies tend to coincide in international trade (see Ito et al. (2011) and Friberg and Wilander (2011)). Therefore, in this paper, I use the terms "pricing currency" and "invoicing currency" interchangeably.

Moreover, it is important to acknowledge that the calculation of invoicing shares involves translating transaction values into a common currency, which can introduce significant valuation effects. For example, consider a Japanese firm that exports goods both to the United States (*in dollars*) and to Thailand (*in yen*). In 2019, the firm's exports to the U.S. amounted to one million dollars, while its exports to Thailand were valued at a hundred million yen. As illustrated in Table 1, if the exchange rate changes from 100 yen per dollar to 120 yen per dollar, the share of dollar invoicing for the firm changes from 50 percent to 54.4 percent, even though there has been no change in the transaction values or invoicing currencies. The appreciation of a specific currency can result in an increase in the shares of invoicing in that currency. To mitigate this currency-related distortion, I adjust the dollar invoicing shares by using constant exchange rates from the year 2000, as elaborated in Appendix A.1.

For calculating dollar borrowing shares, I use the BIS Global Liquidity Indicators (GLI) database, which draws data from the BIS Locational Banking Statistics and BIS International Debt Securities Statistics. This database allows for the calculation of aggregate shares of dollar borrowing by firms. Specifically, I derive these shares by dividing the total dollar credit to non-financial corporations by total credit to non-financial corporations. The total dollar credit is the sum of debt securities and loans denominated in dollars. The construction of these dollar borrowing shares follows Kalemli-Ozcan et al. (2020).

Table 2 provides summary statistics of dollar borrowing shares and dollar invoicing shares across the sample countries. The dataset comprises 21 countries that have annual data available for both invoicing and borrowing currency shares, covering a minimum of 12 consecutive years. On average, approximately 55.8% of exports are invoiced in dollars, while firms' dollar borrowing accounts for 6% of the total. Dollar borrowing shares tend to be lower since they encompass all firms in the respective countries, whereas dollar invoicing shares specifically include exporters.[8] Dollar invoicing shares exhibit considerable variation, ranging from 7.3% to 99.7%, while dollar borrowing shares range from 0.2% to 40%. The table also presents within-country standard deviations, reflecting variations over time. The annual standard deviations for dollar invoicing shares and dollar borrowing shares are 4.6 and 7.3, respectively. The VIX varies from 11 to 31.8, with a mean value of 19.5. In addition, the table provides

[8] "Total credit to non-financial corporations" may include credit extended to firms that do not engage in dollar borrowing. Therefore, the number of firms included in "Total credit" can significantly exceed the number of firms included in "Total dollar credit."

Table 2: Summary Statistics

	Mean	Median	Min	Max	Std	Obs	# countries
Dollar Inv. Shares in Exports							
Raw data	55.8	56.7	7.3	99.7	4.6	340	21
Cyclical components	0.0	0.0	-10.9	10.8	2.3	305	21
Dollar Borr. Shares							
Raw data	6.0	3.0	0.2	40.0	7.3	340	21
Cyclical components	0.0	-0.04	-7.0	12.9	1.4	305	21
VIX							
Raw data	19.5	17.6	11.0	31.8	6.0	21	-
Cyclical components	0.0	-1.2	-5.4	10.9	4.1	19	-

Notes: The table presents summary statistics for all observations obtained after merging the datasets for invoicing and borrowing currencies. The variables in the table represent adjusted percentages, as detailed in Appendix A.1, for both dollar invoicing and dollar borrowing shares. The corresponding summary statistics for the raw data are presented in the Appendix. Cyclical components are estimated using the Hamilton (2018) filter. *Source: Boz et al. (2020) and BIS Global Liquidity Indicator*

summary statistics for the cyclical components of these variables, obtained by de-trending the data using the Hamilton (2018) filter. The cyclical components for dollar invoicing shares and dollar borrowing shares range from -10.9 to 10.8 and -7 to 12.9, respectively. The time-series standard deviations indicate that dollar invoicing shares exhibit more variation than dollar borrowing shares, with standard deviations of 2.3 and 1.4, respectively.

2.2 Stylized Facts

I present two stylized facts regarding the cyclical fluctuations in dollar invoicing and dollar borrowing shares, observed from the country-level data.

Stylized Fact 1: There is a positive co-movement between dollar invoicing in exports and dollar borrowing

Figure 1 depicts the cyclical fluctuations in dollar invoicing and borrowing shares. The figure draws the common factors of the de-trended variables, estimated using a dynamic factor model following Stock and Watson (1999). For consistency, I focus on countries with complete data available for the period spanning from 2000 to 2018.[9] The figure demonstrates a

[9]The list of these countries comprises the Czech Republic, France, Greece, Japan, Norway, South Korea,

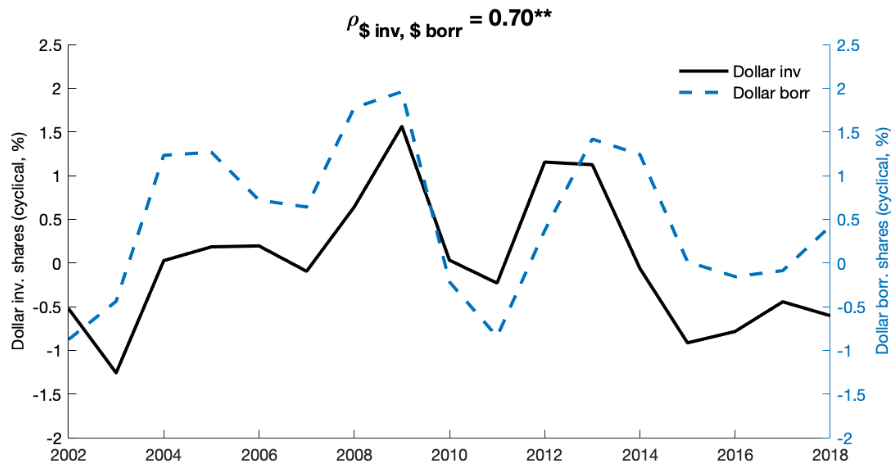

Figure 1: Co-movements between Dollar Invoicing and Dollar Borrowing Shares

Notes: The data is annual and covers the period from 2000 to 2018. The series starts from 2002, although the underlying data begin in 2000, as the cyclical components are calculated based on 2-year-ahead forecast errors using the Hamilton (2018) filter. The common factors of dollar invoicing shares and dollar borrowing shares in the sample are estimated using a dynamic factor model (Stock and Watson (1999)). The variables are adjusted to constant exchange rates, following the methods described in Appendix A.1. ** indicates significance at the 5% level.

positive co-movement between dollar invoicing shares and dollar borrowing shares, indicating a significant correlation of 70%.[10] This finding builds on the work of Gopinath and Stein (2019), who identify a positive correlation between aggregate dollar borrowing and dollar invoicing shares across different countries. I present that this positive correlation is not only consistent across various countries but also persists over time.

Stylized Fact 2: Dollar borrowing shows a positive co-movement with the VIX

I also explore the relationships between dollar borrowing and the global financial cycle, represented by the VIX. Figure 2 illustrates the cyclical dynamics of dollar borrowing shares and the VIX, with the data de-trended using the Hamilton (2018) filter. The blue long-dashed line represents the common factor of dollar borrowing shares, estimated using the dynamic factor model based on Stock and Watson (1999). The red dotted-dashed line depicts the VIX. The figure shows a notable increase in dollar borrowing shares, particularly during

Thailand, and Turkey. Detailed country-by-country correlations for all sample countries can be found in Appendix A.3.

[10] I also observe a positive co-movement between dollar invoicing shares and dollar borrowing shares when using non-adjusted data, as presented in Appendix A.1.

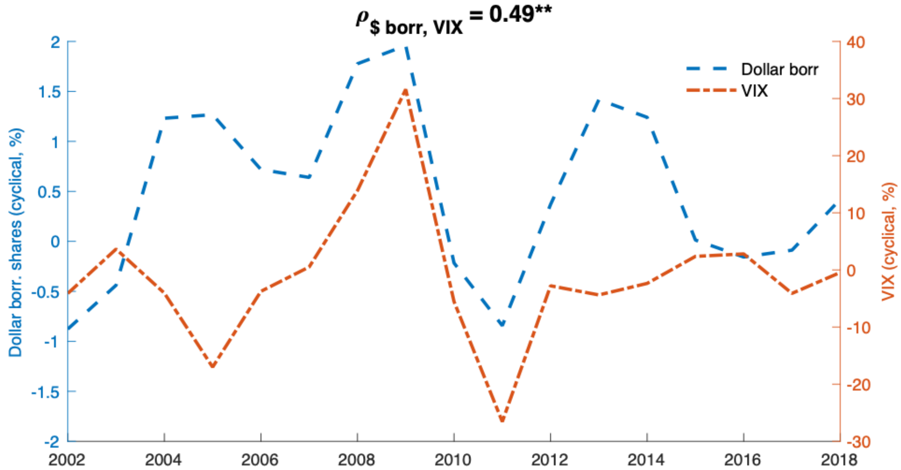

Figure 2: Dollar Borrowing Shares and the VIX

Notes: The data is annual and covers the period from 2000 to 2018. The series starts from 2002, because the cyclical components are calculated based on 2-year-ahead forecast errors using the Hamilton (2018) filter. The common factors of dollar borrowing shares are estimated using a dynamic factor model (Stock and Watson (1999)). The variables are adjusted to constant exchange rates, following the methods described in Appendix A.1. ** indicates significance at the 5% level.

the 2007-08 global financial crisis, followed by a decrease after the crisis subsided. Moreover, we observe simultaneous increases in both the VIX and dollar borrowing shares after 2012, coinciding with events such as the U.S. taper tantrum and the European crisis.

Several studies have consistently emphasized the close relationship between the global financial cycle and credit markets. For instance, di Giovanni et al. (2021) shows a positive co-movement between firms' foreign currency borrowing and the UIP risk premium in Türkiye, both of which exhibit correlations with the VIX. This finding aligns with the observations presented above, given that a substantial portion of Türkiye's foreign currency borrowing is denominated in dollars. Similarly, Kalemli-Ozcan and Varela (2022) identify co-movements between UIP premia and the VIX in the context of emerging market countries, suggesting an increased tendency for dollar borrowing during periods of high global risk, where higher expected excess returns on domestic currency make dollar borrowing relatively more affordable. This observation is in line with theoretical arguments by Salomao and Varela (2018) and Gopinath and Stein (2019), emphasizing that decreases in excess returns for the dollar provide an incentive for dollar borrowing. Adding to these existing findings, I provide an additional observation of a positive co-movement between dollar borrowing and the global financial cycle within my sample countries, complementing the observed positive correlation between dollar borrowing and dollar invoicing shares.

2.3 Possible Mechanism

Consider an exporter who purchases capital K_t for the production of goods. To finance this capital investment, the exporter requires borrowing, which can be in either the home currency, $B_{h,t}$, or in dollars, $B_{\$,t}$:

$$K_t = B_{h,t} + \varepsilon_t B_{\$,t}$$

where ε_t is the exchange rate between the home currency and the dollar, which rises when the dollar appreciates. The exporter decides the currency in which to invoice its exports, choosing between the home currency and the dollar.

I assume that the exporter's dollar borrowing is limited, ensuring that the repayment of dollar debt does not exceed the expected dollar revenue:[11]

$$R_{\$,t} B_{\$,t} \leq \mathbb{E}_t RV_{\$,t+1} \tag{1}$$

where $R_{\$,t}$ denotes the dollar borrowing rate, and $\mathbb{E}_t RV_{\$,t+1}$ is the expected revenues denominated in dollars. This constraint effectively requires that firms must use dollar-denominated collateral when engaging in dollar borrowing. This constraint becomes binding when the UIP condition is violated, resulting in an excess return on the home currency. Studies such as Gilmore and Hayashi (2011) and Hassan (2013) document that safe dollar assets typically yield lower expected returns compared to the risk-free assets of most other currencies. Therefore, suppose that the constraint on dollar borrowing is always binding: $R_{\$,t} B_{\$,t} = \mathbb{E}_t RV_{\$,t+1}$. In addition, assume that the borrowing constraint is tight enough that the firm must also secure a positive amount of borrowing in the home currency to finance its production ($B_{h,t} > 0$).

The mechanism underlying the observations in Stylized Facts 1 and 2 is illustrated in Figure 3. When the VIX increases, the UIP premium also goes up, as documented in di Giovanni et al. (2021) and Kalemli-Ozcan and Varela (2022), meaning a reduction in the cost of dollar borrowing. This occurs because global investors intensify their demand for holding safe assets denominated in dollars, considering the dollar as a safe-haven currency. The heightened demand for dollar-denominated risk-free assets leads to an increase in the price of saving in dollars ($R_{\$,t} \Downarrow$). Then, the constraint on dollar borrowing faced by firms

[11] The constraint can be expressed as a multiple of the expected dollar revenue (i.e., $\lambda \mathbb{E}_t RV_{\$,t+1}$ for a constant λ). For simplicity, I focus on the case where $\lambda = 1$.

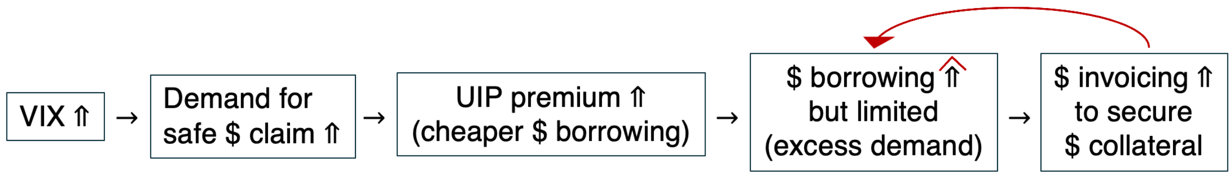

Figure 3: Mechanism

is loosened for a given level of expected dollar revenues. With dollar borrowing now more cost-effective, firms choose to borrow more in dollars ($B_{\$,t} \Uparrow$). This explains the positive co-movement observed between the VIX and dollar borrowing shares in both the existing literature and in Stylized Fact 2.

However, as dollar borrowing becomes cheaper than borrowing in the home currency, firms seek to increase the share of dollar borrowing. Nevertheless, the constraint (1) limits the extent to which firms can borrow in dollars. In response, firms raise the share of dollar invoicing in their exports, thereby increasing the expected revenues denominated in dollars, $RV_{\$,t+1}$, which can serve as collateral for dollar borrowing. This strategic choice, in turn, relaxes the constraint on dollar borrowing, allowing the share of dollar borrowing to increase even further. Thus, a high VIX results in an increase in dollar invoicing, reinforcing the rise in dollar borrowing, as described in Figure 3.

Table 3: Dollar Borrowing as a Mechanism linking Dollar Invoicing and the VIX

	(1)	(2)	(3)	(4)
$ borrowing share	0.405**			0.369**
	(0.147)			(0.149)
VIX		0.109**		0.100*
		(0.048)		(0.048)
UIP premium			0.113	0.081
			(0.148)	(0.141)
Countries	12	12	12	12
Country FE	Yes	Yes	Yes	Yes
Observations	154	154	154	154
R^2	0.269	0.290	0.266	0.315

Notes: The standard errors, adjusted for clustering of observations at the country level, are in parenthesis. Comprehensive regression results are presented in Appendix A.4. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

Table 3 provides additional evidence that emphasizes the close relationship between dollar borrowing and dollar invoicing. The table presents the results of regression analyses base on the following equation:

$$\$ \text{ invoicing share in EX}_{i,t} = \beta \cdot X_{i,t} + \lambda_i + \epsilon_{i,t} \tag{2}$$

where $X_{i,t}$ includes the VIX, UIP premium, dollar borrowing shares, and dollar invoicing shares in imports. I run a panel regression by including the variables one by one and then collectively. λ_i refers to country fixed effects, and $\epsilon_{i,t}$ denotes the error terms. Standard errors are clustered at the country level.

To construct the annual level of the UIP premium for each country, I use 12-month deposit rates from Bloomberg, spot exchange rates from the IMF's International Financial Statistics (IFS), and the 12-month ahead expected exchange rates from Consensus Economics. The UIP premium represents the deviation from the UIP condition in logged terms:

$$\text{UIP premium}_{i,t} = i_{i,t} - i_{US,t} + XR_{i,t} - XR^e_{i,t+1} \tag{3}$$

where $i_{i,t}$ and $i_{US,t}$ are 12-month deposit rates in country i and the U.S., respectively. $XR_{i,t}$ denotes the logged spot exchange rate, and $XR^e_{i,t+1}$ is the 12-month ahead expected exchange rates of country i relative to the dollar (logged). An increase in the exchange rate means depreciation of the currency of country i. I follow Kalemli-Ozcan (2020) and Kalemli-Ozcan and Varela (2022) to calculate the UIP premium.

The results in Table 3 do not establish causality but rather illustrate the correlations between the variables. Of particular interest is the strong relationship between firms' dollar borrowing and dollar invoicing, as emphasized in the table. To ensure consistent comparison of regression results, the sample is limited to countries that have all the variables for dollar borrowing shares, the VIX, and the UIP premium, and dollar invoicing shares in imports. Columns (1)-(4) of the table show the coefficients obtained from the panel regression. From Columns (1)-(2), we observe that the coefficients on the share of dollar borrowing and VIX are all significant and positive, implying that these variables are closely and positively correlated with the share of invoicing in exports. In Column (4), when these variables are included together with the UIP premium, we can see that the coefficient on dollar borrowing shares is still significant and positive. This implies the importance of firms' dollar borrowing decisions in linking the share of dollar borrowing in exports with the global financial cycle.

To summarize, I present two stylized facts about the dynamic co-movements of invoicing and borrowing currency decisions. First, dollar invoicing shares in exports positively co-move with dollar borrowing shares of firms.[12] Second, dollar borrowing shares exhibit positive co-movements with the VIX. Drawing from these facts, I propose that dollar borrowing serves as a key channel linking dollar invoicing in exports and the global financial cycle. As the cost of dollar borrowing decreases during periods of global financial instability, firms choose to invoice a larger share of their exports in dollars, thereby securing dollar revenues that can be used as collateral to expand their dollar borrowing. In the next section, I provide a theoretical model that outlines this mechanism in detail.

3 The Baseline Model

I begin with a baseline model that establishes a link between global uncertainty and the choices made by EM exporters concerning dollar borrowing and dollar invoicing. This model simplifies both the demand and production sides, aiming to illustrate how EM exporters' decisions regarding borrowing and invoicing respond to an external shock that affects the global demand for safe dollar assets.

The model adopts Gopinath and Stein (2019), tailored to investigate the impacts of high global uncertainty on the shares of dollar borrowing and dollar invoicing in exports. Gopinath and Stein (2019) demonstrate that an increased demand for secure dollar assets induces exporters to both invoice and borrow more in dollars, thereby amplifying the violation of the UIP. Depositors demand more safe dollar assets when dollar shares of imports increase, which is fed back to an increase in dollar shares of exports. However, I depart from Gopinath and Stein (2019) in three key aspects. First, I focus on scenarios where high global risk prompts depositors to exhibit a stronger preference for saving in dollars due to the dollar's status as a safe-haven currency. Thus, the external shock that intensifies depositors' interest in safe dollar claims is referred to as a *"safety shock."*[13] Second, by introducing a dynamic model that incorporates the endogenous determination of exchange rates, I examine the evolving impact of increased global uncertainty on the external balance, exchange rates, and the dollar borrowing and invoicing decisions of EMs. Lastly, I investigate how the time-varying endogeneity in invoicing currency choice influences the responses of other key EM variables to the safety shock.

Figure 4 explains the structure of the model, where the world is comprised of two coun-

[12] In Appendix A.2, I show that these cyclical movements are not solely driven by the performance fluctuations of large exporters.

[13] This terminology follows Kekre and Lenel (2021).

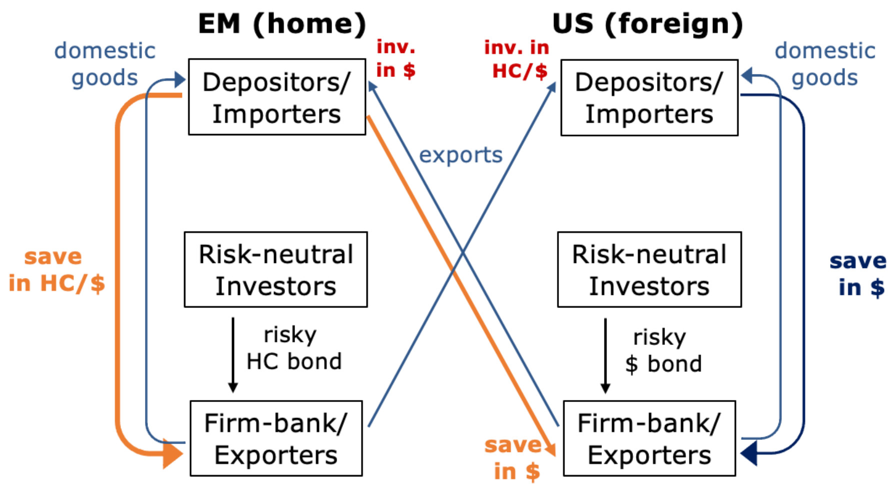

Figure 4: Model Structure

tries: the U.S. and the EM. The EM can be seen as a collective representation of multiple EM countries. Each country hosts three distinct types of agents: risk-averse depositors, risk-neutral investors, and exporters. Depositors, representing households with consumption and savings decisions, are present in both countries. EM depositors have the option to save in both dollars and their home currency, while U.S. depositors exclusively engage in dollar-based savings. When EM depositors choose to save in dollars, they initially acquire safe dollar claims from domestic firms. In case the supply of these claims is insufficient, they turn to foreign sources, typically U.S. treasuries. U.S. depositors, on the other hand, focus solely on domestic saving activities. Each country's depositors own risk-neutral investors. These investors receive endowments from their respective owners, invest in risky assets, and subsequently deliver returns to the owners in the next period. The markets for risky bonds in dollars and home currency are segmented.

Exporters, represented as bank-firm coalitions, seek financing for their production investments. EM exporters engage in borrowing in both dollars and EM currency, while U.S. exporters exclusively borrow in dollars. EM exporters make choices regarding the currency in which they will receive revenues, a decision referred to as invoicing currency choice. EM exporters determine the share of dollar invoicing, with the remaining being invoiced in the home currency. These EM exporters also participate in domestic trade, where payments are exclusively made in EM currency. U.S. exporters, in contrast, exclusively invoice in dollars for both domestic transactions and exports. Details are provided below.

3.1 Depositors/Importers

The representative U.S. depositor engages in consumption of the domestically-produced non-tradable good, C_t^*, and the imported foreign good, M_t^*. The depositor saves in dollars, $D_{\$,t}^*$, with returns at rate $R_{\$,t}$. The U.S. depositor's objective is to solve

$$\max_{C_t^*, M_t^*, D_{\$,t}^*} \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^*)^t [C_t^* + \chi_m^* ln(M_t^*) + \omega_t^* ln(D_{\$,t}^*)]$$

subject to the budget constraint:

$$\begin{aligned} & C_t^* + \{\varepsilon_t^{-1}(1-\eta_{t-1}) + \eta_{t-1}\} M_t^* + D_{\$,t}^* + W_t^* \\ & \leq \Pi_t^* + R_{\$,t-1} D_{\$,t-1}^* + \xi_t^* R_{R,t-1}^* W_{t-1}^* \end{aligned} \tag{4}$$

where Π_t^* represents profits transferred from exporters, W_t^* is an endowment transferred to a risk-neutral investor owned by the U.S. depositor, and ε_t denotes the exchange rate between the EM currency and the dollar at time t, where an increase in ε_t implies dollar appreciation. The parameter χ_m^* reflects the depositor's preference for imported goods, and the price of one unit of EM goods expressed in dollars is given by $\{\varepsilon_t^{-1}(1-\eta_{t-1}) + \eta_{t-1}\}$. EM exporters choose the currency in which they invoice their exports to the U.S. depositor. A share $\eta_{t-1} \in [0, 1]$ of the U.S. depositor's imports from the EM is denominated in dollars.[14] The price of the domestic good in each country is normalized to unity, thus eliminating the distinction between the terms of trade and the real exchange rate between EM currency and the dollar, $\{\varepsilon_t^{-1}(1-\eta_{t-1}) + \eta_{t-1}\}^{-1}$.[15] I assume a linear utility function in domestic consumption to simplify the model and focus on the dynamics related to borrowing and invoicing choices. This assumption can be relaxed in later extensions of the model to explore policy implications.

The term $\omega_t^* ln(D_{\$,t}^*)$ captures a preference for holding safe dollar claims. This formulation aligns with Kekre and Lenel (2021), which incorporates a preference for risk-free dollar bonds in household utility functions. It also follows the approach of Gopinath and Stein (2019) and recent studies including Krishnamurthy and Vissing-Jorgensen (2012), Stein (2012), Greenwood et al. (2015), Sunderam (2015), and Nagel (2016) employing a utility function

[14] The share of dollar invoicing in EM exports at time t is determined at time $t-1$ by EM exporters, which will be described in detail, in the next subsection.

[15] This normalization follows that of Akinci and Queralto (2021). In the extended model, prices of domestically-produced goods will fluctuate, making the distinction between the terms of trade and the real exchange rate relevant.

that explicitly includes a preference for money-like assets. In particular, ω_t^* represents a time-varying demand for safety. When global uncertainty increases, there is an exogenous rise in the U.S. depositor's preference for safe dollar assets, denoted by ω_t^*. This can be interpreted as a flight to safety during periods of high global risk.[16] The first-order conditions for the U.S. depositor are as follows:

$$M_t^* = \frac{\varepsilon_t \chi_m^*}{\varepsilon_t \eta_{t-1} + 1 - \eta_{t-1}} \tag{5}$$

$$1 = \frac{\omega_t^*}{D_{\$,t}^*} + \beta^* R_{\$,t} \tag{6}$$

EM depositors face a problem analogous to that of U.S. depositors, with their discount factor denoted as β, a preference parameter over imports denoted as χ_m, domestic consumption denoted as C_t, and imports denoted as M_t. EM depositors also own risk-neutral investors to whom they provide endowments upon request. The risk-neutral investors generate returns from investment in risky home currency assets, earning the interest on such assets. EM depositors engage in saving in both dollars and the home currency, and they express preferences over safe dollar claims, denoted as ω_t. In sum, the problem faced by EM depositors can be formulated as follows:

$$\max_{C_t, M_t, D_{h,t}, D_{\$,t}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [C_t + \chi_m ln(M_t) + \omega_t ln(D_{\$,t})]$$

subject to

$$\begin{aligned} & C_t + \varepsilon_t M_t + D_{h,t} + \varepsilon_t D_{\$,t} + W_t \\ & \leq \Pi_t + R_{h,t-1} D_{h,t-1} + \varepsilon_t R_{\$,t-1} D_{\$,t-1} + \xi_t R_{R,t-1} W_{t-1} \end{aligned} \tag{7}$$

Then the first-order conditions for the EM depositor are as follows:

$$\varepsilon_t M_t = \chi_m \tag{8}$$

$$\beta R_{h,t} = 1 \tag{9}$$

$$D_{\$,t} = \frac{\omega_t}{\beta(\varepsilon_t R_{h,t} - \mathbb{E}_t \varepsilon_{t+1} R_{\$,t})} \tag{10}$$

Suppose EM depositors never borrow but only engage in saving ($D_{h,t}, D_{\$,t} > 0$), then the

[16] We can also think of ω_t^* as a variable measuring depositor risk aversion. U.S. depositors become more risk-averse during highly uncertain periods that trigger a flight to safety, as in Vayanos (2004), a characteristic that also applies to EM depositors.

EM depositor borrows a positive amount in dollars only when they have a positive preference for safe dollar claims (i.e., $\omega_t > 0$). When $\omega_t > 0$, the UIP condition is violated, implying a positive premium on the EM currency. This deviation from UIP, which I refer to as the UIP premium, u_t, indicates that the EM currency is expected to yield higher returns relative to the dollar when EM depositors favor saving in dollars. This arises because the heightened demand for dollar risk-free bonds leads to an increase in the relative price of saving in dollars:

$$u_t \equiv \frac{R_{h,t}}{R_{\$,t}} \frac{\varepsilon_t}{\mathbb{E}_t \varepsilon_{t+1}} = \frac{R_{h,t}}{\mathbb{E}_t \varepsilon_{t+1} R_{\$,t}} \frac{\omega_t}{D_{\$,t}} + 1 > 1 \tag{11}$$

The UIP condition holds when $\omega_t = 0$.

3.2 Risk-Neutral Investors

In each country, there are risk-neutral investors who invest in risky assets. The markets for risky assets are segmented for each country. Every period, the U.S. risk-neutral investor receives an endowment of W_t^*, consumes domestic goods, $C_{N,t}^*$, and invests $A_{R,t}^*$ in dollar risky assets with expected returns of $\mathbb{E}_t \xi_{t+1}^* R_{R,t}^*$. After receiving returns from the risky assets, the investor returns the endowment with interest, $\xi_{t+1}^* R_{R,t}^* W_t^*$, to the depositor. A risk-neutral investor chooses how much to receive from its owner, W_t^*, and purchases dollar risky assets supplied by exporters. The risk-neutral investor seeks to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\delta^*)^t C_{N,t}^*$$

subject to the resource constraint:

$$C_{N,t}^* + A_{R,t}^* + \xi_t^* R_{R,t-1}^* W_{t-1}^* \leq \xi_t^* R_{R,t-1}^* A_{R,t-1}^* + W_t^*$$

where δ^* denotes the investor's discount factor.

Similarly, the EM risk-neutral investor is endowed with W_t, consumes EM goods, $C_{N,t}$, and invests $A_{R,t}$ in a home-currency risky assets, with expected returns $\mathbb{E}_t \xi_{t+1} R_{R,t}$. Assuming $\mathbb{E}_t \xi_{t+1} = \mathbb{E}_t \xi_{t+1}^* = 1$, the first-order conditions of EM and U.S. risk-neutral investors are given by:

$$\delta R_{R,t} = 1, \quad \delta^* R_{R,t}{}^* = 1$$

Since both investors are risk-neutral, they can invest in risky assets with high expected returns, which indicates that they are less patient than risky investors. Therefore, the risk-neutral investors' discount factor is smaller than that of depositors: $0 < \delta < \beta < \beta^*$. I also assume that the U.S. risk-neutral investors are equally patient as the EM investors, so $\delta^* = \delta$.[17]

3.3 Exporters/Firm-Bank Coalitions

A continuum of exporters, each belonging to a depositor in their respective countries, has a two-period lifespan. In their first period t, these exporters enter the market, invest in capital yielding a risky return, engage in production, sell their products, and receive revenues. Due to uncertainty associated with returns on capital investment, these firms secure necessary funds for investment through a combination of borrowing from domestic depositors and borrowing from risk-neutral investors.

U.S. exporters borrow in dollars, $B^*_{\$,t}$, from U.S. depositors to fund their investment in capital, K^*_t. They invoice all of their revenues in dollars. Let Z^*_{t+1} represent the dividend generated by their capital investment. The objective of U.S. exporters is to maximize their expected profits:

$$\mathbb{E}_t \Pi^*_{t+1} = \mathbb{E}_t[(Z^*_{t+1} + Q^*_{t+1})K^*_t - R_{\$,t}B^*_{\$,t} - \xi^*_{t+1}R^*_{R,t}B^*_{R,t} + \frac{\psi}{2}(1-\alpha)^2\eta_t^2 K_t \varepsilon_t^{-1}]$$

with discount factor β^* subject to the constraints $R_{\$,t}B^*_{\$,t} \le (Z^*_L + Q^*_L)K^*_t$ and $B^*_{\$,t} + B^*_{R,t} \ge Q^*_t K^*_t$. Here, $B^*_{R,t}$ represents funds borrowed from U.S. risk-neutral investors using risky bonds, and Q^*_t is the market price of a unit of capital in the U.S. Z^*_L and Q^*_L denote the worst realizations of Z^*_{t+1} and Q^*_{t+1}, respectively.[18] The last term in the objective function is the cost of dollar invoicing, which EM exporters pay to U.S. exporters. This cost reflects the advantage enjoyed by U.S. exporters operating in the U.S., as they can sell their goods in dollars without incurring the additional risk associated with exchange rate fluctuations. The details of this cost are elaborated on in the EM exporter's problem below.

EM exporters finance their investments in capital, K_t, through a combination of funds borrowed from EM depositors using risk-free bonds $B_{h,t}$ and $B_{\$,t}$, as well as funds borrowed from EM risk-neutral investors using risky bonds $B_{R,t}$:

$$Q_t K_t \le B_{h,t} + \varepsilon_t B_{\$,t} + B_{R,t}$$

[17] I can assume that EM risk-neutral investors are less patient than the U.S. risk-neutral investors ($\delta^* > \delta > 0$) without significantly impacting the analysis results.

[18] Suppose $Z^*_L + Q^*_L \le R_{\$,t}$, then $B^*_{\$,t} = (Z^*_L + Q^*_L)K^*_t / R_{\$,t}$. It means that we need risky bonds $B^*_{R,t}$ to finance the capital investment, as Z^*_{t+1} is stochastic.

where Q_t is the price of capital. The exporters determine in which currency they will receive dividends from their capital investments, which is referred to as the invoicing currency. The revenue of EM exporters can be expressed the sum of dividends from capital investments and the change in the value of the capital they hold:

$$\{\alpha + (1-\alpha)(1-\eta_t + \varepsilon_{t+1}\eta_t)\}Z_{t+1}K_t + Q_{t+1}K_t$$

where $\eta_t \in [0,1]$ denotes the share of dollar invoicing, which is an endogenous variable chosen by the exporter. $\alpha \in [0,1]$ is the share of the returns from capital used for domestic sales to EM depositors, with the remaining share being exported to the U.S.

The borrowing of EM exporters from depositors is constrained by the expectation that their debt repayment should not exceed their revenue under the worst possible realization of returns from capital. This constraint can be expressed as:

$$R_{h,t}B_{h,t} + \mathbb{E}_t\varepsilon_{t+1}R_{\$,t}B_{\$,t} \leq \{\alpha + (1-\alpha)(1-\eta_t + \mathbb{E}_t\varepsilon_{t+1}\eta_t)\}Z_L K_t + Q_L K_t \tag{12}$$

where Z_L and Q_L are the worst realizations of Z_{t+1} and Q_{t+1}.

When EM depositors have a preference for saving in dollars ($\omega_t > 0$), EM exporters are incentivized to borrow in dollars as much as possible due to the relatively cheaper cost of dollar borrowing compared to borrowing in the EM currency. However, from the lender's perspective, lending in dollars to EM exporters can be risky unless the exporters have a sufficient amount of expected dollar revenues to repay the dollar debt. Suppose the dollar appreciates to its most appreciated possible value at time $t+1$, denoted as $\bar{\varepsilon}$, while the EM exporter has borrowed up to the limit only in dollars at time t (i.e., $B_{h,t} = 0$ and $\mathbb{E}_t\varepsilon_{t+1}R_{\$,t}B_{\$,t} = \{\alpha + (1-\alpha)(1-\eta_t + \mathbb{E}_t\varepsilon_{t+1}\eta_t)\}Z_L K_t + Q_L K_t$). Then, the exporter needs to repay $\bar{\varepsilon}R_{\$,t}B_{\$,t}$ in debt, which exceeds its realized revenue ($\frac{\bar{\varepsilon}}{\mathbb{E}_t\varepsilon_{t+1}}\{\alpha + (1-\alpha)(1-\eta_t + \mathbb{E}_t\varepsilon_{t+1}\eta_t)\}Z_L K_t + \frac{\bar{\varepsilon}}{\mathbb{E}_t\varepsilon_{t+1}}Q_L K_t > \{\alpha + (1-\alpha)(1-\eta_t + \bar{\varepsilon}\eta_t)\}Z_L K_t + Q_L K_t$). This could lead to default because the exporter is required to pay more than they receive. Therefore, an additional constraint is imposed on the EM exporter's dollar borrowing to ensure that the repayment of dollar-denominated debt does not exceed the worst realization of dollar-invoiced revenues.

The EM exporter's profit-maximization problem can be stated as:

$$
\begin{aligned}
\max_{B_{h,t},B_{\$,t},B_{R,t},\eta_t,K_t} & \beta\mathbb{E}_t\Pi_{t+1} \\
&= \beta\mathbb{E}_t[\{\alpha + (1-\alpha)(1-\eta_t+\varepsilon_{t+1}\eta_t)\}Z_{t+1}K_t + Q_{t+1}K_t \\
&\quad - R_{h,t}B_{h,t} - \varepsilon_{t+1}R_{\$,t}B_{\$,t} - \xi_{t+1}R_{R,t}B_{R,t} - \frac{\psi}{2}(1-\alpha)^2\eta_t^2K_t] \qquad (13)
\end{aligned}
$$

subject to

$$
\begin{aligned}
B_{h,t} + \varepsilon_t B_{\$,t} + B_{R,t} &\geq Q_tK_t \qquad (14)\\
R_{h,t}B_{h,t} + \mathbb{E}_t\varepsilon_{t+1}R_{\$,t}B_{\$,t} &\leq \{\alpha + (1-\alpha)(1-\eta_t+\mathbb{E}_t\varepsilon_{t+1}\eta_t)\}Z_LK_t + Q_LK_t \qquad (15)\\
R_{\$,t}B_{\$,t} &\leq (1-\alpha)\eta_tZ_LK_t \qquad (16)
\end{aligned}
$$

where I assume that there is a cost associated with dollar invoicing, $\frac{\psi}{2}(1-\alpha)^2\eta_t^2K_t$ with $\psi > 0$, as in Gopinath and Stein (2019).[19]

Define λ_t, μ_t, and γ_t to be the Lagrange multipliers on the constraints (14), (15), and (16), respectively. Then the first-order conditions for the EM exporter's problem are given below:

$$
\begin{aligned}
&[B_{R,t}] \quad \lambda_t = \beta R_{R,t} \qquad (17)\\
&[B_{h,t}] \quad \lambda_t = (\beta+\mu_t)R_{h,t} \qquad (18)\\
&[B_{\$,t}] \quad \varepsilon_t\lambda_t = R_{\$,t}[(\beta+\mu_t)\mathbb{E}_t\varepsilon_{t+1} + \gamma_r] \qquad (19)\\
&[\eta_t] \quad \beta(1-\alpha)^2\psi\eta_t = (\mathbb{E}_t\varepsilon_{t+1}-1)(\beta Z + \mu_tZ_L) + \gamma_tZ_L \qquad (20)\\
&[K_t] \quad \lambda_tQ_t + \frac{\beta\psi}{2}(1-\alpha)^2\eta_t^2 = \{\alpha + (1-\alpha)(1-\eta_t+\mathbb{E}_t\varepsilon_{t+1}\eta_t)\}(\beta Z + \mu_tZ_L)\\
&\qquad\qquad + (1-\alpha)\eta_tZ_L\gamma_t + \beta\mathbb{E}_tQ_{t+1} + \mu_tQ_L \qquad (21)
\end{aligned}
$$

where $Z \equiv \mathbb{E}_tZ_{t+1}$ denotes the expected dividends from capital. Z_{t+1} and the exchange rate ε_{t+1} are assumed to be independent from each other.

[19] Gopinath and Stein (2019) interpret the cost as a proxy for the risk aversion of the ultimate owners of EM exporters. When the owners of these exporters are EM residents who primarily consume goods denominated in their home currency, they tend to prefer a profit stream that is also denominated in their home currency. In this paper, the exporters are owned by depositors who consume both domestic and foreign goods. The cost related to dollar invoicing occurs because EM depositors will collect profits converted to the home currency and then make consumption decisions. Even if EM depositors have high consumption of imported goods, they still incur costs related to converting profits from dollars to the home currency and then back to dollars.

When the U.S. depositor has a particular preference for holding risk-free dollar bonds ($\omega_t^* > 0$), it leads to a violation of the UIP condition, resulting in an excess return on EM currency compared to the dollar. Then the EM exporter's constraint on dollar borrowing (16) becomes binding. When the share of dollar invoicing is fixed, the EM exporter's dollar borrowing can be written as:

$$B_{\$,t} = \frac{1}{R_{\$,t}}(1-\alpha)\bar{\eta} Z_L K_t \tag{22}$$

where $\bar{\eta} \in [0, 1]$ is a constant. If the EM exporter endogenously chooses the share of dollar invoicing in its exports, from the first-order conditions (17) - (20), the share of dollar invoicing, η_t, can be expressed as follows:

$$\begin{aligned}\eta_t &= \frac{1}{\beta\psi(1-\alpha)^2}[(\mathbb{E}_t\varepsilon_{t+1} - 1)(\beta Z + \mu_t Z_L) + \gamma_t Z_L] \\ &= \frac{1}{\psi(1-\alpha)^2}[(\mathbb{E}_t\varepsilon_{t+1} - 1)(Z - Z_L) + Z_L R_{R,t}(\beta^*\varepsilon_t u_t - \beta)]\end{aligned} \tag{23}$$

where $\mu_t = \beta(\frac{R_{R,t}}{R_{h,t}} - 1) > 0$ and $\gamma_t = \beta R_{R,t}(\frac{\varepsilon_t}{R_{\$,t}} - \frac{\mathbb{E}_t\varepsilon_{t+1}}{R_{h,t}}) > 0$. Note that η_t is increasing in the expected exchange rate and the UIP premium. If the dollar is expected to appreciate ($\mathbb{E}_t\varepsilon_{t+1} \Uparrow$), the EM exporter's dollar- denominated revenues are expected to increase when converted to the EM currency, incentivizing the firm to invoice a larger portion of its exports in dollars. On the other hand, an increase in the UIP premium, u_t, means that the relative cost of dollar borrowing becomes substantially more attractive compared to borrowing in home currency. Therefore, the EM exporter's desire for increasing the share of dollar borrowing rises, prompting the firm to invoice a larger amount in dollars to secure additional dollar collateral. This aligns with empirical findings and substantiates the mechanism discussed in Section 2.

3.4 Closing the Economy

I assume a fixed supply of capital in both the EM and the U.S., given by $\bar{K} > 0$.Then the capital market clearing condition is given by $K_t = K_t^* = \bar{K}$ for all periods t. The goods market clearing requires $C_t + C_{N,t} + (\varepsilon_t\eta_{t-1} + 1 - \eta_{t-1})M_t^* = \{\alpha + (1-\alpha)(1-\eta_{t-1} + \varepsilon_t\eta_{t-1})\}Z_t\bar{K}$ and $C_t^* + C_{N,t}^* + M_t = Z_t^*\bar{K}$. The home-currency safe claims held by EM depositors should be equal to the home-currency borrowing of EM exporters: $D_{h,t} = B_{h,t}$. Similarly, the safe dollar claims held by the U.S. and EM depositors should equal the sum of dollar borrowing by EM and U.S. exporters: $D_{\$,t} + D^*_{\$,t} = B_{\$,t} + B^*_{\$,t}$. Lastly, the risky asset markets must clear: $A_{R,t} = B_{R,t}$ and $A^*_{R,t} = B^*_{R,t}$

3.5 Safety Shock and Equilibrium

3.5.1 Safety Shock

The time-varying preference of EM depositors for safe dollar claims, denoted as ω_t, follows a log AR(1) process:

$$log\omega_t - log\bar{\omega} = \rho_\omega(log\omega_{t-1} - log\bar{\omega}) + e_{\omega,t} \tag{24}$$

where $\bar{\omega}$ refers to the steady-state level value of the preference variable. The innovation $e_{\omega,t}$ is drawn from a normal distribution with mean zero and variance one. A positive exogenous shock to $e_{\omega,t}$ corresponds to a positive safety shock, indicating an increase in global uncertainty. This happens because worldwide depositors tend to demand more dollar savings when the global economy becomes more uncertain.

The U.S. depositors' demand for saving in dollars, denoted as ω^*_t, follows

$$log\omega^*_t - log\bar{\omega}^* = \rho_\omega(log\omega^*_{t-1} - log\bar{\omega}^*) + e^*_{\omega,t} \tag{25}$$

where $log\bar{\omega}^* = \Gamma^* log\bar{\omega}$, $\Gamma^* > 0$, and $e^*_{\omega,t} = \Gamma^* e_{\omega,t}$ are the steady-state level of the U.S. depositor's preference for safe dollar claims and the innovation. I will focus on the case where ω_t and ω^*_t are positive.

3.5.2 Equilibrium

The equilibrium of the two-country model is defined as follows.

Definition 1. (Equilibrium) *An equilibrium is a sequence of prices and quantities such that:*

1. *EM and U.S. depositors choose $\{C_t, M_t, D_{h,t}, D_{\$,t}\}$ and $\{C^*_t, M^*_t, D^*_{\$,t}\}$, respectively, to maximize utilities subject to resource constraints.*
2. *EM and U.S. risk-neutral investors choose $\{C_{N,t}, A_{R,t}, W_t\}$ and $\{C^*_{N,t}, {A_{R,t}}^*, W^*_t\}$, respectively, to maximize utilities subject to the resource constraints.*
3. *EM and U.S. exporters choose $\{B_{h,t}, B_{\$,t}, B_{R,t}, \eta_t, K_t\}$ and $\{{B_{\$,t}}^*, B^*_{R,t}, K^*_t\}$, respectively, to maximize the expected profits subject to resource constraints and borrowing*

constraints.

4. *Prices and interest rates are determined so that goods, capital, home-currency credit, and dollar credit markets clear.*

To focus on tracing the impact of a safety shock on specific EM variables, I simplify the equilibrium conditions as follows. The full equilibrium conditions for the baseline model are presented in Appendix B.1. To begin with, combining EM depositors' resource constraint and market clearing conditions result in the following balance-of-payments condition:

$$\varepsilon_t \chi_m^* - \chi_m - \frac{\psi}{2}(1-\alpha)^2 \eta_{t-1}^2 \bar{K} = \varepsilon_t \{D_{\$,t} - B_{\$,t} - R_{\$,t-1}(D_{\$,t-1} - B_{\$,t-1})\} \tag{26}$$

where the left-hand-side is comprised of the home-currency value of net exports, $NX_t = \varepsilon_t \chi_m^* - \chi_m$, net of the cost related to dollar invoicing, $\frac{\psi}{2}(1-\alpha)^2 \eta_{t-1}^2 \bar{K}$. The right-hand-side, $FA_t = \varepsilon_t \{D_{\$,t} - B_{\$,t} - R_{\$,t-1}(D_{\$,t-1} - B_{\$,t-1})\}$, is the net accumulation of foreign assets in home currency terms. I will redefine $NX_{\$,t} = NX_t/\varepsilon_t$ and $FA_{\$,t} = FA_t/\varepsilon_t$ as net exports and the foreign asset accumulation translated into dollars.

Then, given the realizations of exogenous ω_t and ω_t^*, the following equations determine the evolution of variables $D_{\$,t}, D_{\$,t}^*, B_{\$,t}, B_{\$,t}^*, \eta_t, R_{\$,t}, \varepsilon_t$, and u_t:

$$\begin{aligned}
& D_{\$,t} = \frac{\omega_t}{\varepsilon_t - \beta \mathbb{E}_t \varepsilon_{t+1} R_{\$,t}} \quad \text{[EM demand for dollar assets]} \\
& D_{\$,t}^* = \frac{\omega_t^*}{1 - \beta^* R_{\$,t}} \quad \text{[U.S. demand for dollar assets]} \\
& R_{\$,t} B_{\$,t} = (1-\alpha)\eta_t Z_L \bar{K} \quad \text{[EM dollar borrowing]} \\
& R_{\$,t} B_{\$,t}^* = (Z_L^* + Q_L^*)\bar{K} \quad \text{[U.S. dollar borrowing]} \\
& (1-\alpha)^2 \psi \eta_t = (\mathbb{E}_t \varepsilon_{t+1} - 1)(Z - Z_L) + Z_L \delta^{-1}\left(\frac{\varepsilon_t}{R_{\$,t}} - \beta\right) \quad \text{[EM dollar invoicing]} \\
& \varepsilon_t \chi_m^* - \chi_m - \frac{\psi}{2}(1-\alpha)^2 \eta_{t-1}^2 \bar{K} = \varepsilon_t \{D_{\$,t} - B_{\$,t} - R_{\$,t-1}(D_{\$,t-1} - B_{\$,t-1})\} \quad \text{[B.o.P]} \\
& B_{\$,t} + B_{\$,t}^* = D_{\$,t} + D_{\$,t}^* \quad \text{[Dollar asset market]} \\
& u_t = \frac{\varepsilon_t}{\mathbb{E}_t \varepsilon_{t+1}} \frac{R_{h,t}}{R_{\$,t}} \quad \text{[UIP premium]}
\end{aligned} \tag{27}$$

The steady state of the system can be solved as shown in Appendix B.2.

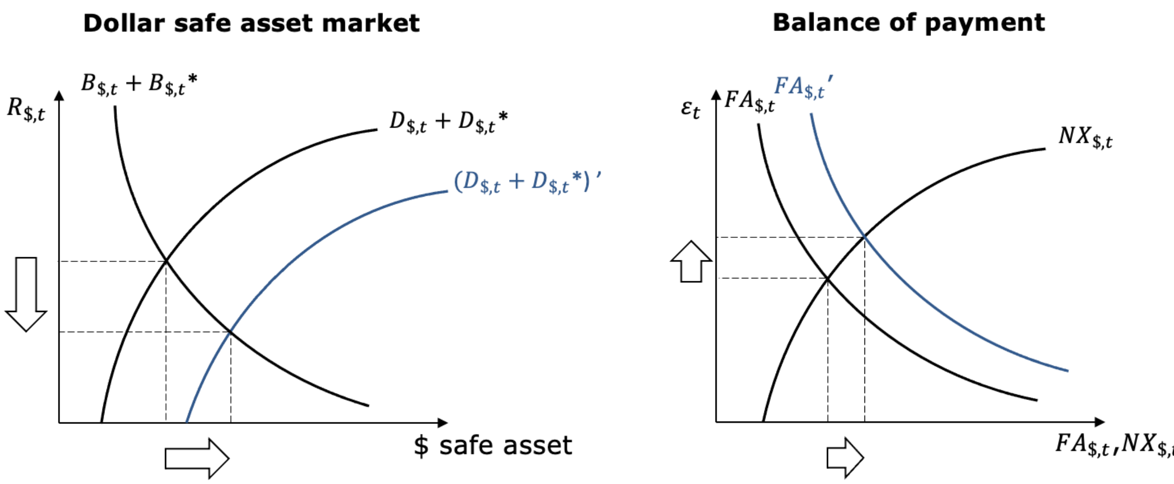

Figure 5: Equilibrium and a Safety Shock: (Case I) Fixed share of dollar invoicing

4 Analytical Insights

In the remainder of the analysis, I will characterize the dynamic effects of an unexpected increase in ω_t, resulting from a one-time positive shock $e_{\omega,t}$ that persists with a first-order autoregressive parameter ρ_ω. To describe the effects of this safety shock, I will use first-order log approximations, denoting deviations from the steady state with $\hat{\cdot}$. I will trace the impact of the shock on dollar borrowing, dollar invoicing, and the external balance of the EM, as well as its impact on the exchange rate and the UIP premium.

4.1 Fixed Share of Dollar Invoicing and Safety Shock

Proposition 1. (Case I: $\hat{\eta}_t = 0$) *Consider the case where the share of dollar invoicing by EM exporters is fixed. On the impact of a positive shock to EM and U.S. depositors' demand for safe dollar claims ($\hat{\omega}_t > 0$):*

- *EM and U.S. depositors' dollar saving increases ($\hat{D}_{\$,t}, \hat{D}^*_{\$,t} \propto \hat{\omega}_t$);*
- *the dollar interest rate decreases and EM exporters' dollar borrowing increases ($\hat{R}_{\$,t} \propto -\hat{\omega}_t$ and $\hat{B}_{\$,t} \propto \hat{\omega}_t$);*
- *the UIP premium increases ($\hat{u}_t \propto \hat{\omega}_t$);*
- *the EM's net exports and net foreign assets increase ($\widehat{NX}_{\$,t}, \widehat{FA}_{\$,t} \propto \hat{\omega}_t$);*
- *the dollar appreciates and is expected to depreciate ($\hat{\varepsilon}_t \propto \hat{\omega}_t$ and $\mathbb{E}_t\hat{\varepsilon}_{t+1} \propto -\hat{\omega}_t$).*

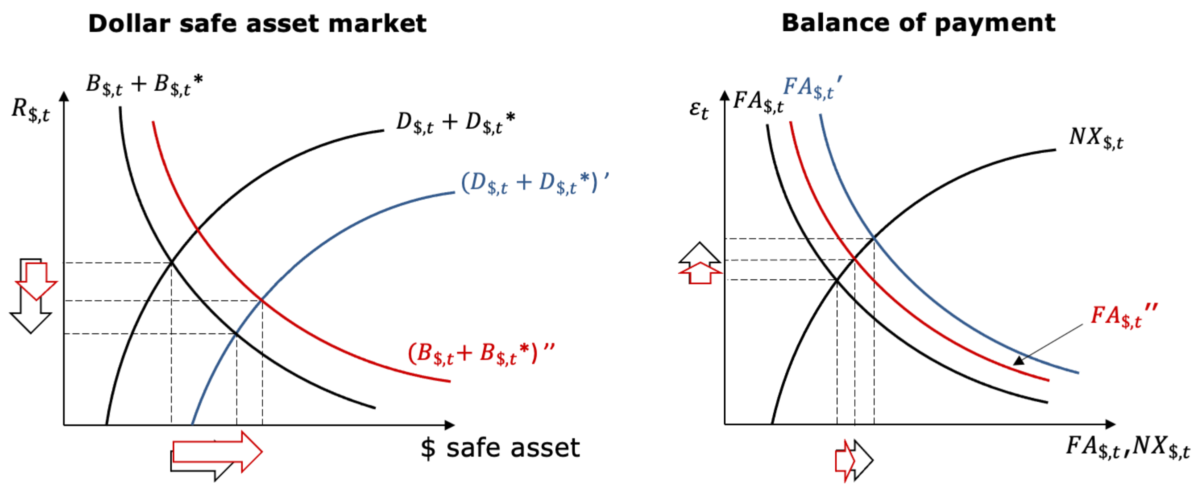

Figure 6: Equilibrium and a Safety Shock: (Case II) Endogenous share of dollar invoicing

The proof of this proposition, like all others, is provided in Appendix B.2.

Figure 5 provides an intuitive illustration of the dynamics described in the above proposition. In response to a positive safety shock ($\hat{\omega}_t > 0$), both EM and U.S. depositors increase their demand for saving in dollars, shifting the demand curve for safe dollar claims, $D_{\$,t}+D^*_{\$,t}$, to the right. Due to the higher demand for safe dollar claims, the price of saving in dollars increases, leading to lower dollar interest rates, $R_{\$,t} \downarrow$. With lower dollar borrowing rates, EM exporters can increase their dollar borrowing slightly. EM depositors, seeking to save more in dollars than what EM exporters can supply, increase their investment in U.S. assets, raising EM's net foreign asset accumulation. The increased demand for dollars raises its value, leading to the appreciation of the dollar. This makes EM imports from the U.S. more expensive and EM exports more competitive, resulting in increased net exports.[20] Depositors anticipate higher dollar returns, reducing their demand for dollars in the next period and contributing to an expected depreciation of the dollar. The increase in the expected depreciation of the dollar relative to the EM currency, along with the decrease in the dollar borrowing rate, leads to a higher UIP premium.

4.2 Endogeneity in Dollar Invoicing and Safety Shock

Proposition 2. **(Case II: $\hat{\eta}_t \neq 0$)** *Consider the case where EM exporters choose the share of dollar invoicing endogenously. On the impact of a positive shock to EM and U.S. depositors'*

[20]The model assumes that the price elasticity of demand is 1 for imported goods, so imports increase at the same rate as import prices.

demand for safe dollar claims ($\hat{\omega}_t > 0$):

- *the EM exporter's share of dollar invoicing increases ($\hat{\eta}_t \propto \hat{\omega}_t$);*
- *EM and U.S. depositors' dollar savings increase more than in Case I ($\hat{D}^{II}_{\$,t} > \hat{D}^{I}_{\$,t} \propto \hat{\omega}_t$ and $\hat{D}^{II*}_{\$,t} > \hat{D}^{I*}_{\$,t} \propto \hat{\omega}_t$);*
- *the dollar interest rate decreases, but less than in Case I ($\hat{R}^{II}_{\$,t} > \hat{R}^{I}_{\$,t} \propto -\hat{\omega}_t$) and EM exporters' dollar borrowing increases more than in Case I ($\hat{B}^{II}_{\$,t} > \hat{B}^{I}_{\$,t} \propto \hat{\omega}_t$);*
- *the UIP premium increases, but less than in Case I ($\hat{u}^{I}_t > \hat{u}^{II}_t \propto \hat{\omega}_t$);*
- *EM's net exports and net foreign assets increase, but less than in Case I ($\widehat{NX}^{I}_{\$,t} > \widehat{NX}^{II}_{\$,t} \propto \hat{\omega}_t$ and $\widehat{FA}^{I}_{\$,t} > \widehat{FA}^{II}_{\$,t} \propto \hat{\omega}_t$);*
- *the dollar appreciates, but less than in Case I ($\hat{\varepsilon}^{I}_t > \hat{\varepsilon}^{II}_t \propto \hat{\omega}_t$).*

where $\hat{X}^{I}_t$ and $\hat{X}^{II}_t$ denote the log approximated values of a variable X_t in Cases I and II, respectively.

Figure 6 depicts the responses of variables to a sudden safety shock when the EM's invoicing currency decision is endogenous. Similar to Case I, a positive safety shock increases the demand for safe dollar claims by both EM and U.S. depositors, initially leading to a decrease in the equilibrium dollar interest rate. As the dollar borrowing cost becomes cheaper due to lower interest rates, EM exporters increase the share of their borrowing in dollars. Unlike in CaseI, share the share of dollar invoicing was fixed, EM exporters can now boost the supply of safe dollar claims by raising the share of dollar invoicing in their exports. This shift in supply results in a smaller decrease in the dollar interest rate and a larger increase in the equilibrium level of total safe dollar claims in the market.

With the dollar interest rate decreasing less than in Case I, the UIP premium increases but to a lesser extent. This indicates that the price of safe dollar claims becomes less expensive due to the increased supply by EM exporters. EM depositors are less inclined to invest in U.S. assets as EM exporters can now supply more safe dollar claims. This decreased flight to U.S. assets results in a smaller increase in EM's net foreign asset accumulation. While the dollar appreciates in response to increased demand, the effect is less pronounced than in Case I due to the moderation in the increase in the UIP premium.

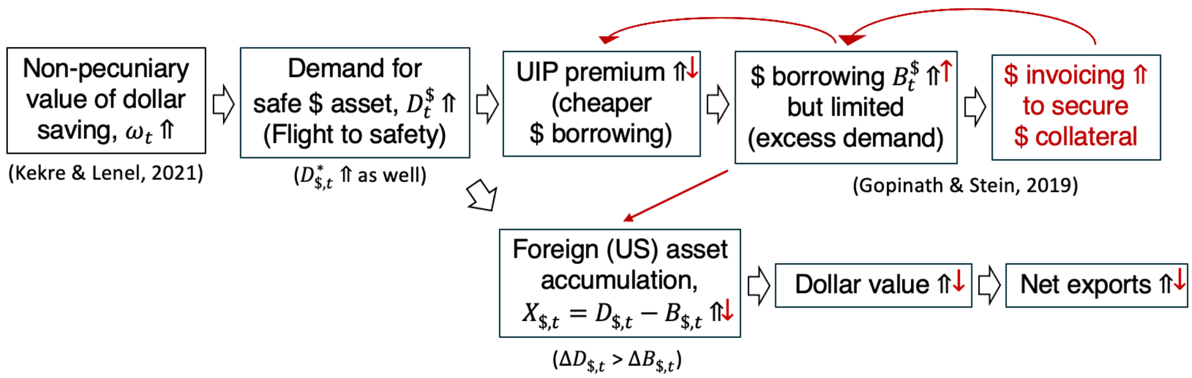

Figure 7: Main Mechanism

4.3 Main Mechanism and Literature

The analytical insights presented in this section shed light on the connection between the choice of invoicing currency by EM exporters and the global demand for safe dollar claims. Extending the work of Kekre and Lenel (2021), who explore the impact of an increase in the non-pecuniary value of holding dollars, driving a flight to safety, I elucidate the relationship between this phenomenon and EM exporters' borrowing decisions. In the framework of Kekre and Lenel (2021), a safety shock amplifies the global demand for safe dollar claims, raising the risk premium to currencies of non-U.S. countries relative to the dollar, denoted as the UIP premium in this paper. The increase in the UIP premium, in turn, encourages a higher share of dollar borrowing by bond issuers due to the more favorable borrowing conditions in dollars. Moreover, the surge in demand for safe dollar claims stimulates increased investments in U.S. risk-free dollar assets, strengthening the value of the dollar. However, Kekre and Lenel (2021) does not account for the endogenous decisions made by EM exporters regarding their invoicing currency choices.

On the other hand, Gopinath and Stein (2019) emphasize the link between the choice of borrowing currencies and invoicing currencies. They study how the dollar becomes dominant both as a unit of account and as a safe store of value. As a larger share of EM's imports is denominated in dollars, EM depositors increase their demand for saving in dollars to secure more dollars for payment. However, EM exporters face a comparative disadvantage in creating safe claims in dollars, incurring a higher cost associated with securing dollar-denominated collateral. This discrepancy results in a violation of the UIP condition. Since EM exporters' dollar borrowing requires dollar collateral, they invoice more exports in dollars, creating a feedback loop that further increases the dollar's share of import invoicing in other EM countries.

In this paper, I extend the analytical framework of Gopinath and Stein (2019), which explores the relationship between borrowing and invoicing currency decisions. I apply the framework to the global economy, providing a dynamic analysis of how macro variables respond to different shocks, with a particular focus on safety shocks, U.S. monetary shocks, and domestic monetary shocks, as previously studied by Kekre and Lenel (2021). Figure 7 describes the complete mechanism introduced in the baseline model. It effectively bridges the gap between two distinct literatures. Drawing from Kekre and Lenel (2021), an increase in the non-pecuniary value of saving in dollars results in a higher global demand for safe dollar assets, which can be interpreted as a flight to safety. This increases the risk premium associated with EM currencies relative to the dollar, making dollar borrowing relatively more cost-effective than borrowing in EM currencies. Therefore, EM exporters seek more dollar borrowing. Simultaneously, the rise in demand for safe dollar claims by EM depositors can lead to an increase in foreign asset accumulation, provided there is no corresponding increase in the supply of domestic safe dollar claims. This implies that capital flows out of EM into the U.S., resulting in an appreciation of the dollar. I assume an elasticity of demand equal to one, indicating that the dollar's appreciation leads to increased imports from the U.S. by EMs, thereby increasing EM's net exports.

By combining the two mechanisms provided in the existing literature, I identify a new feedback effect that links EM exporters' choice of invoicing currency and the responses of macro variables to a global safety shock. When EM exporters can endogenously choose the currency of invoicing, they increase the share of dollar invoicing to secure more dollar collateral and enhance their capacity for dollar borrowing. As the dollar's share in borrowing goes up, the supply of safe dollar claims increases, reducing the risk premium associated with the EM currency. Moreover, the increase in EM exporters' dollar borrowing means that EM depositors save more in dollars within the domestic dollar asset market, attenuating the need to seek external options. Therefore, the increase in EM's foreign asset holdings is mitigated, attenuating the appreciation of the dollar and the expansion of EM's net exports. In short, the endogenous increase in the share of dollar invoicing amplifies the response of EM firms' dollar borrowing and mitigates the responses of the UIP premium, EM's foreign asset accumulation, net exports, and the exchange rate.

5 Dynamic Responses to External Shocks

In this section, I extend the model to incorporate New Keynesian properties, enabling a more robust analysis of the economic impacts associated with dollar invoicing decisions. The major extensions to the model have three key aspects: consumption dynamics, labor, and monetary policy. By introducing these extensions, I aim to explore the impacts of a positive safety shock, a U.S. monetary tightening, and a domestic monetary shock. When there is a positive safety shock, the endogenous change in invoicing currency act as a mechanism, dampening the impact on several macro variables, including the UIP premium, foreign asset holdings, exchange rates, and net exports of the EM, which is consistent with the analytical insights introduced in the previous section.

In response to a U.S. monetary tightening, the share of dollar invoicing increases. This is because the cost of borrowing in dollars becomes more attractive, driven by an increase in the EM interest rate made by the monetary authority in response to inflation caused by higher import prices resulting from dollar appreciation. This endogenous change amplifies the response of EM exporters' reliance on dollar borrowing while mitigating the responses of key macro variables, including the exchange rate, output, and consumption. Similarly, when the domestic monetary authority increases the EM interest rate, the UIP premium rises, motivating EM firms to borrow more in dollars. When the share of dollar invoicing in exports changes endogenously, the firms' capacity for dollar borrowing expands further, amplifying the responses of the exchange rate, foreign asset accumulations, and output.

5.1 Model Extension

5.1.1 Investors

Both U.S. and EM depositors now have per-period utility functions that are non-linear functions of consumption, labor, and their holdings of safe dollar claims. Specifically, U.S. and EM depositors aim to maximize their utilities:

$$U(C_t^i, N_t^i, D_{\$,t}^i) = \frac{1}{1-\sigma_c} {C_t^i}^{1-\sigma_c} - \frac{\kappa}{1+\varphi} {N_t^i}^{1+\varphi} + \omega_t^i ln(\frac{D_{\$,t}^i}{P_t^i}) \tag{28}$$

where $i \in \{EM, U.S.\}$, $\sigma_c > 0$ is the depositors' coefficient of relative risk aversion, and $\varphi > 0$ is the inverse of the Frisch elasticity of labor supply. κ scales the disutility of labor.

Depositors' consumption bundles comprise domestically produced goods, $C_{h,t}^i$, and imports from the other country, M_t^i, for $i \in \{EM, U.S.\}$. Defining ξ^i as the weights of domestic goods in consumption, the consumption bundles are then expressed as:

$$C_t^i = [\xi^{i\frac{1}{\sigma}}(C_{h,t}^i)^{\frac{\sigma-1}{\sigma}} + (1-\xi^i)^{\frac{1}{\sigma}}(M_t^i)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$ is the elasticity of demand, assumed to be identical for both EM and the U.S. The demand for goods produced in EM and the U.S. by depositors can be written as follows:

$$\begin{aligned}
&C_{h,t}^* = \xi^*(\frac{P_{h,t}^*}{P_t^*})^{-\sigma}C_t^*, \quad M_t^* = (1-\xi^*)[\frac{\{\eta_{t-1} + (1-\eta_{t-1})\varepsilon_t^{-1}\}P_{h,t}}{P_t^*}]^{-\sigma}C_t^* \\
&C_{h,t} = \xi(\frac{P_{h,t}}{P_t})^{-\sigma}C_t, \quad M_t = (1-\xi)(\frac{\varepsilon_t P_{h,t^*}}{P_t})^{-\sigma}C_t
\end{aligned}$$

where $P_t^* = [\xi^*(P_{h,t}^*)^{1-\sigma} + (1-\xi^*)\{\eta_{t-1} + (1-\eta_{t-1})\varepsilon_t^{-1}\}^{1-\sigma}P_{h,t}^{1-\sigma}]^{\frac{1}{1-\sigma}}$ and $P_t = [\xi P_{h,t}^{1-\sigma} + (1-\xi)(\varepsilon_t P_{h,t}^*)^{1-\sigma}]^{\frac{1}{1-\sigma}}$ are the consumer price indices in the U.S. and EM.

The budget constraints for each depositor h in the U.S. and EM are

$$\begin{aligned}
&P_t^*C_t^* + D_{\$,t}^* + W_{r,t}^* \leq W_t^*(h)N_t^*(h) + \Pi_{f,t}^* + \Pi_{k,t}^* + (1+i_{\$,t-1})D_{\$,t-1}^* + (1+i_{R,t-1}^*)W_{t-1}^* \\
&P_tC_t + D_{h,t} + \varepsilon_t D_{\$,t} + W_{r,t} \\
&\leq W_t(h)N_t(h) + \Pi_{f,t} + \Pi_{k,t} + (1+i_{h,t})D_{h,t-1} + \varepsilon_t(1+i_{\$,t-1})D_{\$,t-1} + (1+i_{R,t-1})W_{t-1}
\end{aligned}$$

where $\Pi_{f,t}^*$ and $\Pi_{f,t}$ are profits of final producers (exporters), and $\Pi_{k,t}^*$ and $\Pi_{k,t}^*$ are profits of capital producers, both owned by the depositors. Note that EM depositors save both in dollars and the EM currency, while U.S. depositors save only in dollars. From the optimality conditions of the depositors, Euler equations for safe claims can be derived:

$$\begin{aligned}
&\beta^*(1+i_{\$,t}) = \mathbb{E}_t\frac{P_{t+1}^*}{P_t^*}(\frac{C_t^*}{C_{t+1}^*})^{-\sigma_c} - \frac{\omega_t^*}{D_{\$,t}^*}\mathbb{E}_t\frac{P_{t+1}^*}{C_{t+1}^{*\,-\sigma_c}} \\
&\beta(1+i_{h,t}) = \mathbb{E}_t\frac{P_{t+1}}{P_t}(\frac{C_t}{C_{t+1}})^{-\sigma_c}, \quad \beta(1+i_{\$,t})\mathbb{E}_t\varepsilon_{t+1} = \varepsilon_t\mathbb{E}_t\frac{P_{t+1}}{P_t}(\frac{C_t}{C_{t+1}})^{-\sigma_c} - \frac{\omega_t}{D_{\$,t}}\mathbb{E}_t\frac{P_{t+1}}{C_{t+1}^{-\sigma_c}}
\end{aligned}$$

Depositors adjust their wage rates with probability $1-\delta_w$, subject to a Calvo friction when setting wages. They face a downward-sloping demand given by $N_t(h)^i = (\frac{W_t(h)^i}{W_t^i})^{-\nu}N_t^i$, where $\nu > 1$ is the constant elasticity of labor demand, W_t^i is the aggregate nominal wage rate, and N_t^i is the aggregate labor for country i. The standard optimality condition for wage setting in EM is given by

$$\mathbb{E}_t \sum_{m=0}^{\infty} (\delta_w \beta^i)^m (\frac{C^i_{t+m}}{C^i_t})^{-\sigma_c} \frac{P^i_t}{P^i_{t+m}} N^i_{t+m} (W^i_{t+m})^{\nu(1+\varphi)} [\frac{\nu}{\nu-1} \kappa P^i_{t+m} (C^i_{t+m})^{\sigma_c} (N^i_{t+m})^{\varphi} - \frac{(\bar{W}_t(h)^i)^{1+\nu\varphi}}{(W^i_{t+m})^{\nu}\varphi}] = 0 \tag{29}$$

where $\bar{W}_t(h)^i$ is the optimal reset wage in period t. The optimal wage is set as a constant markup over the expected weighted average of future marginal rates of substitution between consumption and labor and aggregate wage rates, during the duration of the wage. Sticky wages are adopted in the standard literatures (see Gali (2008)). The risk-neutral investors solve the same problems as in the baseline model.

5.1.2 Producers

Capital producers use domestic labor and final goods to produce capital, which is then sold to exporters. Exporters utilize this capital for the production of final goods in the next period. The capital producers aim to maximize their profits, denoted as $\Pi^i_{k,t} = Q^i_t K^i_t - P^i_{h,t} X^i_t - W^i_t L^i_t$ with the Cobb-Douglas production functions $K^i_t = (X^i_t)^{\gamma} (L^i_t)^{1-\gamma}$ where $\gamma \in (0,1)$. The optimality conditions for capital producers are expressed as:

$$\gamma W^i_t L^i_t = (1-\gamma) P^i_{h,t} X^i_t \tag{30}$$

As in the baseline model, exporters function as final goods producers who acquire capital, produce final goods, and sell these goods both in domestic and foreign markets. Both U.S. and EM exporters solve the same problems as in the baseline, with the only extension being that they now receive revenues with prices determined in the market. In the baseline, the prices of final goods were normalized, and only the exchanger rates determined the relative price between domestic and imported goods.

5.1.3 Monetary Policy

The domestic risk-free interest rate in EM is determined by the monetary authority and follows an inflation-targeting Taylor rule with inertia:

$$i_{h,t} - \bar{i}_h = \rho_m (i_{h,t-1} - \bar{i}_h) + (1-\rho_m)\phi_m \pi_t + e^h_{i,t} \tag{31}$$

where ϕ_m captures the sensitivity of policy rates to domestic price inflation, and ρ_m captures the inertia in setting rates. i_h is the target nominal interest rate. The shock to the interest

Table 4: Parameters

Parameter	Description	Value	Notes
Household			
β	Discount factor (EM)	0.9812	3-month deposit rate of Turkey
β^*	Discount factor (U.S. risk-averse)	0.9986	3-month U.S. treasury yield
δ, δ^*	Discount factor (U.S. & EM risk-neutral)	0.96	$\delta = \delta^* < \beta < \beta^*$
σ_c	Risk aversion	2	Gopinath et al. (2020)
φ^{-1}	Frisch elasticity of labor	0.5	Gopinath et al. (2020)
κ	Disutility of labor	0.5	Gopinath et al. (2020)
ν	Labor demand elasticity	4	Gopinath et al. (2020)
ξ, ξ^*	Home bias	0.7	Gopinath et al. (2020)
σ	Elasticity of demand	5	Gopinath et al. (2020)
σ_w	Wage rigidity	0.85	Christiano et al. (2011)
Production			
Z, Z^*	Average returns for capital (U.S. & EM)	1.5	
Z_L, Z_L^*	Worst returns for capital (U.S. & EM)	1	
ψ	Cost related to EM's dollar invoicing	0.1	Average $ inv. share in Turkey
γ	MPL	0.7	Gopinath et al. (2020)
Safety shock			
ρ_ω	Safety persistence	0.4	Kekre & Lenel (2021)
$\bar{\omega}$	Safety skewness	0.002	Kekre & Lenel (2021)
Monetary policy			
ρ_m	Inertia parameter	0.5	Gopinath et al. (2020)
ϕ	Inflation sensitivity	1.5	Gopinath et al. (2020)
$\bar{i}_h$	steady state interest rate	$1/\beta - 1$	Gopinath et al. (2020)

rate, $e^h_{i,t}$, follows an AR(1) process: $e^h_{i,t} = \rho_e e_{i,t-1} + \epsilon_{m,t}$, where $\epsilon_{m,t} \sim N(0,1)$. The U.S. interest rate is set by the U.S. monetary authority as:

$$i_{\$,t} = \bar{i}_{\$} + e^{\$}_{i,t} \tag{32}$$

where $e^{\$}_{i,t}$ follows an AR(1) process and captures a shock in U.S. monetary policy.

5.2 Calibration

Table 4 provides a list of parameter values employed in the simulation, with quarters as the time period, spanning the sample from 2000 to 2018, consistent with the empirical analysis. The household parameters are set to values standard in the literature and follow Gopinath et al. (2020). The discount factor in EM, β, is set lower than the discount factor in the U.S., β^*. This difference reflects the higher steady-state interest rate in EM, indicative of a higher premium on the EM currency compared to the dollar. This captures the positive UIP premium observed in EM. Specifically, the calibration matches the discount factor to the 3-month deposit rate for Turkey and the 3-month U.S. treasury yield for the U.S. The cost parameter, ψ, is calibrated to match the average share of dollar invoicing in exports of Turkey.

Following Christiano et al. (2011), the parameter for wage stickiness is set to 0.85, corresponding to a year and a half average duration of wages. The parameters related to the safety shock are calibrated following Kekre and Lenel (2021), as I adopt their concept of the safety shock. The safety persistence parameter, ρ_ω, is set to 0.4, and the skewness parameter, $\bar{\omega}$, is set to 0.002. Regarding the monetary policy rule, the inertia parameter, ρ_m, is set to 0.5, and the inflation sensitivity parameter, ϕ_m, is set to 1.5, in line with standard values found in the literature (see Gopinath et al. (2020)).

5.3 Dynamic Responses

5.3.1 A Positive Safety Shock

Figure 8 plots the impulse responses to a one percentage point increase in the non-pecuniary value of saving in dollars. This exogenous increase in the value of holding dollar safe claims results in a surge in depositors' demand for dollar savings, leading to a reduction in the premium given to the dollar. Therefore, the UIP premium for the EM experiences a positive increase (Fig.8(b)). The rise in the premium for the EM currency implies that, from a

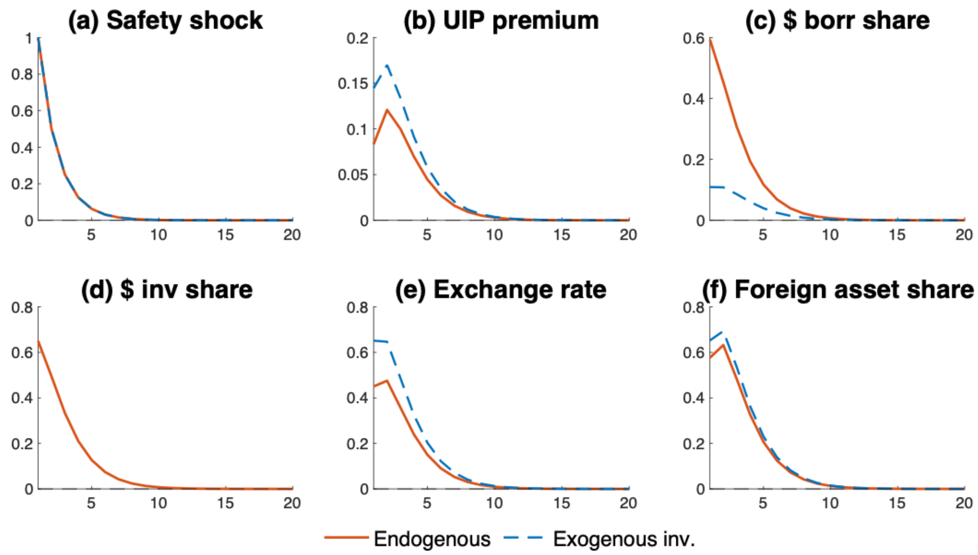

Figure 8: Impulse Responses of the EM to a Positive Safety Shock

borrower's perspective, it becomes relatively cheaper to borrow in dollars than in the EM currency, motivating EM exporters to increase their dollar borrowing (Fig.8(c)). However, if these exporters cannot increase the share of exports invoiced in dollars, their ability to increase the share of dollar borrowing is limited due to the necessary collateral required for dollar borrowing. This case is depicted by the blue dashed line in the figure. If firms have the flexibility to endogenously increase the share of dollar invoicing in their exports, they will do so to secure more dollar collateral for dollar borrowing, which is cheaper than borrowing in their home currency (Fig.8(d)). Therefore, the share of dollar borrowing increases further, as shown by the red line in the figure. In this case, since the supply of dollar safe claims increases further, the increase in the UIP premium is dampened.

As EM depositors increase their demand for dollar savings, they accumulate a larger volume of safe dollar claims by lending to EM exporters. However, since EM exporters' dollar collateral is limited, EM depositors choose to invest their savings abroad, typically by purchasing U.S. securities. This increases their share of foreign assets relative to their total assets (Fig.8(f)). This increase in foreign asset shares results in higher exchange rates, causing dollars to become more expensive (Fig.8(e)). When EM exporters have the capacity to enhance the supply of safe dollar claims by securing additional dollar collateral, primarily through increasing their share of dollar invoicing in exports, the responses of the foreign asset shares and exchange rates are mitigated.

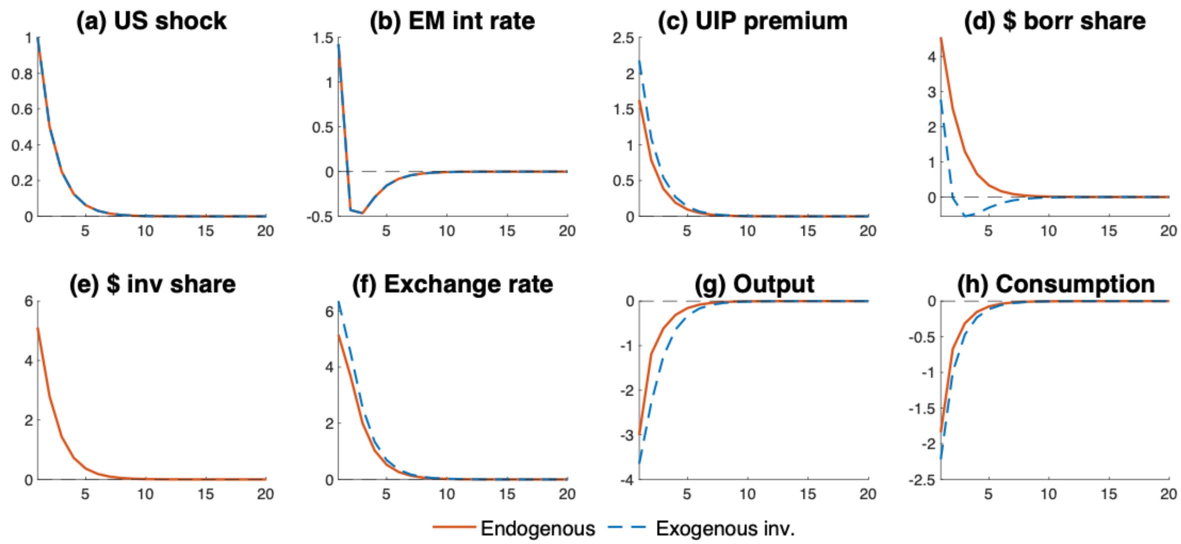

Figure 9: Impulse Responses of the EM to a U.S. Monetary Tightening

5.3.2 A U.S. Monetary Tightening

Figure 9 illustrates the responses of the EM economy to a one percentage point increase in the U.S. interest rate. In response to the U.S. interest rate hike, the EM monetary authority raises its own interest rate to counter potential inflationary pressures stemming from higher import prices due to the stronger dollar. The immediate increase in the EM interest rate is even higher than the U.S. shock, by 1.5%p, raising the UIP premium on the EM currency. Since borrowing in dollars becomes cheaper, EM exporters respond by increasing the share of dollar borrowing, as shown in Fig.9(d) with the blue dashed line. The response turns negative in the third period, likely because the EM interest rate experiences a subsequent decrease two periods after rising in response to the shock. This may be because the EM inflation is immediately tamed by the EM monetary authority, prompting a downward adjustment in the interest rate to prevent excessive economic downturns. When the U.S. interest rate rises, the demand for saving in dollars by EM depositors increases. However, this increased demand cannot be entirely met in the domestic market due to the limitations on borrowing capacity faced by EM exporters. Therefore, depositors seek to save in dollars abroad, leading to an appreciation of the dollar. Since higher interest rates encourage more savings from EM depositors, resulting in reduced savings and increased consumption, this ultimately leads to a decrease in domestic output.

Similarly to the safety shock, when EM exporters are unable to adjust the invoicing currency for their exports, their ability to increase dollar borrowing is restricted. However, if they have the flexibility to increase the share of dollar invoicing, they respond to the U.S. monetary shock by raising the share by 5%p as shown in Fig.9(e). This allows exporters to borrow more in dollars, increasing the supply of safe dollar claims in the domestic dollar asset market. This prevents more domestic exporters from shifting their savings to the U.S., mitigating the appreciation of the dollar. Furthermore, since the increase in the supply of safe dollar claims reduces the returns on dollar savings by moderating the rise in the UIP premium, EM exporters experience a less increase in overall savings. This, in turn, mitigates the decline in consumption and output. Note that the responses of output and consumption can vary, either being amplified or mitigated, depending on the sensitivity of demand for savings. If the price elasticity of safe claims is low, resulting in EM depositors increasing their overall savings with higher supply, EM consumption and output will decrease even more.

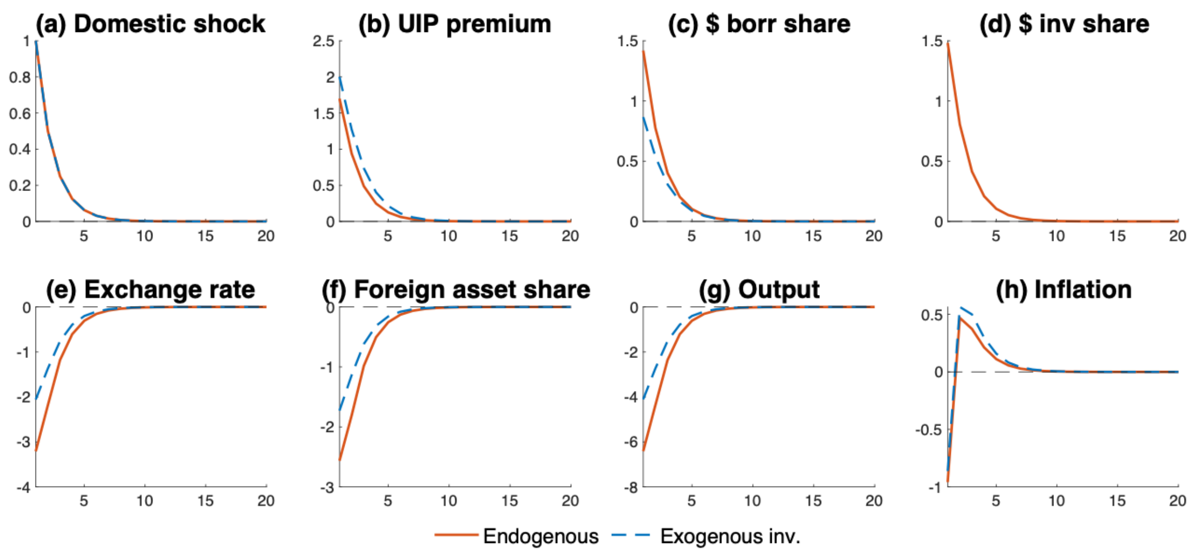

Figure 10: Impulse Responses of the EM to a Domestic Monetary Tightening

5.3.3 A Domestic Monetary Tightening

Figure 10 shows the responses to a domestic monetary tightening within the EM. The figure depicts the responses of EM variables to a one percentage point increase in the EM interest rate. As the EM interest rate rises, the UIP premium goes up. This results from EM firms borrowing more in dollars, as the borrowing cost in EM currency has become relatively higher. To secure more dollar collateral, if possible, EM firms increase their dollar invoicing shares. Simultaneously, the higher EM interest rate implies that depositors will receive a

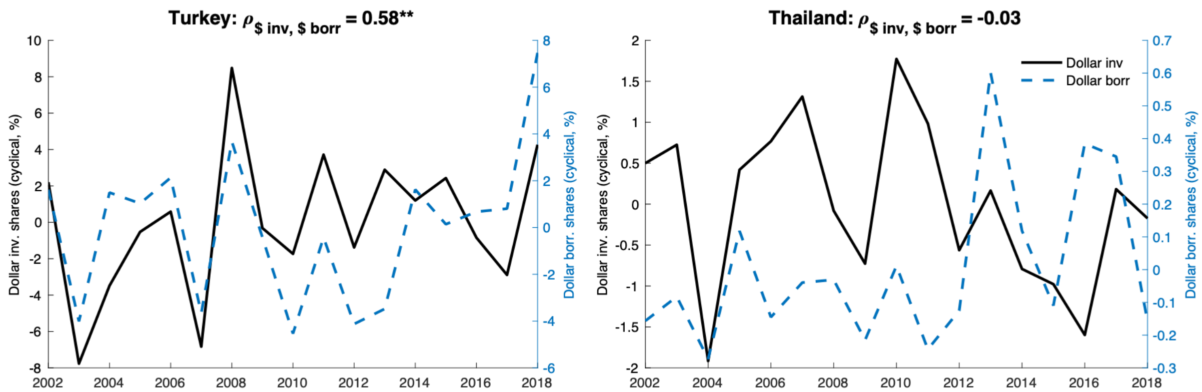

Figure 11: Turkey vs. Thailand: Dollar Invoicing/Borrowing Shares

higher return from safe claims in EM currency. Therefore, depositors seek to hold more domestic assets, reducing the proportion of foreign assets in their portfolios. This, in turn, leads to a depreciation of the dollar. In the case where the dollar invoicing share can respond to domestic monetary policy, EM exporters increase the share of dollar invoicing in their exports, amplifying the response of firms' dollar borrowing shares. This increase supplies more safe dollar claims, which dampens the increase in the UIP premium. However, unlike the safety shock, the increase in dollar invoicing shares further amplifies the responses of foreign asset shares. This happens because the UIP premium cannot increase as significantly.

EM output decreases further due to an overall increase in EM depositors' savings. Note that EM inflation immediately decreases due to the drop in the domestic interest rate but then increases after two periods. This inflation increase may be attributed to a rise in the consumption of imported goods as the dollar depreciates, leading to higher prices. In addition, the increase in EM inflation is somewhat mitigated, which can be attributed to an overall rise in savings by EM depositors, dampening the increase in consumption.

5.4 Empirical Evidence: Turkey vs. Thailand

In this section, I verify the theoretical observations using empirical data. The model analyses have demonstrated that endogenous changes in dollar invoicing shares can either mitigate or amplify the responses of EM macro variables to external shocks. To test this observation against real- world data, we compare two countries: Turkey, which experiences significant fluctuations in dollar invoicing shares, and Thailand, where these shares are less volatile.

Figure 11 presents the cyclical movements of dollar invoicing and borrowing shares in Turkey and Thailand. Notably, the share of dollar invoicing exhibits higher volatility in

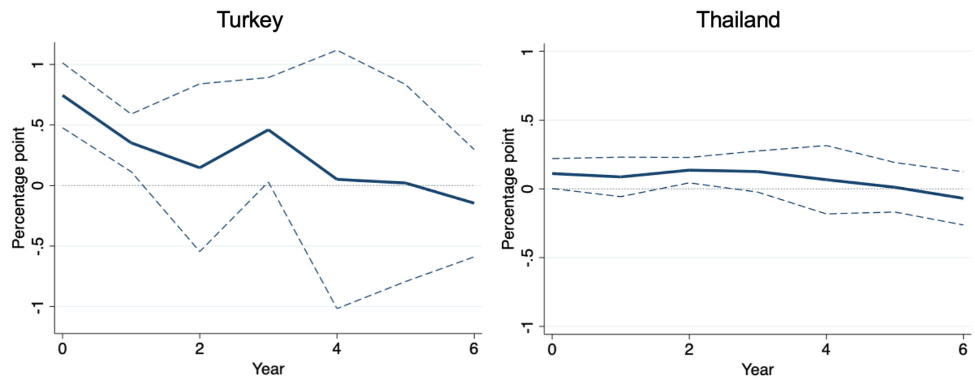

Figure 12: Turkey vs. Thailand: Responses of Dollar Invoicing Shares to a Safety Shock

Turkey, ranging from -8 to 8 percentage deviations from the trend. In contrast, Thailand's share fluctuates within a narrower range, typically between -2 and 2 percentage points. Moreover, the co-movement between dollar invoicing and borrowing shares is evident in Turkey, as indicated by a significantly positive correlation of 58%. In Thailand, I do not observe a clear correlation between these two shares. Therefore, based on the theory, I anticipate Turkey to exhibit a larger impact of endogenous invoicing currency choice, whereas Thailand is expected to experience a lesser impact.

To conduct the comparison, I first examine the response of dollar invoicing shares in Turkey and Thailand to a positive safety shock, which is approximated by the VIX. To investigate these responses, I employ the following local projection model:

$$\$INV_{t+h} = \beta_h VIX_t + \beta_h^w W + \epsilon_{t+h}, \quad h = 0, 1, 2, ... \tag{33}$$

where β_h is the impulse response coefficient of the VIX on the share of dollar invoicing in exports. W is the set of control variables, including current account balance and two lags of the dependent variable and the instrumented variable.

Given that invoicing currency choice is available on an annual basis, I estimate the responses at the yearly level. In Turkey and Thailand, the share of dollar invoicing responds to the shock, with an immediate increase of 0.76 %p in Turkey and a smaller immediate increase of less than 0.2 %p in Thailand. These increases persist for six horizons in Turkey.

To validate the shock propagation dynamics outlined in the theoretical analyses, I examine the responses of key EM macro variables, including dollar borrowing shares, the UIP premium, exchange rates, and net exports, to a positive safety shock. I employ local projections as described earlier, but use quarterly data to capture clearer patterns with higher

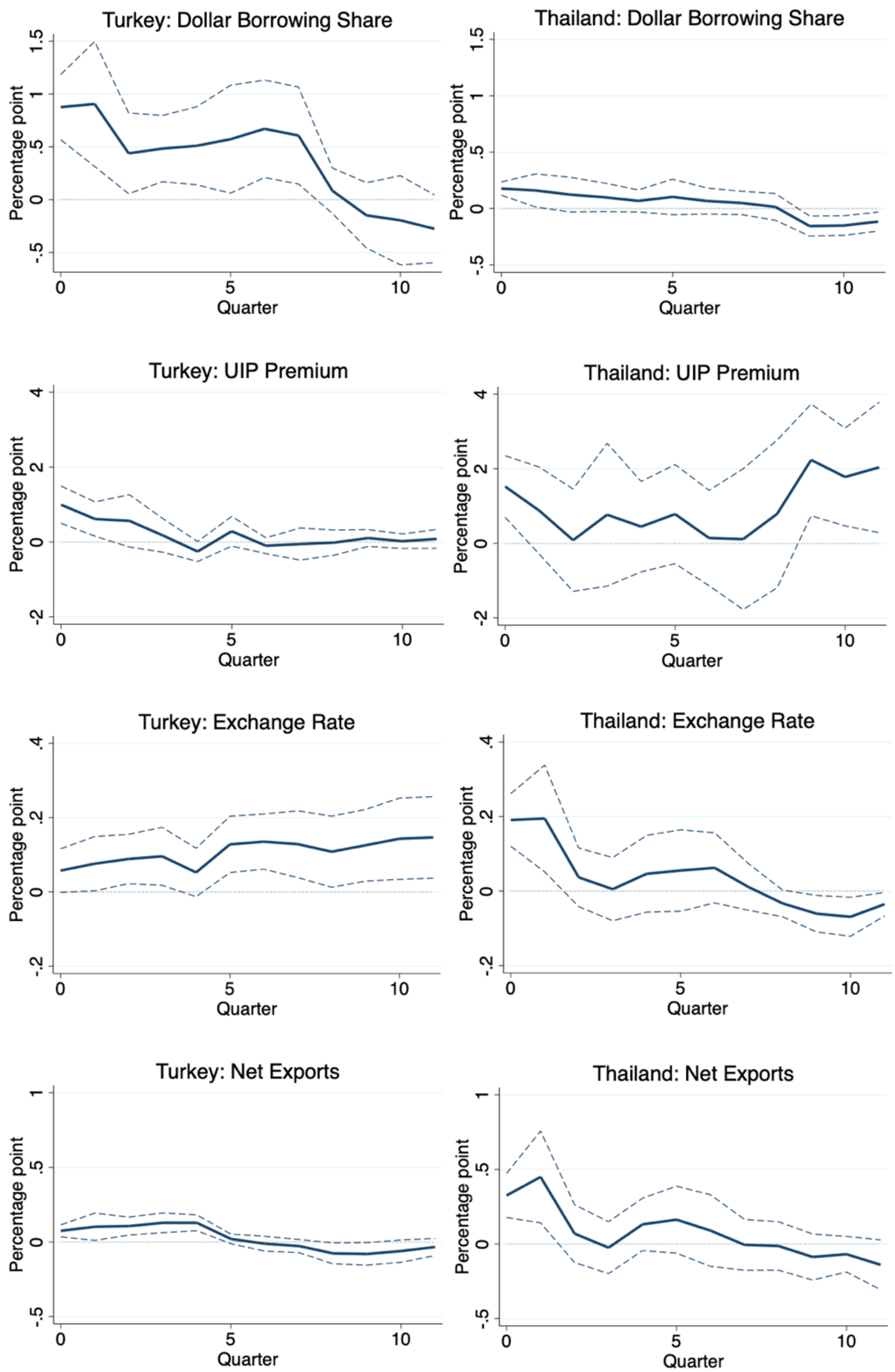

Figure 13: Turkey vs. Thailand: Responses of Macro Variables to a Safety Shock

frequency. Figure 13 illustrates the dynamic responses of the UIP premium, dollar borrowing shares, exchange rates, and net exports in Turkey and Thailand following a positive increase in the VIX. When global uncertainty increases exogenously, I observe that all the macro variables presented in the figure increase in both countries.

The figures show that the increase in the share of dollar borrowing is more pronounced in Turkey, while other macro variables respond more significantly in Thailand. When there is a one unit increase in the VIX, in Turkey, the share of dollar borrowing goes up by 0.9%p, significantly higher than the 0.2%p increase observed in Thailand. On the other hand, the rise in the UIP premium, exchange rate, and net exports is less marked in Turkey than in Thailand. Specifically, Turkey experienced increases of 1%p, 0.08%p, and 0.09%p, whereas Thailand shows larger increases of 1.8%p, 0.2%p, and 0.3%p. This observation aligns with the theoretical results outlined in the previous section. As the share of dollar invoicing increases to a greater extent in Turkey compared to Thailand, firms in Turkey can more effectively secure dollar collateral, which can then be used to further increase their dollar borrowing shares. This dampens the increase in the UIP premium in response to the safety shock, as the supply of safe dollar claims increases. Additionally, the rise in dollar borrowing shares among domestic firms implies that domestic depositors can save more in dollars within the domestic market. Depositors in Turkey are less inclined to shift their savings to U.S. securities compared to those in Thailand, resulting in a mitigation of currency depreciation. Furthermore, I observe that exports increase to a lesser extent in Turkey compared to Thailand.

6 Conclusion

In this paper, I established a dynamic link between exporters' choices of invoicing currency and borrowing decisions, shedding light on their cyclical co-movements. Through country-level data analysis, I observe positive correlations between dollar invoicing shares and dollar borrowing shares, along with a positive association between dollar borrowing shares and the global financial cycle, represented by the VIX. I suggest that dollar borrowing decisions play a key role in shaping exporters' choices of invoicing currency, influenced by global financial conditions.

To show this mechanism, I present a general equilibrium model where exporters not only choose the currency for borrowing but also determine the share of exports invoiced in dollars. When there is a heightened demand for safe dollar claims, the cost of borrowing in dollars becomes relatively cheaper than borrowing in other currencies. Therefore, EM firms try to increase their dollar borrowing, constrained by the dollar-denominated revenues they expect to receive. Since the domestic firms lack the capacity to provide sufficient safe dollar claims, EM depositors fulfill their increased demand for saving in dollars by investing in U.S. safe assets, such as U.S. treasuries. This leads to a capital outflow from EM to the U.S., resulting in an appreciation of the dollar. However, if EM exporters can endogenously increase the share of dollar invoicing, they can augment their capacity for dollar borrowing in response to safety shocks. This implies that a greater demand for saving in dollars by EM depositors can be satisfied domestically, mitigating the increase in foreign savings and dampening the appreciation of the dollar. Furthermore, I show that the effects of U.S. and domestic monetary policy shocks can also be either dampened or amplified based on the endogenous response of invoicing currency choices.

I explored the dynamic connection between changes in global financial conditions, firms' decisions on invoicing currency, and their choices of borrowing currencies. I present an open macro framework to elucidate the significance of endogenous changes in invoicing currency in propagating external shocks, including global risk and monetary policy shocks. Presenting the crucial role of exporters' invoicing currency decisions, I emphasize the importance of considering these decisions in policy- making and predicting policy outcomes quantitatively.

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A. Data Appendix

A.1. Adjustment of Invoicing Currency Shares

The dataset classifies currencies of invoicing into four categories: dollars (\$), euros (€), home currency (hc), and others. Among the sample countries, European countries including the Czech Republic, France, and Portugal record trade values in euros. South Korea, Thailand, and Turkey translate the values into dollars when reporting, while Japan and Norway use their own currencies. Suppose exports are invoiced in currency k and values are translated into currency l where $k \in \{\$, €, hc, other\}$ and $l \in \{\$, €, hc\}$. Define X_t^k as the share of invoicing in currency k at t. Define the relative share of invoicing in euros to dollars as $A_t \equiv \frac{X_t^{€}}{X_t^{\$}}$ and in the home currency to dollars as $B_t \equiv \frac{X_t^{\mathrm{hc}}}{X_t^{\$}}$. Then the relative share of other currencies to dollars is $(\frac{1}{X_t} - 1 - A_t - B_t)$.

Suppose x_t is the currency l value of exports that are invoiced in dollars. Then the share of dollar invoicing at t, $X_t^{\$}$, is calculated based on currency l values of transactions invoiced in currency $k \in \{\$, €, hc, other\}$, as presented in the first row of Table A.1. Define $\varepsilon_{k/l,t}$ as the bilateral exchange rate between currencies k and l for $k, l \in \{\$, €, hc\}$. $\varepsilon_{other/l,t}$ is calculated as $\varepsilon_{other/l,t} = \varepsilon_{other/\$,t} \times \varepsilon_{\$/l,t}$ where $\varepsilon_{other/\$,t}$ denotes the dollar index that proxies the value of dollars relative to currencies other than the euro and the home currency.[21] Since transaction values are given in current terms, the values in the currency of invoicing (k) are given as in the second row of Table A.1. To get the adjusted shares of dollar invoicing, I apply the exchange rates from 2000 when converting the trade values into currency l. Then the adjusted dollar invoicing share at t can be calculated as

$$\begin{aligned} \Rightarrow \hat{X}_t^{\$} &= \frac{x_t \frac{\varepsilon_{\$/l,t}}{\varepsilon_{\$/l,0}}}{x_t \frac{\varepsilon_{\$/l,t}}{\varepsilon_{\$/l,0}} + A_t x_t \frac{\varepsilon_{€/l,t}}{\varepsilon_{€/l,0}} + B_t x_t \frac{\varepsilon_{hc/l,t}}{\varepsilon_{hc/l,0}} + (\frac{1}{X_t^{\$}} - 1 - A_t - B_t) x_t \frac{\varepsilon_{other/l,t}}{\varepsilon_{other/l,0}}} \\ &= \frac{1}{1 + A_t \frac{\varepsilon_{€/\$,t}}{\varepsilon_{€/\$,0}} + B_t \frac{\varepsilon_{hc/\$,t}}{\varepsilon_{hc/\$,0}} + (\frac{1}{X_t^{\$}} - 1 - A_t - B_t) \frac{\varepsilon_{other/\$,t}}{\varepsilon_{other/\$,0}}} \end{aligned} \tag{A1}$$

which does not depend on the reporting currency l.

Similarly, dollar borrowing shares are adjusted with the constant exchange rate following the same method as in dollar invoicing shares. Table A.2 compares summary statistics for

[21] This may generate some errors in the adjustment because the dollar index is calculated based on main currencies, including the euro and some home currencies. However, the dataset does not specify which currencies are included in the "Other" category, so I use the general index. Since the purpose of adjusting the variables is to see if the properties of dollar invoicing shares are explained by dollar valuation effects, this procedure is reasonable if the adjustments reflect the appreciation and depreciation of the dollar.

Table A.1. Construction of Adjusted Dollar Invoicing Shares

Currency of Inv. (k)	Dollar	Euro	HC	Other
Values in l	x_t	$A_t x_t$	$B_t x_t$	$(\frac{1}{X_t^{\$}} - 1 - A_t - B_t)x_t$
Values in k (XR_t)	$x_t \varepsilon_{\$/l,t}$	$A_t x_t \varepsilon_{€/l,t}$	$B_t x_t \varepsilon_{hc/l,t}$	$(\frac{1}{X_t^{\$}} - 1 - A_t - B_t)x_t \varepsilon_{other/l,t}$
Adjusted values in l (XR_0)	$x_t \frac{\varepsilon_{\$/l,t}}{\varepsilon_{\$/l,0}}$	$A_t x_t \frac{\varepsilon_{€/l,t}}{\varepsilon_{€/l,0}}$	$B_t x_t \frac{\varepsilon_{hc/l,t}}{\varepsilon_{hc/l,0}}$	$(\frac{1}{X_t^{\$}} - 1 - A_t - B_t)x_t \frac{\varepsilon_{other/l,t}}{\varepsilon_{other/l,0}}$

Notes: Currency l is the currency of record. For an example of Japan, l is ¥. k is the currency of invoicing/pricing.

non-adjusted data with adjusted data. The statistics do not differ significantly from their unadjusted counterparts. Adjusted dollar invoicing shares vary from 7.3% to 99.7%, while non-adjusted shares vary from 5.5% to 99.5%. The Mean is higher after adjustments. Adjusted dollar borrowing shares vary from 0.2% to 40%, while non-adjusted dollar borrowing shares vary from 0.2% to 31.7%.

Figures A.1 - A.3 repeat the exercise for the stylized facts with the non-adjusted data. The co-movements of dollar borrowing and dollar invoicing with the VIX become weaker, but the positive correlation between dollar borrowing and dollar invoicing shares becomes much stronger, with an 88% correlation.

Table A.2. Summary Statistics

	Mean	Median	Min	Max	Std	Obs	# countries
Dollar Inv. Shares in Exports							
Raw data							
Adjusted	55.8	56.7	7.3	99.7	4.6	340	21
Non-adjusted	52.3	50.4	5.5	99.5	3.3	340	21
Cyclical components							
Adjusted	0.0	0.0	-10.9	10.8	2.3	305	21
Non-adjusted	0.0	0.05	-6.1	7.7	1.7	305	21
Dollar Borr. Shares							
Raw data							
Adjusted	6.0	3.0	0.2	40.0	7.3	340	21
Non-adjusted	5.0	2.8	0.2	31.7	2.3	340	21
Cyclical components							
Adjusted	0.0	-0.04	-7.0	12.9	1.4	305	21
Non-adjusted	0.0	-0.03	-7.5	4.9	1.0	305	21

Notes: The table presents summary statistics for all observations after merging the datasets for invoicing and borrowing currencies. The variables represent percentages. Cyclical components are estimated using the Hamilton (2018) filter. *Source: Boz et al. (2020) and BIS Global Liquidity Indicator*

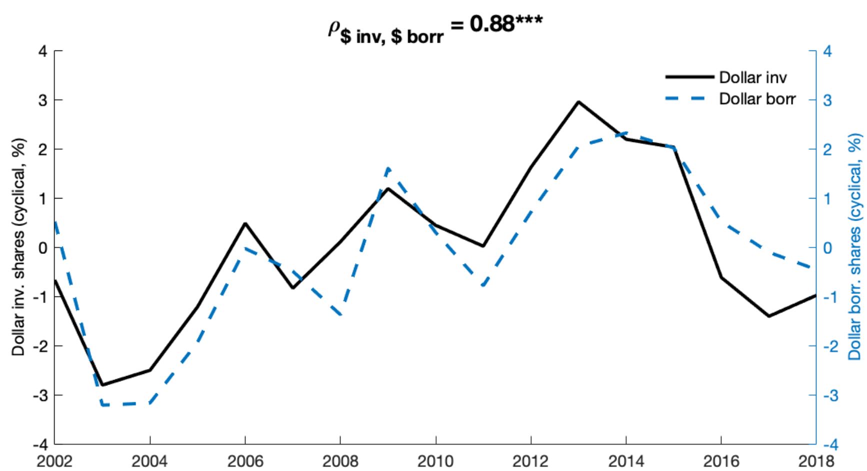

Figure A.1. Co-movements between Dollar Invoicing and Dollar Borrowing Shares: Non-adjusted

Notes: The data is annual and covers the period from 2000 to 2018. The series starts from 2002, although the underlying data begin in 2000, as the cyclical components are calculated based on 2-year-ahead forecast errors using the Hamilton (2018) filter. The common factors of dollar invoicing shares and dollar borrowing shares in the sample are estimated using a dynamic factor model (Stock and Watson (1999)). ** indicates significance at the 5% level.

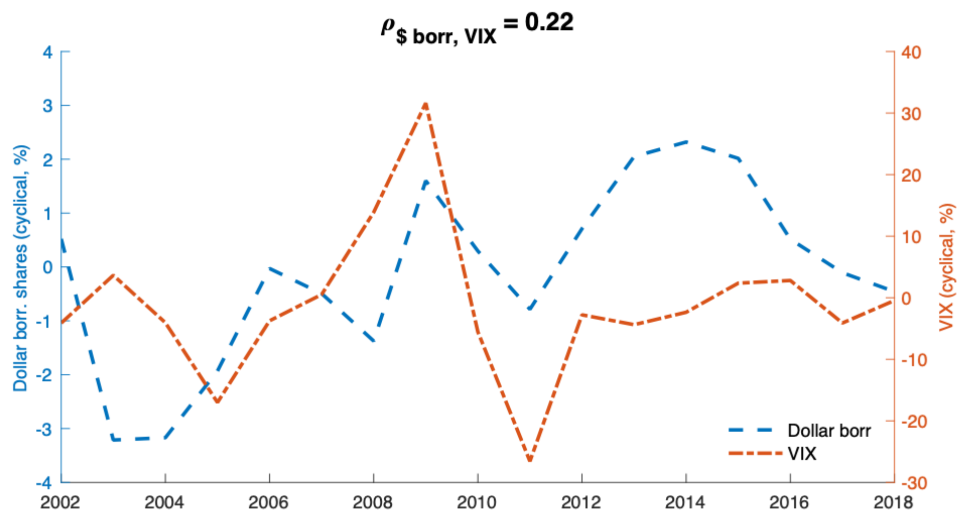

Figure A.2. Dollar Borrowing Shares, Dollar Invoicing Shares, and the VIX: Non- adjusted

Notes: The left panel shows dollar borrowing shares and the VIX, while the right panel shows dollar invoicing shares and the VIX, both from 2000 to 2018. The series starts from 2002 even though underlying data start in 2000 because the cyclical components are calculated based on 2-year-ahead forecast errors using the Hamilton (2018) filter. The common factors of dollar invoicing and dollar borrowing shares are estimated by the dynamic factor model (Stock and Watson (1999)).

A.2. Composition Effects of Cyclical Movements in Invoicing Currency Choices

It is possible that cyclical movements observed in Section II are caused by movements in large exporters' export shares. If large exporters that use dollar invoicing export more during the global financial downturn and less during the boom, it can explain the dynamic movements of dollar invoicing shares. However, Figures A.4 and A.5 show that this is not the case for the example of Korea. The four largest exporters in Korea do not explain the movements in dollar invoicing shares, both in raw data and in cyclical components. Therefore, it is hard to argue that the observed co-movements between dollar invoicing shares and the global financial cycle and dollar borrowing shares are driven by the composition effect.

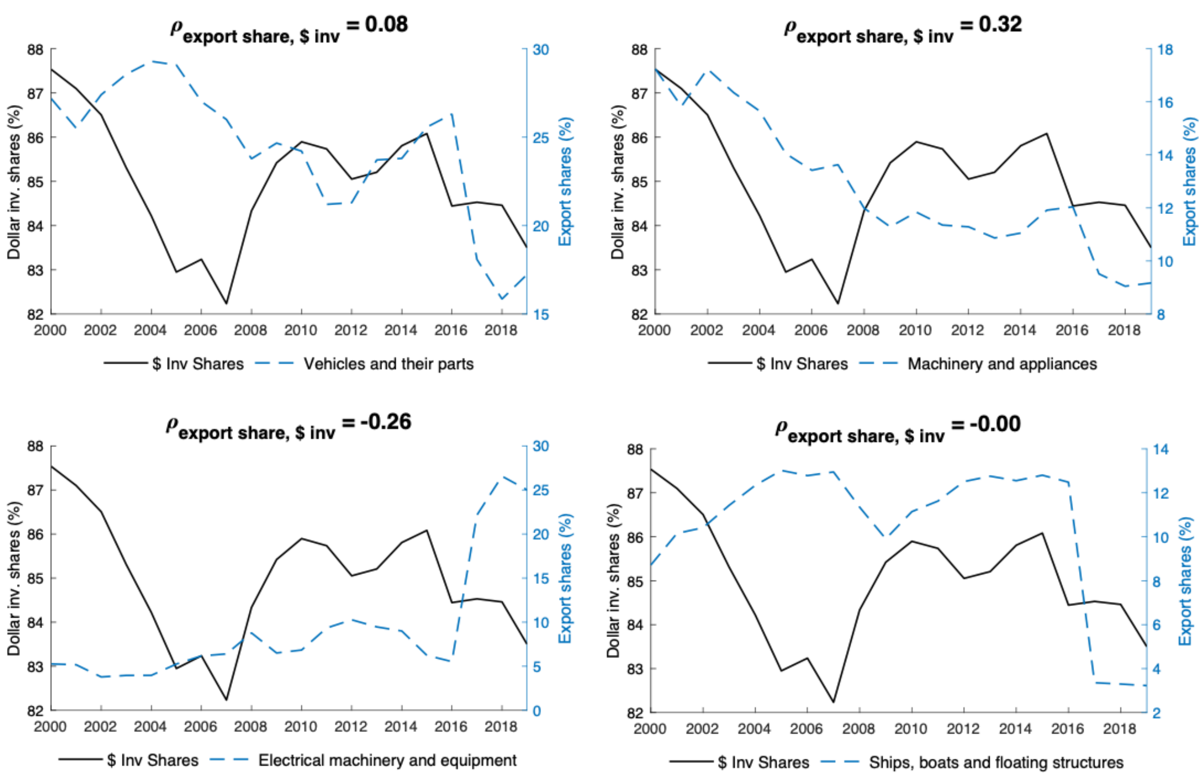

Figure A.4. Export Shares of the Largest Exporters in Korea

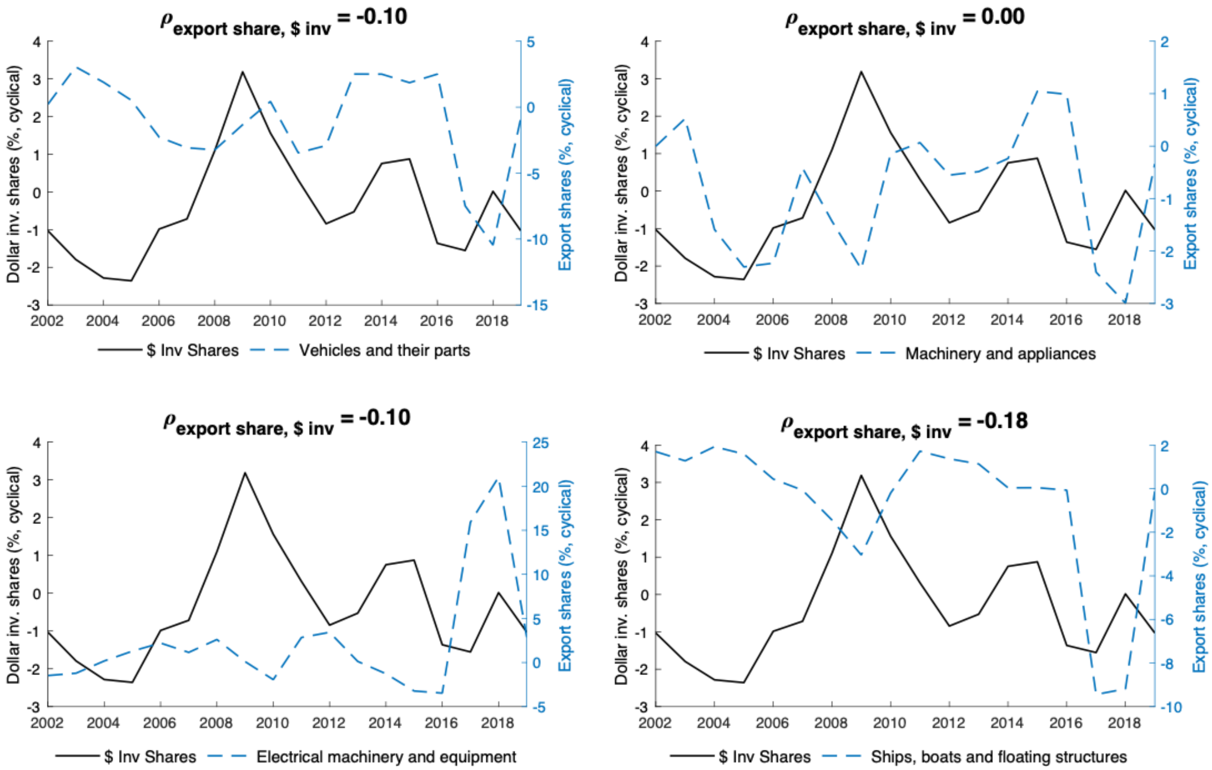

Figure A.5. Export Shares of the Largest Exporters in Korea: Cyclical

A.3. Correlations of Dollar Invoicing Shares, the VIX, and Dollar Borrowing Shares

Table A.3. Correlations of Dollar Invoicing Shares, the VIX, and Dollar Borrowing Shares

	Corr($ Inv, $ Borr)		Corr($ Borr, VIX)	
	non-adjusted	adjusted	non-adjusted	adjusted
Australia	-0.07	0.07	0.37	0.50
Belgium	0.77	0.86	0.56	0.79
Brazil	0.39	0.44	-0.03	0.21
Chile	0.04	0.32	0.01	0.02
Colombia	0.37	0.21	-0.08	-0.26
Czech Republic	0.00	0.08	-0.42	-0.35
France	0.46	0.29	0.09	0.37
Germany	-0.05	-0.38	0.38	0.65
Greece	0.05	-0.10	-0.20	0.01
Indonesia	0.25	-0.15	-0.25	-0.37
Italy	0.42	0.46	-0.11	-0.02
Japan	0.53	0.65	0.00	0.28
Luxembourg	0.35	0.39	0.16	0.38
New Zealand	0.34	0.52	0.15	0.25
Norway	-0.13	-0.25	-0.07	0.06
Portugal	-0.19	-0.02	0.05	0.20
Russia	-0.23	0.49	0.39	-0.48
South Korea	0.22	0.36	0.17	0.01
Spain	-0.21	0.14	0.61	0.83
Thailand	0.21	-0.03	-0.09	0.16
Türkiye	0.07	0.58	0.47	0.52

Notes: The table presents country-level correlations for dollar invoicing shares, the VIX, and dollar borrowing shares. *Source: Boz et al. (2020), BIS Global Liquidity Indicator, and FRED*

A.4. Full Regression Results for Table 3

Table A.4. Dollar Borrowing as a Mechanism linking Dollar Invoicing and the VIX

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
\$ borrowing share	0.405**			0.388**	0.380**		0.369**
	(0.147)			(0.155)	(0.140)		(0.149)
VIX		0.109**		0.107**		0.101*	0.100*
		(0.048)		(0.048)		(0.049)	(0.048)
UIP premium			0.113		0.105	0.088	0.081
			(0.148)		(0.149)	(0.140)	(0.141)
\$ invoicing in IM	0.639*	0.657*	0.681*	0.651*	0.673*	0.684*	0.676**
	(0.324)	(0.323)	(0.321)	(0.109)	(0.321)	(0.311)	(0.304)
Countries	12	12	12	12	12	12	12
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	154	154	154
R^2	0.269	0.290	0.266	0.307	0.283	0.299	0.315

Notes: Standard errors are in parenthesis. Standard errors are corrected for clustering of observations at the country level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

B. Theoretical Proofs

B.1. Full Set of Equilibrium Conditions in the Baseline Model

Variables $\{C_t^*, M_t^*, D_{\$,t}^*, C_t, M_t, D_{h,t}, D_{\$,t}, u_t, C_{N,t}^*, W_t^*, C_{N,t}, W_t, B_{\$,t}^*, B_{R,t}^*, K_t^*, \Pi_t^*, Q_t^*, B_{h,t}, B_{\$,t}, B_{R,t}, \eta_t, K_t, \Pi_t, Q_t, \varepsilon_t, R_{\$,t}, R_{h,t}, A_{R,t}^*, A_{R,t}, R_{R,t}^*, R_{R,t}, \omega_t^*, \omega_t\}$ can be characterized by the set of equilibrium conditions:

$$C_t^* + (\varepsilon_t^{-1}(1-\eta_{t-1}) + \eta_{t-1})M_t^* + D_{\$,t}^* + W_t^* = \Pi_t^* + R_{\$,t-1}D_{\$,t-1}^* + \xi_t^* R_{R,t-1}^* W_{t-1}^* \tag{A2}$$

$$M_t^* = \frac{\varepsilon_t \chi_m^*}{\varepsilon_t \eta_{t-1} + 1 - \eta_{t-1}} \tag{A3}$$

$$\frac{\omega_t^*}{D_{\$,t}^*} + \beta^* R_{\$,t} = 1 \tag{A4}$$

$$C_t + \varepsilon_t M_t + D_{h,t} + \varepsilon_t D_{\$,t} + W_t = \Pi_t + R_{h,t-1}D_{h,t-1} + \varepsilon_t R_{\$,t-1}D_{\$,t-1} + \xi_t R_{R,t-1}W_{t-1} \tag{A5}$$

$$\varepsilon_t M_t = \chi_m \tag{A6}$$

$$B_{h,t} = D_{h,t} \tag{A7}$$

$$D_{\$,t} = \frac{\omega_t}{\beta(\varepsilon_t R_{h,t} - \mathbb{E}_t \varepsilon_{t+1} R_{\$,t})} \tag{A8}$$

$$C_{N,t}^* + A_{R,t}^* + \xi_t^* R_{R,t-1}^* W_{t-1}^* = \xi_t^* R_{R,t-1}^* A_{R,t-1}^* + W_t^* \tag{A9}$$

$$A_{R,t}^* = W_t^* \tag{A10}$$

$$C_{N,t} + A_{R,t} + \xi_t R_{R,t-1} W_{t-1} = \xi_t R_{R,t-1} A_{R,t-1} + W_t \tag{A11}$$

$$A_{R,t} = W_t \tag{A12}$$

$$B_{\$,t}^* + B_{R,t}^* = Q_t^* K_t^* \tag{A13}$$

$$R_{\$,t} B_{\$,t}^* = (Z_L^* + Q_L^*) K_t^* \tag{A14}$$

$$K_t^* = \bar{K} \tag{A15}$$

$$(Z^* + \mathbb{E}_t Q_{t+1}) + (\frac{R_{R,t}^*}{R_{\$,t}} - 1)(Z_L^* + Q_L^*) = Q_t^* R_{R,t}^* \tag{A16}$$

$$Q_t K_t = B_{h,t} + \varepsilon_t B_{\$,t} + B_{R,t} \tag{A17}$$

$$R_{h,t} B_{h,t} + \mathbb{E}_t \varepsilon_{t+1} R_{\$,t} B_{\$,t} = \{\alpha + (1-\alpha)(1 - \eta_t + \mathbb{E}_t \varepsilon_{t+1} \eta_t)\} Z_L K_t + Q_L K_t \tag{A18}$$

$$R_{\$,t} B_{\$,t} = (1-\alpha)\eta_t Z_L K_t \tag{A19}$$

$$K_t = \bar{K} \tag{A20}$$

$$\psi(1-\alpha)^2 \eta_t = (Z - Z_L)(\mathbb{E}_t \varepsilon_{t+1} - 1) + R_{R,t} Z_L (\frac{\varepsilon_t}{R_{\$,t}} - \frac{1}{R_{h,t}}) \tag{A21}$$

$$\frac{\psi}{2}(1-\alpha)^2\eta_t^2 + R_{R,t}Q_t = \{\alpha + (1-\alpha)(1-\eta_t + \mathbb{E}_t\varepsilon_{t+1}\eta_t)\}[(Z - Z_L) + Z_L\frac{R_{R,t}}{R_{h,t}}$$

$$+ (1-\alpha)\eta_t Z_L R_{R,t}(\frac{\varepsilon_t}{R_{\$,t}} - \frac{\mathbb{E}_t\varepsilon_{t+1}}{R_{h,t}} + (\mathbb{E}_t Q_{t+1} - Q_L) + Q_L\frac{R_{R,t}}{R_{h,t}} \tag{A22}$$

$$A^*_{R,t} = B^*_{R,t} \tag{A23}$$

$$A_{R,t} = B_{R,t} \tag{A24}$$

$$\Pi^*_t = (Z^*_t + Q^*_t)K^*_{t-1} - R_{\$,t-1}B^*_{\$,t-1} - \xi^*_t R^*_{R,t-1}B^*_{R,t-1} + \frac{\psi}{2}(1-\alpha)^2\eta^2_{t-1}K_{t-1}\varepsilon^{-1}_{t-1} \tag{A25}$$

$$\Pi_t = \{\alpha + (1-\alpha)(1-\eta_{t-1} + \varepsilon_t\eta_{t-1})\}Z_tK_{t-1} + Q_tK_{t-1}$$

$$- R_{h,t-1}B_{h,t-1} - \varepsilon_t R_{\$,t-1}B_{\$,t-1} - \xi_t R_{R,t-1}B_{R,t-1} - \frac{\psi}{2}(1-\alpha)^2\eta^2_{t-1}K_{t-1} \tag{A26}$$

$$C_t + C_{N,t} + M^*_t(\varepsilon_t\eta_{t-1} + 1 - \eta_{t-1}) = \{\alpha + (1-\alpha)(1-\eta_{t-1} + \varepsilon_t\eta_{t-1})\}Z_tK_{t-1} \tag{A27}$$

$$\beta R_{h,t} = 1 \tag{A28}$$

$$B_{\$,t} + B^*_{\$,t} = D_{\$,t} + D^*_{\$,t} \tag{A29}$$

$$\delta R_{R,t} = 1 \tag{A30}$$

$$\delta^* R^*_{R,t} = 1 \tag{A31}$$

$$u_t = \frac{\beta}{\beta^*}\frac{R_{h,t}}{R_{\$,t}} \tag{A32}$$

$$log\omega_t - log\bar{\omega} = \rho_\omega(log\omega_{t-1} - log\bar{\omega}) + e_{\omega,t} \tag{A33}$$

$$log\omega^*_t = \Gamma^* log\omega_t \quad \text{for} \quad \Gamma^* > 0 \tag{A34}$$

B.2. Proofs of Propositions

Steady state

Variables without subscripts denote their steady-state values. The equations below can be used to solve for the steady-state values η, ε, and $R_\$$ as functions of the model's parameters:

$$(1-\alpha)^2\psi\eta = (Z - Z_L)(\varepsilon - 1) + \delta^{-1}Z_L(\frac{\varepsilon}{R_\$} - \beta) \tag{A35}$$

$$(1-\alpha)^2\eta Z_L\bar{K} + (Z_L^* + Q_L^*)\bar{K} = \frac{\bar{\omega}R_\$}{\varepsilon(1-\beta R_\$)} + \frac{\bar{\omega^*}R_\$}{1-\beta^* R_\$} \tag{A36}$$

$$\chi_m - \varepsilon\chi_m^* + \frac{\psi}{2}(1-\alpha)^2\eta^2\bar{K} = \varepsilon(R_\$ - 1)(\frac{\bar{\omega}}{\varepsilon(1-\beta R_\$)} - \frac{1}{R_\$(1-\alpha)^2\eta Z_L\bar{K})} \tag{A37}$$

then given $\{\eta, \varepsilon, R_\$\}$ from above, the steady-state values $D_\$$, $D_\$^*$, $B_\$$, $B_\$^*$, and u satisfy

$$\begin{aligned}
D_\$ &= \frac{\bar{\omega}}{\varepsilon(1-\beta^* R_\$)} \\
D_\$^* &= \frac{\Gamma^*\bar{\omega}}{1-\beta^* R_\$} \\
B_\$ &= \frac{1}{R_\$}(1-\alpha)\eta Z_L\bar{K} \\
B_\$^* &= \frac{1}{R_\$}(Z_L^* + Q_L^*)\bar{K} \\
u &= \frac{1}{\beta R_\$}
\end{aligned}$$

Log-linearized equilibrium conditions

To describe the effects of the safety shock, I employ first-order log approximations and use $\hat{\cdot}$ to denote log/level deviations from the steady-state. Then the simplified equilibrium conditions (27) can be written as:

$$\hat{D}_{\$,t} = \hat{\omega}_t - \frac{1}{1-\beta R_\$}[\hat{\varepsilon}_t - \beta R_\$ \mathbb{E}_t \hat{\varepsilon}_{t+1} - \beta R_\$ \hat{R}_{\$,t}] \tag{A38}$$

$$\hat{D}^*_{\$,t} = \hat{\omega}_t + \frac{\beta^* R_\$}{1-\beta^* R_\$}\hat{R}_{\$,t} \tag{A39}$$

$$\hat{R}_{\$,t} + \hat{B}_{\$,t} = \hat{\eta}_t \tag{A40}$$

$$\hat{B}^*_{\$,t} = -\hat{R}_{\$,t} \tag{A41}$$

$$\psi(1-\alpha)^2\hat{\eta}_t = (Z - Z_L)\varepsilon \mathbb{E}_t \hat{\varepsilon}_{t+1} + \delta^{-1} Z_L \frac{\varepsilon}{R_\$}\hat{\varepsilon}_t - \delta^{-1} Z_L \frac{\varepsilon}{R_\$}\hat{R}_{\$,t} \tag{A42}$$

$$\chi^*_m \hat{\varepsilon}_t - \psi(1-\alpha)^2 \eta \bar{K} \varepsilon^{-1} \hat{\eta}_{t-1} = D_\$ \hat{D}_{\$,t} - B_\$ \hat{B}_{\$,t} - (D_\$ - B_\$) R_\$ \hat{R}_{\$,t-1} - (R_\$ - 1)(D_\$ - B_\$)\hat{\varepsilon}_t \tag{A43}$$

$$B_\$ \hat{B}_{\$,t} + B^*_\$ \hat{B}^*_{\$,t} = D_\$ \hat{D}_{\$,t} + D^*_\$ \hat{D}^*_{\$,t} \tag{A44}$$

$$\hat{u}_t = \hat{\varepsilon}_t - \mathbb{E}_t \hat{\varepsilon}_{t+1} - \hat{R}_{\$,t} \tag{A45}$$

Proof of Proposition.1

Suppose the share of dollar invoicing is fixed to a constant, then $\hat{\eta}_t = 0$. Solving the equations, we can express the log-linearized variables as functions of $\hat{\omega}_t$. First, when $\hat{\omega}_t > 0$, the dollar appreciates:

$$\hat{\varepsilon}_t = \frac{1}{R_\$}[(1 - \beta R_\$ + 3(1 - \beta^* R_\$) - (\beta^* - \beta))(1 + \frac{\beta^2 \rho_\omega^2}{4 - 2\beta\rho_\omega}) + \rho_\omega]\hat{\omega}_t + \Lambda_1 \tag{A46}$$

where $\Lambda_1 \equiv \hat{\varepsilon}_{t-1} - (\beta^* - \beta)\hat{\omega}_{t-1} + \sum_{i=1}^{\infty}(\frac{\beta}{2})^i [\frac{1}{R_\$}(1 - \beta R_\$ + 3(1 - \beta^* R_\$)) \sum_{j=0}^{i} \rho_\omega^j e_{\omega,t+i-j} - (\beta^* - \beta)\sum_{j=0}^{i-1} \rho_\omega^j e_{\omega,t+i-j}]$ includes past and error terms. Since $[(1 - \beta R_\$ + 3(1 - \beta^* R_\$) - (\beta^* - \beta))(1 + \frac{\beta^2\rho_\omega^2}{4-2\beta\rho_\omega}) + \rho_\omega]$ is positive, the exchange rate is proportional to $\hat{\omega}_t$. Similarly, the dollar interest rate decreases in response to the safety shock as shown in the equation below:

$$[\frac{1}{1-\beta^* R_\$} + \frac{1}{1-\beta R_\$}]\hat{R}_{\$,t} = -[2 - \frac{R_\$}{1-\beta R_\$}(\beta^* - \beta)]\hat{\omega}_t + \Lambda_1 \tag{A47}$$

where $\Lambda_2 \equiv \frac{R_\$}{1-\beta R_\$}[(\beta^* - \beta)\{(\frac{1}{2\beta}(1 + \frac{\beta}{\beta^*} - R_\$)\hat{\omega}_{t-1} - \frac{R_\$}{2\beta}(1 + \frac{\beta}{\beta^*})\hat{\omega}_{t-1}\} + \frac{1}{2\beta}(1 + \frac{\beta}{\beta^*})\{-(\frac{1}{2}(1 + \frac{\beta}{\beta^*}) + \frac{1}{R_\$})\hat{\varepsilon}_{t-1} + \hat{\varepsilon}_{t-2}\}]$.

Since the cost of dollar borrowing becomes cheaper, EM exporters borrow more in dollars: $\hat{B}_{\$,t} = -\hat{R}_{\$,t}$. Since returns to safe dollar claims go down, $\hat{D}_{\$,t}$ and $\hat{D}^*_{\$,t}$ increase. Since the dollar appreciates and the dollar rate decreases, we can also prove that the UIP premium, $\hat{u}_t$, goes up. With the fixed share of dollar invoicing, EM exporters cannot increase dollar borrowing as much as they want, because they need more of dollar collateral which cannot increase further without increasing the share of dollar invoicing. Therefore, EM depositors turn to U.S. exporters when their demand for safe dollar claims cannot be satisfied enough by saving domestically. It means an increase in the foreign asset accumulation, $\hat{FA}_{\$,t}$, which is the same as the net exports net the cost of dollar invoicing.

Proof of Proposition.2

Now suppose EM exporters can choose the share of dollar invoicing, η_t, endogenously ($\hat{\eta}_t \neq 0$). In this case, from the equilibrium conditions, the dollar share of invoicing can be written as a function of $\hat{\omega}_t$:

$$\begin{aligned} & \frac{1}{R_\$}(1-\beta R_\$)[\frac{2-R_\$}{1-\beta^* R_\$} + \frac{1+\beta R_\$}{1-\beta R_\$}(R_\$ - 1)]\hat{\eta}_t \\ & = \frac{1}{1-\frac{\beta\rho_\omega}{2}}[\frac{1}{R_\$}(1-\beta R_\$ + 3(1-\beta^* R_\$))\rho_\omega - (\beta^* - \beta)] \\ & \times [(\frac{1+\beta R_\$}{1-\beta R_\$} + \frac{1}{1-\beta^* R_\$}(1+\frac{\beta\rho_\omega}{2}) + \frac{\beta}{2(1-\beta^* R_\$}]]\hat{\omega}_t + \Lambda_3 \end{aligned} \tag{A48}$$

where Λ_3 includes past and error terms. Thus, $\hat{\eta}_t$ increases in $\hat{\omega}_t$.

Since EM exporters invoice more of their exports in dollars, their capacity for dollar borrowing goes up, as they can create more dollar collateral. Therefore, EM exporters' dollar borrowing increase further, dampening the decrease in the dollar interest rate. This is followed by a larger increase in depositors' holdings of safe dollar claims. In this case, EM depositors fly less to the U.S. treasury assets, thereby dampening the appreciation of the dollar and the increases in foreign assets and net exports, compared to Case I.

C. Dynamic Responses

C.1. A Safety Shock

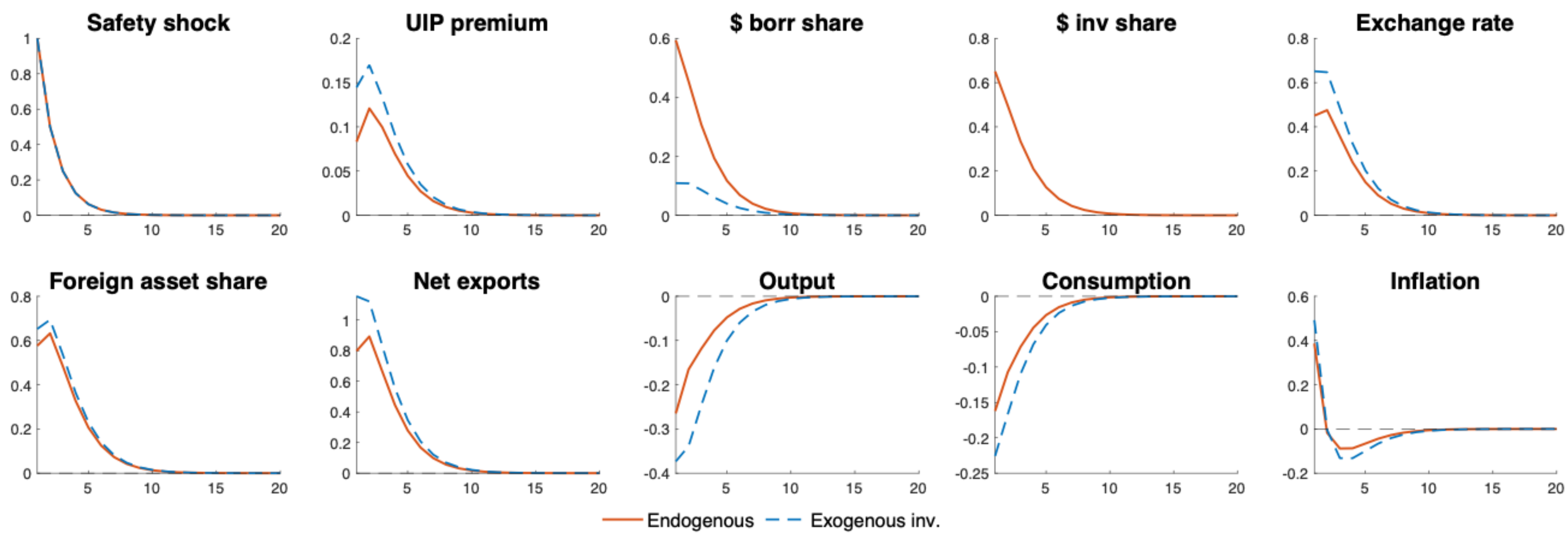

Figure C.1: Impulse Responses of the EM to a Positive Safety Shock

C.2. A U.S. Monetary Tightening

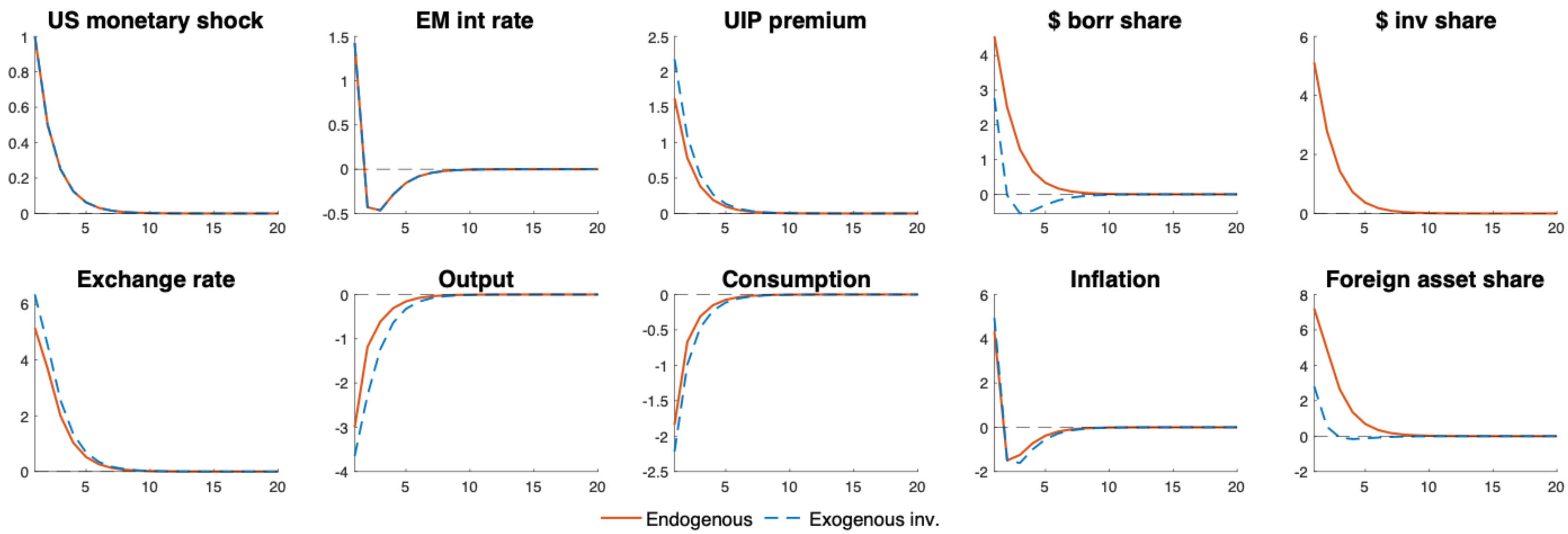

Figure C.2: Impulse Responses of the EM to a U.S. Monetary Tightening

C.3. A Domestic Monetary Tightening

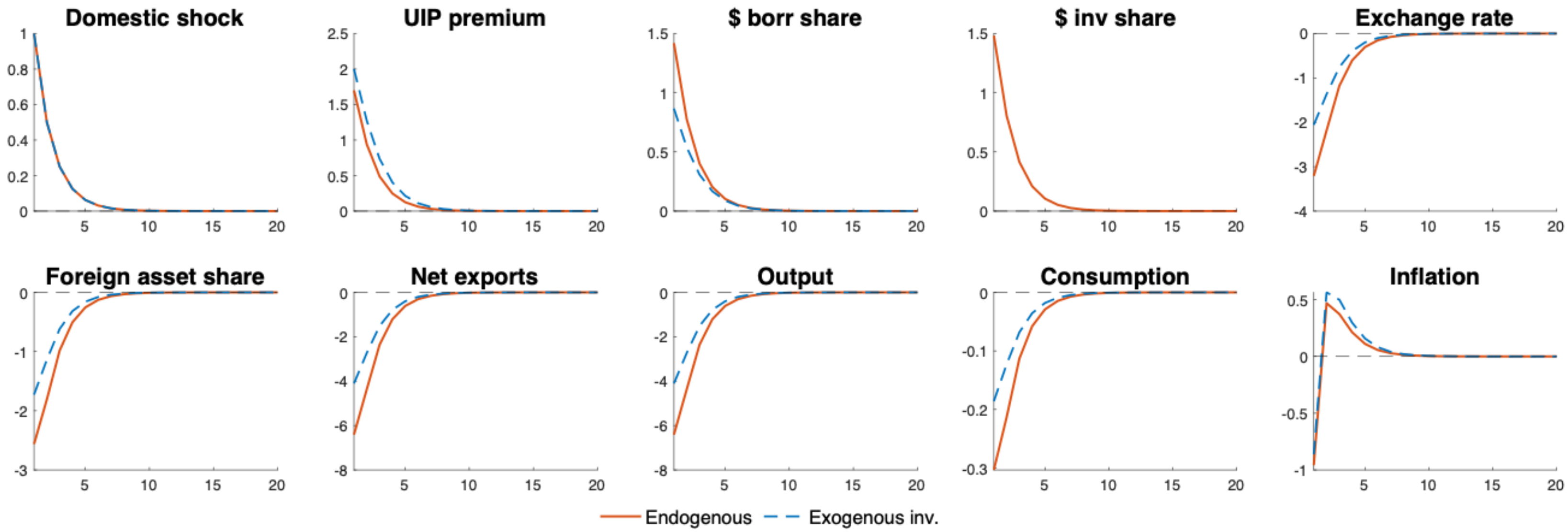

Figure C.3: Impulse Responses of the EM to a Domestic Monetary Tightening