Bank Home Bias and Monetary Policy*

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Abstract

This paper studies bank home bias, i.e. banks' relative preference for domestic lending over foreign lending. We document the patterns of bank home bias in the past two decades and explain how monetary policy contributes to its variations. Using panel data from over thirty countries, we find that country-level bank home bias exhibits substantial fluctuations, and the average level of home bias decreases at first but then increases after the Great Recession. This differs from equity home bias, which exhibits a downward trend over the same periods. To shed light on the mechanism, we build a two-country open economy banking model, which features monetary policy rate pass-through to deposit and lending rate and endogenous variance of bank investment. In this setup, monetary policy affects banks' lending not only through a risk-taking channel but also through a bank profitability channel. The model shows that when the bank can manage the investment variance at a cost, and the cost is endogenously decreasing in the banks' profitability, the effect of monetary policy on bank home bias is state-dependent. If the pass-through elasticity from the risk-free rate to deposit rate is sufficiently low, or the bank's total asset size is sufficiently large, a further cut in the interest rate can lead to higher bank home bias. Finally, we extend the analytical model to a dynamic incomplete market model setup, and then we use structural VAR model to provide empirical evidence for the mechanism.

Keywords: Home Bias, International Capital Flow, Monetary Policy, Banks.

JEL codes: E43, F34, E58, F41

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...the banker must not only know what the transaction is which he is asked to finance and how it is likely to turn out but he must also know the customer, his business and even his private habits, and get, by frequently "talking things over with him", a clear picture of the situation.

Joseph A. Schumpeter (1939)

1 Introduction

Cross-border lending by international banks has been decreasing since the Great Recession, despite the accommodative monetary policy during this period. McCauley et al. (2021) find the ratio between outstanding international claims and world GDP goes down from over 60% to around 40%; in European Union, cross-border claims by banks dropped by 25% (Emter et al., 2019), in spite of the zero or even negative policy rates. Levels of cross-border claims might not reveal the whole picture, as this index alone cannot distinguish between a retreat from foreign market and a symmetric reduction in domestic and foreign claims. Nor does it capture the demand-side effects, i.e. whether the reduction is due to low demand for credit abroad or a change in banks' lending preference. One approach to overcome these issues is to study the lenders' *home bias*, an index widely used in equity portfolio problems and first applied to cross-border banking by Coeurdacier and Rey (2013).

In this paper, we investigate the patterns of bank home bias and its relationship with the monetary policy rate. In particular, how does monetary policy influence global banks' lending behaviors? Recent research (Brunnermeier and Koby, 2018; Ulate, 2021b) has shed light on the impact of low interest rates on bank lending. However, these studies focus on the quantity of credit, whereas the *composition* in terms of domestic and foreign claims is less investigated. In addition, understanding this question has crucial implications for the coordination between monetary and macroprudential policies, as cross-border credit intermediation is a strong driver of both financial integration and financial instability, due to cross-border externalities (Clayton and Schaab, 2021) or exposure to international regulation coordination (Calzolari and Loranth, 2011).

To address this question, we first construct an empirical measure of country-level bank home bias over the past two decades, and we find that the overall trend of bank home bias exhibits a V-shaped pattern. Our construction of the *bank home bias* index follows the influential work by Coeurdacier and Rey (2013). It is an index of bank lending preference defined in such a way that the cross-border asset share of a given investment portfolio is normalized by the corresponding share of the foreign asset in the world portfolio. With this normalization process, the index can distinguish between the case of a cut in foreign lending due to the lack of investment opportunities abroad and that of a pure decrease in the preference. That is, a higher home bias index always indicates a lower preference for cross-border lending activities.[1] Based on this definition, we collect domestic and cross-border lending data of banks for over thirty countries and build country-wise bank home bias since early 2000s, at a quarterly frequency.

We find that since early 2000, bank home bias has experienced a reverse in the general trend. Prior to the crisis, the weighted average bank home bias has been on a steady decrease. The downward trend ceased to continue after the Great Recession, as the home bias level bounced back by 8% from the historical low and remained high even after the recession has ended. This V-shaped pattern of bank home bias is in stark contrast with that of equity. Although equity home bias also jumped up during the crisis, the level goes down soon after the recession, and the overall downward trend is preserved. To rationalize the difference between bank and equity investors' home bias, monetary policy is one obvious candidate, the low interest rate environment after the crisis in particular. Low interest rates are known to have the effect of encouraging risk-taking (Borio and Zhu, 2012; Bruno and Shin, 2015a; Adrian, 2020) and boosting asset prices, even with spillover effects to emerging markets (Bhattarai et al., 2021). However, for banks investment, there is an additional countervailing force, as recent studies stress low interest rates erode bank profitability (Ulate, 2021b) and hinder investment. By comparing the home bias of the United States and the overall return on assets of the US banking sector, we find there is a negative relationship between the two: bank home bias goes down when banks become more profitable. Therefore, the overall impact of monetary policy on banks' international lending preferences is complicated and may depend on multiple factors.

To account for the role of risks, we use multiple country-level uncertainty measures, including *World Uncertainty Index* and *Monetary Uncertainty Index*, as a proxy to examine the effect of riskiness on bank home bias. We find that bank home bias is highly correlated with uncertainty, and the correlation is higher with uncertainty lagging for four to five quarters, suggesting that uncertainty is a leading indicator for bank home bias. Furthermore, for the United States, we construct indices of foreign uncertainty and domestic uncertainty to perform structural analysis using structural vector auto-regression exercises. We find that the former account for a significant share of variations of bank home bias but not the latter.

Based on the empirical observations, we develop an analytical model to shed light on bank home bias determination and the role of monetary policy. We find that contrary to the popular belief that accommodating monetary policy stimulus lending, decreasing interest rate can suppress bank lending under a high uncertainty environment. This is due to the fact that a low interest rate has detrimental effects on banks' profitability if the pass-through of

[1] Essentially, this indicator can be understood as a measure of the degree of financial integration of the banking sector. A home bias of 1 indicates that the banking sector is in a state of autarky, while a home bias of 0 implies that the bank portfolio is fully diversified in terms of domestic and foreign assets. For a more detailed explanation of the index construction, see Section 2.1 and B.

risk-free rate decrease to deposit rate is rigid, which leads to less collateral value and higher cost of funding for interim stage uncertainty management. The overall impact is thus state-dependence, depending on the pass-through elasticities from risk-free rates to deposit rate and the asset size of the bank. Moreover, if the need for uncertainty management is stronger for foreign investment projects, as is often the case, lowering interest rate can have an unintended consequence of inducing higher bank home bias, which might further exacerbate economic disparities between countries and hinder global economic recovery.

The model is based on the portfolio approach of banking, extended to a two-country open economy setup. With CARA-type utility, banks make domestic and cross-border investment decisions taking into consideration both the first and second-order moments of returns. Our model thus speaks to the risk-taking channel of monetary policy in an international context. We assume one common monetary authority has the ability to determine the unique risk-free interest rate in the open economy, thus there is no arbitrage on risk-free returns. To characterize the profitability channel of monetary policy, we model the pass-through of risk-free rate to deposit rates and loan rates. Risk-free rate and pass-through elasticity thus jointly determine banks' profitability.

Importantly, our model features an *endogenous variance management* mechanism in order to better capture the characteristics of bank lending as opposed to other types of investments. We assume that the variance of the investments is *endogenous* in the sense that it can be reduced by costly management activities, which we refer to as uncertainty management at the interim stage. Investment project requiring further management at the interim stage is the common assumption in financial intermediation literature (Holmstrom and Tirole, 1997; Farhi and Tirole, 2012), and our management assumption can be understood in the sense of monitoring. The need to monitor the investment is one distinct feature of banks, as their asset portfolios include more non-tradable long-term assets with relatively opaque quality. Recent research shows that bank monitoring can indeed improve the repayment of loans (Branzoli and Fringuellotti, 2020). In addition, our model allows for *endogenous management costs*, in the sense that the banks' future profitability can help reduce the cost of management. This assumption seeks to capture the fact that banks need to secure interim stage financing for management, and the collateral value of future profits lowers the borrowing cost. This assumption is thus in a similar spirit to the capital constraint assumption in (Brunnermeier and Koby, 2018), as the cost reduction ability can be viewed as the shadow price of the constraint.

The first result of the analytical model is the banks' portfolio allocation. We show that with the presence of exogenous uncertainty friction, the bank's foreign investment is unambiguously biased downwards, whereas the impact on domestic investment depends on the correlation between two countries' fundamentals. In this case, monetary policy only affects the portfolio allocation decisions through the risk-taking channel. However, once we allow for the cost of managing uncertainty to be endogenously dependent on bank's profitability, multiple new channels are introduced. Monetary policy affects bank's profitability through both risk-free asset return and risk premium of domestic and foreign investment. This profitability channel would in turn determine bank's uncertainty management decision. As a result, the impact of an interest rate cut on bank's lending decisions becomes non-trivial, as it increases the risk premium of the risky asset but decreases bank's profitability if the pass-through from the risk-free rate to deposit rate is low.

Given that we assume foreign asset is more prone to be affected by the uncertainty friction, as bank's ability to manage foreign investment uncertainty is lower than that of domestic investment, an expansionary monetary policy have an asymmetric impact on domestic and foreign investment. To evaluate the overall impact, we apply the same formula of bank home bias used in the empirical section to our two-country model, and we compute the comparative statics of home bias changes with respect to the risk-free rate. What we find is that the impact of monetary policy on bank home bias is state-dependent, depending on the pass-through elasticity from the risk-free rate to deposit rate and the total size of bank's balance sheet. As a result, we obtain a diagram showing the state-dependent effect of monetary policy. We show that when asset size is large, or when the pass-through elasticity is low, an expansionary monetary policy can have an unintended consequence of increasing bank home bias. In this case, monetary policy can contribute to financial instability in the sense of reducing regional risk-sharing.

Lastly, we connect our model to the theory of reversal rate proposed by (Brunnermeier and Koby, 2018). Our model predicts that under certain parametric conditions, there exists a *reversal rate corridor*, within which an interest rate cut would encourage domestic lending but suppress foreign lending. In this case, although the overall credit supply quantity might remain relatively stable, the composition in terms of domestic versus foreign assets have been adjusted. We proceed to extend the analytical model to a dynamic version, and we plan to analyze the impact of endogenous variance management on precautionary saving decisions.

Related literature. This paper relates to several strands of the literature. The first is the transmission channel of monetary policy through financial intermediaries. Previous research have highlighted risk-taking channel of monetary policy, and more recently bank profitability channel. Our paper offers a model that touches on both channels but with different implications. Risk-taking channel of monetary policy focuses on showing how low interest rate can fuel banks' risk-taking, through search-for-yield behavior or through a re-evaluation of the risky assets (Borio and Zhu, 2012; Adrian, 2020). We add on to this literature by enriching the definition and range of risk-taking. First of all, we allow the riskiness of assets to be *endogenous* in the sense that banks can partially reduce the non-fundamental risk (or *uncertainty*) through active management. We believe that this is more consistent with the characteristics of banks' investment. If banks decide to take on *ex ante* riskier investment, they may choose to exert more effort to reduce the risk, so that the *ex post* risk is not too high. Second of all, while most studies on this topic interpret banks' risk-taking as banks' preference across different asset categories, we focus on a new perspective of domestic and foreign assets. This not only broadens the discussion on risk-taking to an international level but also allows for the examination of banks' role in efficient capital allocation and risk-sharing across countries.

Bank profitability channel is a novel channel documented in recent empirical studies, which document that low interest rates may harm banks' profit margin. Claessens et al. (2017) measure the net interest rate margin for a large sample of banks and show that the erosion of profitability is larger when interest rates have been low for a long time. Ampudia and Van den Heuvel (2018) analyse the stock prices of European banks and document that unexpected interest rate cuts lead to a significant fall in their valuation. They also argue that the decrease can be attributed to the rigidity of deposit rates near the zero lower bound region. Studies using data from countries other than the United States also document similar effects. Eggertsson et al. (2019) use data from Swedish banks to empirical evidence for the detrimental effect of low interest rates on bank equity and show that the impact of negative policy rates on bank profits serves as a sufficient statistic for the assessment of the impact of negative policy rates on bank lending. Boungou (2019) employs a panel dataset of 2442 banks in EU from 2011 to 2017 and documents that negative rates squeeze banks' interest rate margin and reduce risk-taking. Balloch and Koby (2019) provide evidence on the long run impact of low rates using Japan data reverse rate. profitability channel. In particular, they show that more exposed banks face higher costs of funding, but banks can leverage their market power to mitigate the issue, which leads to heterogeneity of the banking sector. On the contrary, Altavilla et al. (2021) document that negative rates can be passed on to some extent to corporate depositors due to firms' high demand for safe and liquid assets. Nevertheless, they find that firms still cope with negative rates by increasing investment and decreasing cash holding.

Based on these observations, recent contributions as Wang (2018), Heider et al. (2019), Ulate (2021b), or Ulate (2021a) seek to formalize this channel that nominal interest rates close to zero lower bound region suppress bank lending because of low profitability. As in Ulate (2021b), our banking environment features a similar duration for deposits and loans and thus abstracts from maturity transformation. However, contrary to the closed-economy setup in previous studies, our paper is, to the best of our knowledge, the first to embed the bank profitability channel into an international context, in which cross-border information frictions and market incompleteness impose the need to conduct costly risk management activities. We thus argue that low interest rate environments may alter the relative preference between domestic and foreign lending, which complements the previous discussions on the effects of monetary policy on aggregate domestic lending. Furthermore, Döttling (2021) argues that when interest rates are close to the ZLB, capital regulation decreases banks' franchise value and thereby induces more risk-taking. Karadi and Nakov (2021) argue that quantitative easing flattens the yield curve, impairs bank profitability, and thus slows down the recapitalization of banks. This in turn prolongs the duration of such unconventional policies, such that the policy itself may have additive and persistent effects. In a similar spirit, Brunnermeier and Koby (2018) and Darracq Pariès et al. (2020) point out the existence of a reversal interest rate, below which accommodative monetary policy has a contractionary effect on bank lending. In contrast to the closed economy setup in Brunnermeier and Koby (2018), our paper pins down a reversal rate on relative bank lending preferences in an open economy context. As the reversal rate differs for domestic and cross-border lending, a low interest rate environment has another unintended consequence for bank lending: it does not only affects banks' aggregate credit supply but also biases its composition.

The second strand of literature that we relate to is the international capital flow literature, in particular cross-border bank lending. One of the most frequently studied candidates is the exchange rate. Bruno and Shin (2015b) examine the role of global banks as opposed to local banks in transmitting liquidity shocks through cross-border lending, highlighting the importance of bank leverage level. Cesa-Bianchi et al. (2018) also assume one global bank, and they stress the role of collateralized borrowing, together with the exchange rate, in determining international capital flows. More recent papers focus on the need for liquidity and safe asset. Correa et al. (2018) show that contractionary monetary policy induces banks' perceived riskiness of domestic borrowers to increase as compared to that of the foreign borrowers and thus biases lending decisions. Kekre and Lenel (2021) show that the demand for safe dollar bonds can cause an appreciation of dollar, after the rebalancing of the portfolio due to risk premium changes.

Instead of directly explaining the level of cross-border lending, another strand of literature seeks to provide a more normative empirical framework. By analyzing to what extent the current cross-border lending is sub-optimal compared to certain diversification criteria, they define an index of bank home bias, which reflects the overall preferences for foreign assets. The index is commonly used to analyze equity and bond investment (Hau and Rey, 2008; Coeurdacier and Gourinchas, 2011, 2016). In terms of the mechanism, Mondria et al. (2010) use search index to show that the extent of information acquisition for domestic and foreign investment are different. The index is adapted to bank lending in recent research. Coeurdacier and Rey (2013) empirically document bank home bias for different world regions, and Giannetti and Laeven (2012) and Saka (2017) analyze the behavior of bank home bias during economic crises. Our paper follows this empirical approach and provides a more detailed documentation of bank home bias, with quarterly frequency and a length of twenty years.

Our empirical and theoretical analysis of bank home bias are consistent with this literature, and is not confined to the periods around financial crises.

Lastly, our paper also touches on the topic of the impact of uncertainty and information friction. Pioneered by Bloom (2009), the analysis on the macroeconomic consequences of uncertainty has become a central topic of interest over the past decade. A key issue in this literature deals with the measurement of uncertainty. Overall, two distinct measurement approaches are commonly used. The first one relies on text-mining techniques applied to writings such as research reports or newspaper articles, as in Baker et al. (2016) and Ahir et al. (2018). The second approach relies on exploiting rich financial data to compute model-implied uncertainty. Examples include among others Jurado et al. (2015) and Berger et al. (2020). The data used in the former studies, ranging from macro-economic statistics to high-frequency financial asset returns, capture volatilities and variances of agents' expectations and thus measure to what extent outcomes are perceived to be uncertain. In our paper, we use uncertainty indices constructed based on the first approach because of their availability in time and cross-country dimensions. In terms of the mechanism, recent studies have shown uncertainty shock can be protracted due to strategic interactions and lack of learning (Fajgelbaum et al., 2017; Straub and Ulbricht, 2015). The uncertainty is endogenously determined by the actions of the agents. Our model provides a further microfoundation for endogenous uncertainty, which works through banks' risk management.

For the management of uncertainty, our model also relates to the strand of literature on the monitoring. Among others, Holmström and Tirole (1993) and Holmstrom and Tirole (1997) develop models of imperfect information, in which creditors need to exert monitoring effort to observe true underlying project returns. Repullo (2004) and Martinez-Miera and Repullo (2020) study bank monitoring, where investment projects are monitored at a private cost. The extent to which risk-free rate changes thereby affect banks' investment decisions depends on their market power. In terms of modeling, monitoring literature usually features a increase in the mean of the project by changing the probability distribution, while at the same time decreasing the variance. In our model, we keep the mean of the project unchanged and focus on management that reduces the second-order moment.

Structure of the paper. The rest of the paper proceeds as follows. Section 2 introduces data and measurement methods and documents empirical facts on bank home bias. Section 3 provides an analytical model which explains the key mechanisms that determine the global lending preferences of banks, as well as the channels of impacts of monetary policy. In section 4, we adapt the model to a dynamic setup. Section 5 shows structural VAR estimation of the impact of monetary and uncertainty shocks on bank home bias. Finally, section 6 concludes.

2 Data and Empirical Facts

2.1 Home Bias Index

We start by introducing the home bias index. We choose this index, as opposed to directly comparing foreign and domestic lending quantity, as it captures the extent to which the existing investment activities *could have* been diversified if the banks had *replaced* some of their domestic assets by foreign ones. Therefore, bank home bias can be intuitively understood as a deviation from a *neutral* level of preference for foreign assets. The construction of this concept thus boils down to: (*i*) specifying a benchmark portfolio consisting of foreign and domestic asset holdings, and (*ii*) measuring how far the actual portfolio deviates from this benchmark level. In the context of international financial markets, we follow the practice of Coeurdacier and Rey (2013) and define the benchmark portfolio as a diversified portfolio in the CAPM sense. It implies that the share of foreign asset holdings in this portfolio (i.e. *portfolio foreign share*) equals the share of investment into foreign countries' in world's total investment (i.e. *world portfolio foreign share*).

Formula for bank home bias. Our computation of bank home bias is at country level. The countries are indicated by $i \in I$. Denote by d_i the domestic asset holdings of country i's banks, and c_i the cross-border asset holdings. Suppose the home country is country i^*. To compute the benchmark portfolio for country i^*, we first need to compute the total investment to countries that are foreign to country i^*, which equals $\Sigma_{i \neq i^*} d_i + \Sigma_{i \neq i^*}(c_i - c_i^{i^*}) + c_{i^*}$. The first term denotes all the other countries' domestic investment. The second term is all the other countries' cross-border investment, net of the investment that goes to country i^*. Finally, the third term is the cross-border investment of home country i^*. The world's total investment is given by $\Sigma_{i \in I}(c_i + d_i)$. Based on this definition, the formula for bank home bias is given by:

$$\mathcal{HB}_{i^*} \equiv 1 - \frac{\text{portfolio foreign share of } i^*}{\text{world portfolio foreign share of } i^*} = 1 - \frac{\frac{c_{i^*}}{c_{i^*} + d_{i^*}}}{\frac{\Sigma_{i \neq i^*} d_i + \Sigma_{i \neq i^*}(c_i - c_i^{i^*}) + c_{i^*}}{\Sigma_i (c_i + d_i)}} . \tag{1}$$

The index denotes a *real measure* which lies in the range $[0, 1]$[2], if all asset positions are weakly positive. For a given world foreign share, the upper bound of unity is reached if banks of country i do not engage in cross-border lending. The index is zero if the banks of country i have a portfolio foreign share equal to the world foreign share.

[2]Note that the definition of home bias index allows for a range of $(-\infty, 1]$. It becomes negative if relative cross-border lending is above world foreign share. This is, however, rarely the case in our dataset. With the exception of a few countries, the domestic investment share is always larger. Therefore, we restrict our analysis to the case where home bias is larger than zero.

2.2 Data Description

We develop the empirical counterparts of the components of home bias index using data from multiple sources. In addition, we also look at several data on the potential factors that drives bank home bias, in particular uncertainty and banking sector characteristics. A more detailed explanation of the data sources can be found in the Appendix A.

Banking sector. In order to obtain a clear overview of banks' lending decision to both domestic and foreign borrowers, we use data from multiple resources. Therefore, it is important to first state the definition of banks in the context of this research and explain why the definition is consistency across datasets. While different institutions have different classification standard, the key feature of the entities that are of interest to us is clear: depositing taking institutions that engage in loan generating activities. Therefore, we rule out financial intermediaries that relies mainly on wholesaling financing (e.g. most shadow banks) and those who take deposit but only invest in standardized financial securities (e.g. money market funds).

For domestic lending, we obtain data from International Monetary Fund (IMF)'s International Financial Statistics (IFS) dataset. The institutions under the classification system of would be Other Depository Corporations (ODCs), which, together with central banks, consists of the broader category of Financial Corporations (FCs). For cross-border lending, we turn to Bank for International Settlements' Locational Banking Statistics (LBS). Although IFS dataset also provides data on foreign lending, LBS captures around 95% of all cross-border activities from the perspective of residence and gives richer details regarding the characteristics. The definition of bank in LBS is Deposit-taking Corporations except the Central Bank. [3]

Equity investment. Besides banking sector, we also apply the definition of home bias to countries' equity investment portfolio. The key data source used for equity is Coordinated Portfolio Investment Survey from IMF, which documents the holdings of foreign equity investment at country level. Combined with data on domestic equity market capitalization obtained from the World Bank, we construct annual home bias indicator for equity in the same way as bank home bias. The details of dataset construction can be found in the Appendix A.3.

Uncertainty. Uncertainty is one of the key drivers for cross-border decisions that we want to examine. While the concept of uncertainty are sometimes used interchangeably with *risk*, in this research we opt for the former. The reason is that we want to capture the degree to which investors are not sure about the realization of investment returns, which depends on

[3]To define what classifies as cross-border lending in LBS dataset involves distinguishing between several closely related concepts, the details of which can be found in the Appendix A.2.

various economic and policy environment in addition to the investment project itself. In this sense, the concept of uncertainty captures more than just the risk of one asset. We adopt two measures from the literature to compute our uncertainty index. The first one is the Economic Policy Uncertainty Index (EPU), a comprehensive index of uncertainty based on news, tax code and survey results developed by Baker et al. (2016). Although this index is available for over a dozen of countries, to ensure that we have the maximum data coverage, we also use the World Uncertainty Index (WUI) developed by Ahir et al. (2018). The dataset provides country level data on a monthly basis for over one hundred countries. Using this dataset, we are able to construct domestic uncertainty index and foreign uncertainty index for each country. The details of variable construction can be found in the Appendix A.4.

Banking sector characteristics. The last set of data is on banking sector characteristics, including banks' balance sheet size and composition, profitability, and capital ratios. For the United States, we obtain data from Federal Reserve Bank of New York's *Consolidated Financial Statistics for the U.S. Commercial Banking Industry* for an overview of US banking sector. For European Union countries, we obtain similar data from European Central Bank Statistical Data Warehouse, in the dataset of *Consolidated Banking data*.

2.3 Three Stylized Facts

Fact I: Bank Home Bias. To start with, we want to see the general trend of bank home bias. The red line in Figure 1 displays the bank home bias for the United States and the black line the weighted world bank home bias. The most salient feature we observe is a V-shaped trend. Prior to the Great Recession, US banks have experienced a steady decrease in bank home bias. After the crisis, however, the trend has reversed and returns back to the original level at the early 2000s. The weighted world average of bank home bias shows a similar trend. These variations across time suggest that relative preferences for domestic lending are not constant, but rather a state-dependent reflection of various underlying economic forces.

In addition, we want to check whether the bank home bias exhibits patterns similar to capital home bias, in particular equity home bias. Using annual data, we compute country level equity home bias and compare the results with bank home bias. Figure 2 displays the result. The details on the construction of equity home bias can be found in Appendix A.3, and a panel table of country-wise equity home bias can be found in Appendix B. From the figure, we see that weighted world bank home bias and weighted world equity home bias have similar trend prior to the Great Recession. After the recession, however, the trend continues for equity home bias but reverses for bank home bias.

The departure in the trends suggests that either bank home bias and equity home bias react differently to the same shock, or there are factors that affect only banking sector but not

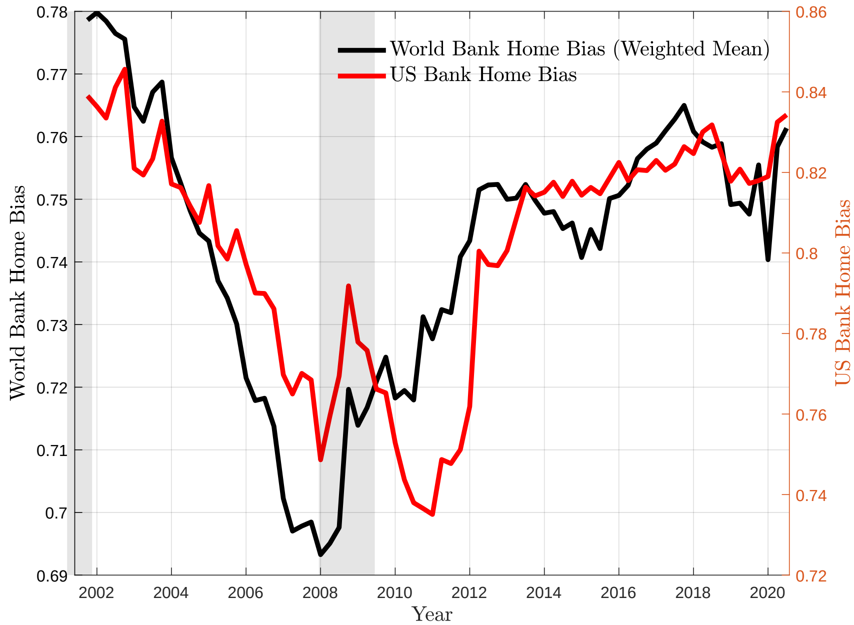

FIGURE 1. BANK HOME BIAS FLUCTUATIONS.

Notes: The dark line displays the average level of bank home bias of the countries in our sample at quarterly frequency, from 2001 Q4 to 2020 Q2. Weights are computed based on the size of their banking sectors' total assets. The red line displays the home bias of US banks.

equity. There are a few candidates. Firstly, major regulation reforms took place during and after the recession. The new Basel III regulatory framework, which specifies stringent capital requirements and liquidity requirements, could shift in banks' attitude toward cross-border lending. Secondly, unprecedented scale of quantitative easing after the crisis might also cause bank investments and equity investments to move in different directions. While equity investments benefit from the expansionary monetary policy due to the appreciation of asset prices, bank investments, most of which are loans, are less liquid and often non-tradable. Moreover, due to interest rate-pass through rigidity, they experience loss in the profit if the deposit rate is rigid. In Section **??**, we examine the role of monetary policy on bank home bias with an analytical framework and show that if the profit channel is strong enough, the model indeed predicts a difference in bank and equity home bias under low interest rate environment.

Fact II: Bank home bias and uncertainty. We proceed to examine the driving forces of bank home bias, of which the first one is uncertainty. As stated in previous section, we are interested in uncertainty as a measure of the overall investment environment. Therefore, instead of asset specific index like VIX, we use the text-based measures, as bank assets consist of asset of broad categories. Figure 3 displays the result of plotting the weighted average world bank home bias against the weighted average Economic Policy Uncertainty (EPU) Index. The EPU

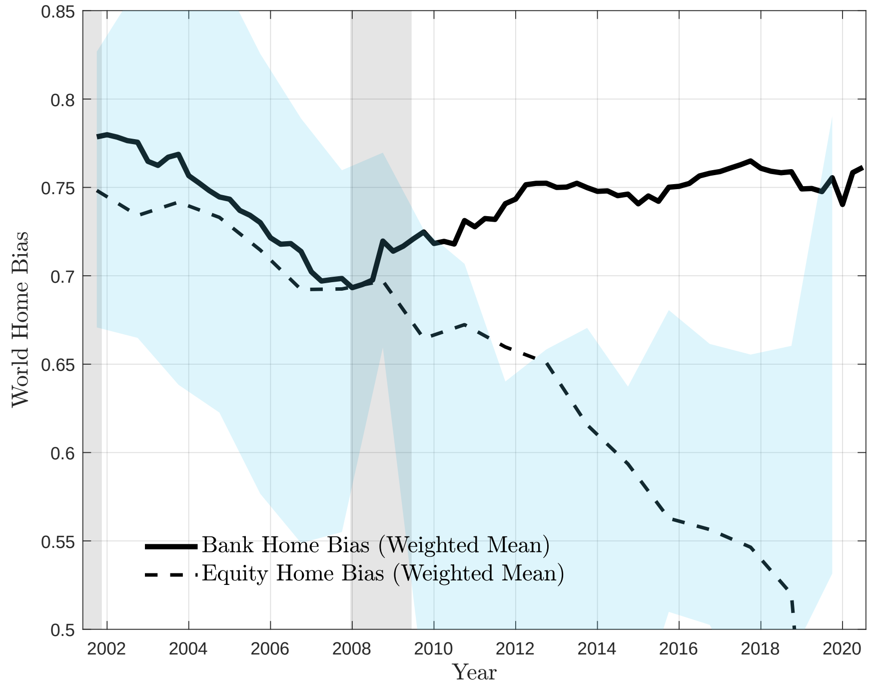

FIGURE 2. WORLD BANK HOME BIAS VS. WORLD EQUITY HOME BIAS.

Note: The solid line shows the average level of bank home bias weighted by total bank asset, as in Figure 1. The dash line shows the average equity home bias weighted by GDP computed in large sample. The blue shaded area is the [25, 50] quantile of the equity home bias panel dataset. For the equity home bias values of each country, see Table 2.

is weighted in the same way as bank home bias and is shown with 4 quarters lag[4].

In the Figure, we see that the weighted bank home bias and the lagged weighted EPU index exhibit very similar pattern, in terms of both general trends and short-run variations. This indicates that uncertainty has strong predictive power of bank home bias, which is consistent with the intuition as uncertainty itself is a forward looking index. Therefore, high uncertainty level signals potential adjustment of the portfolios. Considering the maturity and liquidity structure of banks' portfolio, the adjustment is observed with a lag. In addition, we notice that uncertainty index also remains high after the end of the Great Recession, same as a prolong period of high home bias. In Section **??**, we further investigate the role of uncertainty by decomposing it into domestic and foreign uncertainty and show that the latter turns out to be the most important one. In Section **??**, we show how foreign uncertainty determines the preference of foreign investment through its interaction with monetary policy.

Fact III: Bank home bias and profitability. Our next step is to investigate the characteristics

[4] For unweighted mean of both, see Figure 15 in the Appendix B

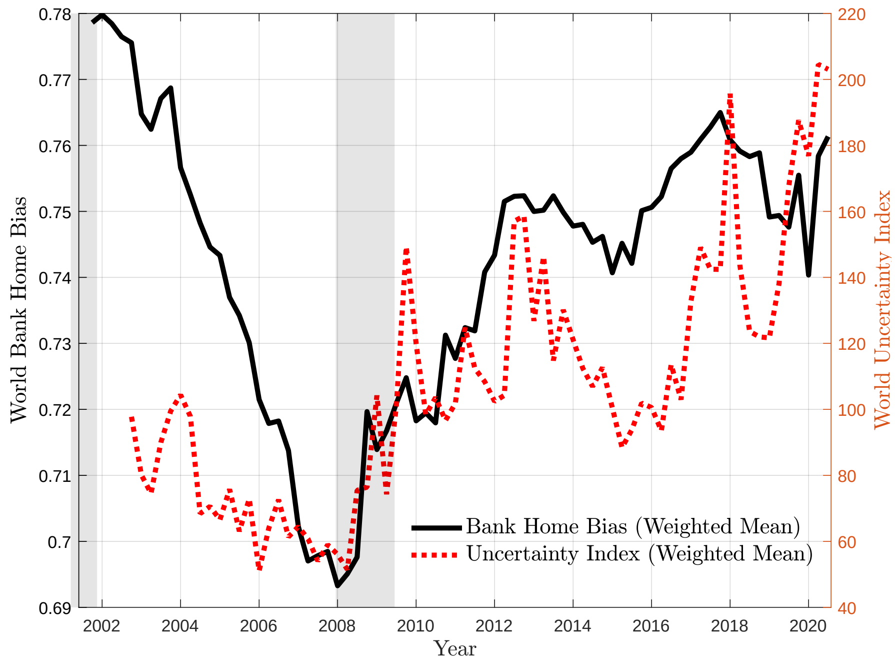

FIGURE 3. WEIGHTED MEAN OF WORLD BANK HOME BIAS AND UNCERTAINTY.

Note: The solid line shows the average level of bank home bias weighted by total bank asset, as in Figure 1. The red dash line shows the average Economic Policy Uncertainty index weighted by total bank assets, lagged by 4 quarters.

of banking sector, for which we focus on the United States. Using the dataset from Federal Reserve Bank of New York, we examine the correlation of the profitability of the U.S. banking sector with the bank home bias[5].

Figure 4 shows the comparison between US banks' home bias and the return on asset, and Figure 16 in the Appendix shows that of home bias and return on equity. Notice is that the average level of return dropped sharply during the crisis and has since been in recovery, but the returns are still slightly below pre-crisis level until late 2018, similar to the level of home bias. In addition, an increase in the returns is often accompanied by a decrease in the home bias. As stated in previous section, low interest rate environment and tight regulatory framework are most likely to contribution to the shrink in bank profit. In the analytical model, we further pin down the channel through which bank profitability translates into preference of foreign investment.

[5]In addition, we also check regulatory variables like capital ratio and leverage ratio. See Appendix B.

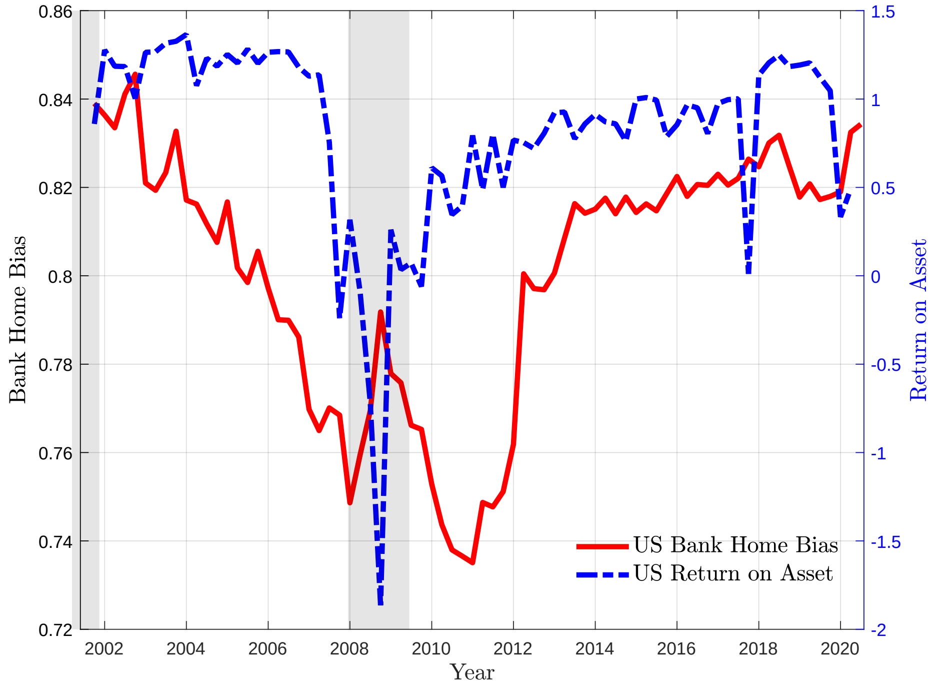

FIGURE 4. US BANK HOME BIAS AND RETURN ON ASSET.

Notes: The solid line shows the bank home bias of United States as in Figure 1. The blue dash line shows the return on equity of banks, provided by Federal Reserve Bank of New York.

3 Analytical Model

This section outlines our tractable two-country open economy model on international bank lending, taking into consideration the presence of second-order moments and the ability of the bank to manage them. In particular, the model embeds multiple channels of effect of monetary policy and high light how interest rate cut can have state-dependent effect on bank lending, depending on bank asset size and pass-through elasticity of risk-free rates. The key feature of our model is that uncertainty frictions and monetary policy interact with each other. The ability of banks to manage uncertainty hinges on their profitability, which is tight to the interest rate pass-through channel: movements in the monetary policy rate are accompanied by subsequent movements in loan and deposit rates. Thus, if monetary policy rates falls into a region where bank profitability is compressed, such as the effective ZLB region, two key channels jointly determine the degree of bank home bias: (i) a *standard bank lending channel* according to which expansionary monetary policy decreases the risk-free rate, increases risk premia and hence domestic and foreign lending, and (ii) a *bank profitability channel* according to which expansionary monetary policy decreases bank profitability, uncertainty management activities and hence increase bank home bias. Which of the aforementioned channels dominate, depends on the underlying model primitives.

This section is organized as follows. In Section 3.1 we outline the setup of the static open economy banking model and introduce the timing of events. Section 3.2 explains the interim stage uncertainty management problem and pins down the endogenous variance of investment. Section 3.3 solves for the optimal portfolio allocation of banks in closed form. Given the solution, Section 3.4 presents the implications of monetary policy on bank home bias fluctuations. Section 3.5 links our model to the reversal rate literature and discuss how our mechanism can general reversal rates for domestic and foreign lending. Section **??** provides some further discussions. Analytical derivations and proofs are deferred to Appendix C.

3.1 Setup

Our baseline framework features a small open economy composed of two countries, denoted by (i, j). In each country, the economy consists of three sectors: household, firms and financial intermediaries (banks). For simplicity, we abstract from heterogeneity within sector, so that all sectors are representative. Countries are symmetric and differ only in terms of fundamental parameters. In addition, we assume that there is one common central bank that sets risk-free rates and supply risk-free asset. We abstract away from exchange rates fluctuations in this economy. These assumption can be understood as the characterization of a monetary union, but it can also be seen as a case in which exchange rate fluctuations have been perfectly hedged and there is no risk-free rate arbitrage opportunities. Without loss of generality, we describe the setup from the perspective of country i.

Household. There exists a unit measure of identical households. Each household consumes, saves and supplies labor. Households cannot directly invest into assets, they rather save by lending depository funds to financial intermediaries. Workers supply inelastically one unit of labor $l_i^s = 1$ in the local labor market and return their wage earnings to the family. They also choose to hold an amount d_i of local deposits at their bank account at a financial intermediary which is not owned by the family.

Central Bank. We assume that there exists one central bank, whose role is to determine risk-free return R^f, which is the same across both countries, and set regulatory policies. The risk-free asset can thus be understood as reserves directly provided by the central bank, or other form of safe asset whose return is under the influence of central bank operations.

Firm. The production sector features a representative firm producing a final consumption good with the technology

$$y_i = F(A_i, k_i, l_i) = A_i k_i l_i^{\xi} \quad \text{with} \quad 0 \leq \xi < 1 \; . \tag{2}$$

A_i denotes a country specific aggregate technology shock. Moreover, k_i is the aggregate physical capital invested into country $i's$ firms through lending decisions of both countries banks, i.e. $k_i = k_{ii} + k_{ji}$. The production function $F(A_i, k_i, l_i)$ features constant returns to scale in (k_i, l_i) due to constant equilibrium hours worked.

Aggregate TFP of the two countries (A_i, A_j) follows the structure

$$A_i = z_i \; , \quad \text{and} \quad A_j = z_j \; , \tag{3}$$

where (z_i, z_j) denote two technology shocks which determine the fundamental component of the respective TFP process. We assume that the random variables (z_i, z_j) are jointly Gaussian distributed with means (μ_{z_i}, μ_{z_j}), variances $(\sigma^2_{z_i}, \sigma^2_{z_j})$, and correlation $\rho \in (-1, 1)$. As a result, capital returns to production are linear in the fundamental technology component.

In addition to fundamental TFP shock, we assume that there will be a second set of shocks that contribute to the variance of project returns received by the banks, which we refer to as *uncertainty*. Uncertainty shocks, denoted by (ϵ_i, ϵ_j), is Gaussian with zero mean and variance denoted by $(0, \sigma^2_\epsilon)$. Moreover, we impose that (ϵ_i, ϵ_j) is independent from (z_i, z_j). The economic intuition of this component is that it captures the non-fundamental risky components of project returns, such as information friction, regulatory frictions or policy uncertainty. Since it is not fundamental, we assume that it can be reduced by the bank through *management* activity, but with a cost. This can be understood as banks hiring more project managers to oversee their loans in order to reduce the possibility of default. The details of this specification will be introduced in Bank and Interest Rates Determination section.

Bank. Bank is the only financial intermediation of our economy. We assume that there is one representative banking sector in each country, who performs both domestic and foreign lending. The asset side of the banks' balance sheet thus includes loans to domestic firm project, loans to foreign project, and one risk-free asset. We assume that the risk-free asset is the same for both countries with gross return R^f. The liability side is assumed to include only equity and deposit. The bank is endowed with initial equity e_i, and deposit d_i is supplied uniquely by domestic households. The size of the balance sheet, or the bank's total loanable wealth, is thus given by $w_i = e_i + d_i$. Denote $\delta = \frac{d_i}{w_i}$ as the deposit-to-asset ratio.

We adopt the portfolio approach of banking and assume that the banks have CARA preferences of the standard form

$$u(e_i) = -\frac{1}{\alpha} e^{-\alpha e_i} ,$$

where $\alpha > 0$ denotes the absolute risk aversion parameter. The reason why we choose this specification of bank utility is two-fold. First of all, since we seek to capture the risk-taking channel of monetary policy in our model, the CARA-normal framework is a convenient form since it allows us to develop tractable portfolio solutions conditioning on both first and second-order moment of the investment projects. Second of all, although many banking literature assume risk neutrality of banks, risk also plays an important role in these model, through the risk-weighted capital requirement constraint. Therefore, the risk-aversion of banks in our framework can also arise from similar motives to control for riskiness.

Interest Rates Determination. Beside the risk-free interest rate chosen by the central bank, there are two additional interest rates in our economy, the deposit rate and the loan rates. We assume that both rates depends on the risk-free rate, and we specify the degree of pass-through. The deposit rate offered by the bank is R^d. For simplicity, we assume that the deposit rate is a functional of the gross monetary policy rate R^f. Specifically, we impose $R^d = \left(r^f\right)^{\omega}$, where $\omega \in \left[0, \delta^{-1}\right]$ denotes the pass-through elasticity from the risk-free monetary policy rate to the deposit rate. The previous parametric specification serves as short-cut to model deposit competition in a low interest rate environment. Consistent with empirical evidence, ω takes a value close to zero at the ZLB. Away from the ZLB, ω is close to its upper bound of unity.

The loans rates charged by the banks are determined in two steps. First, given the gross return (R^i, R^j) of the risky projects and the risk-free rate R^f, banks bargain with entrepreneurs over the division. Specifically, we assume that banks have bargaining power $\theta \in (0, 1]$, and entrepreneurs have respectively bargaining power $1 - \theta$. The standard Nash bargaining outcome predicts that equilibrium loan rates are given by

$$\bar{R}^l_{ii} = \theta \left(R_i - R^f\right) + R^f \ , \quad \text{and} \quad \bar{R}^l_{ij} = \theta \left(R_j - R^f\right) + R^f \ , \tag{4}$$

If $\theta = 0$, there is complete pass-through of policy rate to loan rates. On the contrary, if $\theta = 1$, there is no pass-through and banks completely extract matching returns.

Second, as stated previously in Firm section, there are non-fundamental uncertainty shocks (ϵ_i, ϵ_j) that affect project returns received by the bank. To be more specific, we assume that the bargained outcome $(\bar{R}^l_{ii}, \bar{R}^l_{ij})$ is subject to the perturbation of uncertainty shocks, i.e. $\bar{R}^l_{ii} + \epsilon_i$, $\bar{R}^l_{ij} + \epsilon_j$, where ϵ_i, ϵ_j are uncertainty of the respective country. However, since uncertainty can be reduced through management, the *ex post* uncertainty that changes the project return is given by $R^l_{ii} = \bar{R}^l_{ii} + \epsilon_i \mathcal{P}(m_i, k_{ii})$, $R^l_{ij} = \bar{R}^l_{ij} + \epsilon_j \mathcal{P}(m_j, k_{ij})$. $\mathcal{P} \in (0, 1)$ is the uncertainty reduction technology, or *management*, of the banks, and it depends on m_j, the effort level of managing, and the loan size. Without loss of generality, we assume that domestic uncertainty can be eliminated effortlessly, i.e. $\mathcal{P}(m_i, k_{ii}) = 0$ for all $m_i = 0$. This is equivalent to saying that we focus not on the absolute level of uncertainty, but the relative level of uncertainty difference in domestic and foreign investments. Management of uncertainty is associated with a cost of $\mathcal{C}$, the functional form of which will be specified in Uncertainty Management section. As a result, we have

$$R^l_{ii} = \bar{R}^l_{ii} \;, \quad \text{and} \quad R^l_{ij} = \bar{R}^l_{ij} + \epsilon_j \mathcal{P}(m, k_{ij}) \;. \tag{5}$$

Timing of Events. Timing of events is summarized in Figure 5.

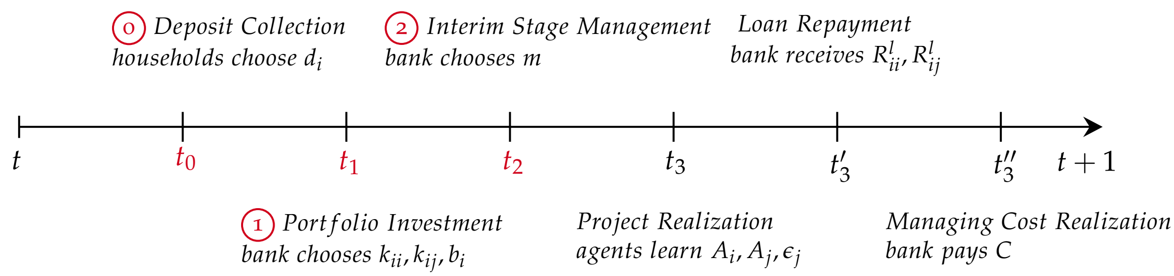

Figure 5. Timing of events.

0. *Depositing collection.* Households deposit their money into respective domestic bank, given the *gross* deposit rate R^d.

1. *Portfolio investment.* Bank chooses the portfolio allocation $\{k_{ii}.k_{ij}, b_i\}$, given the available funds w_i, which is the sum of the initial equity e_i and deposit received d_i.

2. *Interim stage management.* Given the portfolio $\{k_{ii}.k_{ij}, b_i\}$, bank choose the optimal level of management m to exert to reduce uncertainty in foreign investment.

Bank Profitability. Under this setup, we can define the end-of-period equity before the management cost realization, denote as $e_i{}'$:

$$\tilde{e}_i{}' = \underbrace{R^f b_i}_{\text{risk-free repayment}} + \underbrace{R^l_{ii} k_{ii}}_{\text{domestic loan repayment}} + \underbrace{R^l_{ij} k_{ij}}_{\text{foreign loan repayment}} - \underbrace{R^d d_i}_{\text{deposit payment}} .$$

Based on $\tilde{e}_i{}'$, we define *Bank profitability* as increment of equity before managing cost

$$\Delta \tilde{e}_i{}' = \tilde{e}_i{}' - e_i.$$

And after the management cost has realized, we have the final end of period equity:

$$e_i' = R_{ii}^l k_{ii} + \Big(\bar{R}_{ij}^l + \epsilon_j\big(1 - \mathcal{P}(m^*, k_{ij})\big)\Big)k_{ij} + r^f b_i - R^d d_i - \mathcal{C}(m^*, k_{ij}, \Delta\tilde{e}_i{}') \,.$$

Note that under this setup, we can redefine the expected profitability as follows

$$\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right] = \underbrace{(\mathbf{1} - \boldsymbol{\omega\delta})w_i r^f}_{\text{risk-free increment}} + \underbrace{\theta(\mu_i - r^f)k_{ii} + \theta(\mu_j - r^f)k_{ij}}_{\text{risky increment}} \qquad (\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right])$$

where (μ_i, μ_j) are the net return from the project, r_f is the net risk-free rate, and $\mathcal{I}$ contains all the information regarding portfolio allocation. This expression shows that the expected profitability essentially, contains two component. The first component, risk-free increment, denote the profit coming from the interest rate margin. As the bank pays the depositors at a lower rate than risk-free rate, and the deposit-to-asset ratio δ is always less than 1, this part is what banks can *arbitrage* between depositors and risk-free asset issuer, i.e. the central bank. The second component, which we refer to as risky increment, comes from the risk premium of domestic and foreign investment. θ is the Nash bargaining parameter that determines to what extent this part can be extracted by the bank. We can see that the risk-free interest rate has positive effect on the first component and negative impact on the second. The following lemma characterizes the overall impact of monetary policy.

Lemma 1 (Expected Bank Profit and Monetary Policy)**.** *Assume that the two countries' TFP shocks have the same mean, i.e. $\mu_i = \mu_j = \mu$. Denote the domestic risky asset share by κ_{ii}, respectively the cross border risky asset share by κ_{ij}. A monetary policy tightening increases expected bank profitability $\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]$ if the following condition holds*

$$\frac{b_i}{w_i} \geq \frac{\theta + \omega\delta - 1}{\theta} - \frac{\mu - r^f}{r^f}\left(\varepsilon_{k_{ii},r^f}\kappa_{ii} + \varepsilon_{k_{ij},r^f}\kappa_{ij}\right) \,, \qquad (6)$$

where ε_{k_{ii},r^f} and ε_{k_{ij},r^f} denote elasticities of risky asset investments with respect to the net monetary policy rate.

To understand the result of Lemma 1, notice that the left hand side of equation (6) denotes the share of risk-free central bank reserve hold by banks of country i. The right hand side is composed of two terms. The first term denotes the *mechanical effect* of a monetary policy tightening. It reflects the change in expected bank profitability holding the current portfolio unchanged. Contrary, the second term documents the *behavioral effect* of a monetary policy tightening. It reflects the change in expected profitability induced by a change in the portfolio composition in response to the policy change.

The mechanical effect trades off two channels: First, a standard bank lending channel according to which a monetary policy tightening reduces the excess return on risk asset investments. The strength of this channel is captured by banks' bargaining power θ. Second, a net risk-free return exposure channel according to which a monetary policy tightening increases the return margin between central bank reserve holdings and deposit rates, which is captured by the leverage ratio δ and the deposit elasticity ω. For larger values of δ, θ and ω, a larger risk-free asset share is required for expected bank profitability to increase. The intuitions are as follows: an increase in the leverage ratio δ exposes banks to larger amounts of deposit return payments and hence decreases profits. For expected profitability to increase by compensating for the bank lending channel, a larger central bank reserve share is necessary. Moreover, an increase in pass through of monetary policy to deposit rates ω increases the deposit rate and reduces profitability. As a result, a larger central bank reserve share is required to compensate for the negative margin arising from the standard bank lending channel. If the economy is close to the ZLB, i.e. ω is close to zero, the mechanical effect will always induce an increase in expected bank profitability as $\omega < \delta^{-1}(1-\theta)$ in this case. Finally, an increase in the bargaining weight θ for loan rates strengthens the mechanical effect arising from the standard bank lending channel by reducing the expected bank profitability.

The behavioral effect implies that a monetary policy tightening decreases excess returns of loans and hence reduces risky asset holdings. This goes along with a reduction is expected profitability which requires in turn a higher central bank reserve share to compensate for the downward pressure arising from the bank lending channel. The elasticities $(\varepsilon_{k_{ii},r^f}, \varepsilon_{k_{ij},r^f})$ also encompass endogenously substitution effects among risk asset holdings in response to changes in the monetary policy environment and hence reflect the change of the home bias of banks. The former channel is relevant for expected bank profitability in case of loan rate heterogeneity across countries, i.e. if $\mu_i \neq \mu_j$ applies.

We are now ready to define the bank's problem under this setup.

Bank's Problem. The maximization problem of banks is solved by backward induction. Given $\mathcal{I}$, they maximize expected utility, which depends on terminal equity e_i'. The objective of the multistage problem can be written as

$$\max_{\{k_{ii},k_{ij},b_i,m\}} \mathbb{E}\left[u(e_i')|\mathcal{I}\right] \qquad s.t. \tag{P1}$$

$$e_i' = R_{ii}^l k_{ii} + \left(R_{ij}^l + \epsilon_j\big(1-\mathcal{P}(m,k_{ij})\big)\right)k_{ij} + r^f b_i - R^d d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i{}') \ ,$$

$$w_i = k_{ii} + k_{ij} + b_i$$

where $(R_{ii}^l, R_{ij}^l, r^f)$ denote the gross returns of investment opportunities.

3.2 Interim Stage Management

Given the timeline of events, we solve the banks' optimization problem (P1) by backward induction. At second stage, bank has chosen the portfolio $\{k_{ii}.k_{ij}, b_i\}$ and need to exert an effort to control for the detrimental effect of uncertainty. Specifically, we assume that banks can reduce the uncertainty σ_ϵ^2 by choosing, for a given cross-border investment level k_{ij}, an effort level m^* to maximize expected utility gains

$$m^* = \arg\max \mathbb{E}\left[u\left(\epsilon_j \mathcal{P}(m, k_{ij})k_{ij} - \mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}')\right)|\mathcal{I}\right] , \tag{7}$$

where $\mathcal{P}(m, k_{ij})$ is the uncertainty reduction function depending on uncertainty-managing effort m. The uncertainty management cost function, $\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}')$, also depends on the effort level m and investment k_{ij}. What's different is that we assume the cost also hinges on the gross profitability of banking $\Delta\tilde{e}_i{}'$, measured by the expected equity gains *before* uncertainty management costs. The cost is wasted in the sense that it is not redistributed back to households.

Our setup of uncertainty management seeks to capture bank's active monitoring feature in a parsimonious way, in the spirit of Holmstrom and Tirole (1997) that emphasizes the importance of monitoring effort for banks. As a major part of bank investments is long term and non-tradeable projects, banks need to continuously monitor the project they invested in through actions such as auditing and screening. Therefore, the monitoring effort exerted by the banks is crucial in determining the riskiness of investment projects[6]. Nonetheless, the management mechanism is not confined to this interpretation. For example, it is also consistent with the noisy information framework in portfolio choice problem. (Van Nieuwerburgh and Veldkamp, 2010) points out costly information acquisition as one reason for portfolio under-diversification. The paper argues that there exists a positive feedback loop between the amount of investment in a certain asset and the intensity of information acquisition. Essentially, investors would like to learn more about the assets which they hold the most, thereby reducing its risks. The act of learning in turn may strengthens the investors' incentives to increase their holdings of this particular asset, thereby completing a self-enforcing loop. Apart

[6]Research in the costly monitoring literature (see for instance Holmstrom and Tirole (1997) or Repullo (2004)) often model monitoring by shifting the mean of the investment project by changing the probability distribution, while at the same time decreasing the variance. Whether this increases the expected net payoff depends on the monitoring cost and the strength of changing the probability distribution. On the contrary, in our setup, we decrease mean and variance. The first effect occurs as the probability distribution is unaffected through our managing effort and information acquisition is costly. The second effect is similar to choosing the size of the second period uncertainty realization. Our modeling is thus more similar to the costly information acquisition literature and to a lesser extend to the monitoring literature. Increasing the mean of the project, as it is allowed in the monitoring literature, would offset parts of the uncertainty effects. As a result, one would limit the cross-border friction driving home bias fluctuations, as it would in principle allow to obtain a mean variance dominating transformation.

from noisy information, moral hazard issue, pointed out by (Farhi and Tirole, 2012), might also explain why banks face no uncertainty in domestic investment but need to exert effort to manage foreign investment, as banks might be expecting explicit bail-out promises from domestic government on their domestic projects.

We parameterize the uncertainty reduction function and management cost function $\mathcal{P}(m, k_{ij})$ in an elasticity form

$$\mathcal{P}(m, k_{ij}) = m^{-\varphi} k_{ij}^{\eta}\,, \qquad \text{with} \quad \varphi > 0,\ \eta > 0 \tag{8}$$

$$\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}') = \left(1 - \psi \mathbb{E}\left[\Delta\tilde{e}_i{}' | \mathcal{I}\right]\right)^{\lambda} m^{\chi} k_{ij}^{\nu}\,, \quad \text{with} \quad \psi \in \Psi,\ \lambda \geq 0,\ \chi > 1,\ \nu > 0\,, \tag{9}$$

where Ψ is the feasible set for the sensitivity parameter ψ, formalized in the appendix. Under this formulation, the parameters $(\varphi, \eta, \lambda, \chi, \nu)$ all have direct interpretations, as they denote the elasticities of the *effective* uncertainty reduction and management cost with respect to the respective inputs. Assumption 1 characterizes the key property we assume of the management cost function.

Assumption 1 (Uncertainty Management Costs)**.** *We assume that uncertainty management costs $\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}')$ decrease in expected bank profitability, i.e. $\psi \in \Psi \subset \mathbb{R}_+$.*

Assumption 1 limits the support of ψ, which denotes the sensitivity of the uncertainty management cost with respect to expected bank profitability. This implies that the cost of uncertainty management is endogenously affected by banks' investment decisions. The assumption is in a similar spirit to the corporate finance models that feature a interim stage liquidity shocks. In this type of models, after investing money in the first period and before the project return realizes, banks or investors need to secure new funds for interim stage liquidity needs. The amount of new funds that can be raised depends either on some collateral or on the pledgeable part of future project return realization, and the latter is just what we assume. At the uncertainty management stage, banks have already invested their total available funds w_i. Hence, to conduct uncertainty management activities they need to borrow additional funds, which they repay at the end of the period. We assume that the counterparty lender is risk neutral, makes zero profits and offers a contract in which the interest rate depends on the expected profitability of bank activities. For simplicity, we abstract from modeling a full-blown inter-bank market equilibrium. Instead, we simply assume that the interest rate charged for borrowing at interim stage decreases in the expected profitability of banking activities, as higher expected profitability implies higher pledgeable return.[7] From a modelling perspective, this specification also introduces a wealth-dependent component into the portfolio choice problem of banks.

[7] In Appendix **??**, we show that this setup is equivalent to a moral hazard constraint, in which banks have *skin in the game* and uncertainty management costs cannot exceed a certain fraction of expected bank profitability.

The result of the second-stage uncertainty management problem is summarized in the following Lemma 2.

Lemma 2 (Optimal uncertainty management). *Given the first stage investment $\{k_{ii}, k_{ij}, b_i\}$, the variance of foreign loans under optimal effort level m^* is given by*

$$\underbrace{\sigma_j^2}_{\text{① TFP Shock Variance}} + \underbrace{\zeta_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right) \times \frac{1}{k_{ij}}}_{\text{Management reduction}} \times \underbrace{\sigma_\epsilon^2}_{\text{② Uncertainty Shock Variance}} ,$$

where (ζ_i, ψ) are the coefficients determined by the parametrization of the uncertainty reduction function $\mathcal{P}(m, k_{ij})$ and the cost function $\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}')$.

Lemma 2 shows that the size of the *ex post uncertainty*, i.e. the uncertainty regarding cross-border investment returns after banks have exerted effort to reduce its size, depends on *ex ante uncertainty* σ_ϵ^2. In addition, it also depends one three key components. First, it depends on the parameter ζ_i, which we refer to as inverse uncertainty management ability. It is a scaled version of the managing cost shifter c_i. The scaling term in turn hinges on the management costs and uncertainty reduction elasticities as well as the banks inherent risk aversion. The lower the value of ζ_i, the lower is the ex post uncertainty. Second, ex post uncertainty depends negatively on the expected profitability before uncertainty management costs. The degree of this reduction in turn increases in the sensitivity parameter ψ, as imposed in 1. Third, ex post uncertainty depends negatively on the total size of cross border investment k_{ij}, in the sense that there is return to scale effect in uncertainty management. Several theories in the literature can explain this return to scale effect, i.e. a negative correlation between asset size and asset risk. For example, it might arise from a moral hazard problem between banks and regulators, i.e. due to too big to fail incentives. Farhi and Tirole (2012) point out strategic complementarities in balance-sheet risk choices due to ex post bailouts. In our model, an increase in cross border asset holdings increases overall risky asset holdings of the banking sector. In the light of the *too big to fail* argument, this raises the likelihood to receive governmental bailouts in case of failure, which is in turn equivalent to a decrease in risks.

Before we move on to the first stage portfolio allocation problem, we state two corollaries of comparative statics of the optimal management effort m^* and reduced form management efficiency paratmer ζ_i with respect to the elasticity parameters.

Corollary 1 (Comparative Statistics of Optimal Management Effort). *The key comparative statics of optimal managing effort m^* satisfy*

$$\frac{dm^*}{d\alpha} > 0 , \quad \frac{dm^*}{d\sigma_\epsilon^2} > 0 , \quad \frac{dm^*}{dk_{ij}} \gtrless 0 ,$$

Under the functional forms specified in Lemma Uncertainty and Assumption Elasticity, optimal risk management effort m^* are characterized by the following properties:

(a) *If $\psi = 0$, i.e. risk management costs are insensitive to expected bank profitability, m^* is strictly increasing and concave in cross border investment k_{ij}.*

(b) *If $\psi > 0$, i.e. risk management costs are sensitive to expected bank profitability, m^* is strictly increasing and admits an inverse S-shape in cross border investment k_{ij}.*

The sign of the comparative statics with respect to the first stage investment k_{ij} is arbitrary. This is due to the assumption that managing costs may be increasing in initial investments.

We graphically illustrate Corollary 1 in Figure 6. It can be seen that optimal uncertainty management effort under $\psi > 0$ constitutes an upper envelop of optimal uncertainty management effort under $\psi > 0$, as long as Assumption **??** (a) holds. Consequently, the case of $\psi > 0$ limits the uncertainty friction faced by banks, and thus strengthens portfolio diversification incentives.

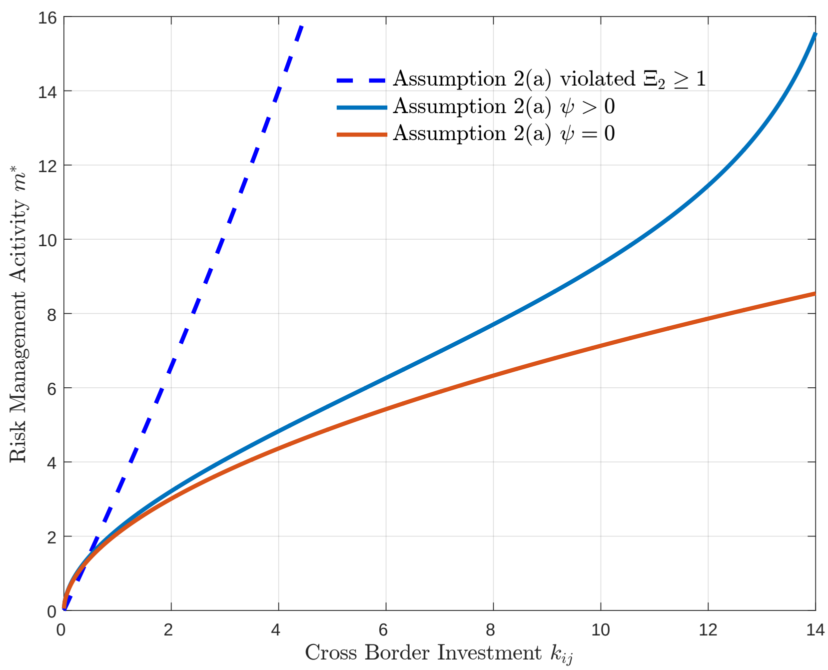

FIGURE 6. OPTIMAL UNCERTAINTY MANAGEMENT ACTIVITY m^* UNDER ASSUMPTION **??** (A).

Notes: Figure 6 is constructed under the following parameter values: $\alpha = 1.00$, $\delta = 0.90$, $\eta = 0.75$, $\nu = 0.40$, $\varphi^{uc} = 1.00$, $\varphi^c = \frac{1+2\eta}{2(1-\nu)} + 0.25$, $\chi^{uc} = 1.10$, $\chi^c = \frac{2\varphi^c(1-\nu)}{1+2\eta}$, $\lambda^{uc} = 1.20$, $\lambda^c = 1 + \frac{\chi^c}{2\varphi^c}$, $\sigma_\epsilon = 2.00$, $\psi \in \{0.00, 0.50\}$, $\theta = 0.75$, $\omega = 0.05$, $\mu_i = \mu_j = 0.25$, $c_i = 0.20$, $r^f = 0.10$, $k_{ii} = 1.00$, $w_i = 2$. Parameters with a subscript "c" have constrained values by Assumption **??** (a), whereas subscript "uc" stands for unconstrained parameter values.

The intuition for the first part of Corollary 1 is straightforward. If uncertainty management costs are independent of expected bank profitability, Assumption **??** (a) imposes decreasing returns to scale on the uncertainty reduction problem. This ensures that optimal uncertainty management effort m^* is concave in cross border investment k_{ij}. However, in the presence of decreasing uncertainty management costs with respect to expected bank profitability, a countervailing increasing returns to scale channel is at work. A larger cross border investment position increases expected bank profitability, which translates into a larger reduction on uncertainty management costs due to $\lambda > 1$. This channel induces a more than proportional increase of optimal uncertainty management effort. As the DRS channel is strong for small cross border positions, whereas the IRS channel is especially pronounced for larger cross border positions, the shape of optimal uncertainty management effort m^* follows a combination of both channels. It is thus concave for small cross border positions and convex for large cross border positions.

Corollary 2 (Comparative Statistics of Managing Ability)**.** *Under the functional forms specified in Lemma Uncertainty and Assumption Elasticity, the key comparative statics of the inverse risk management ability ζ_i are given by*

$$\frac{\partial \zeta_i}{\partial \alpha} < 0\,, \quad \frac{\partial \zeta_i}{\partial \varphi} < 0\,, \quad \text{and} \quad \frac{\partial \zeta_i}{\partial c_i} > 0\,.$$

Additionally, the comparative statics with respect to the risk reduction elasticity η and the management cost elasticity ν are hump-shaped such that

- *(a)* $\frac{\partial \zeta_i}{\partial \eta} \geq 0$ *if* $\eta \geq \underline{\eta}$, *respectively* $\frac{\partial \zeta_i}{\partial \eta} < 0$ *if* $\eta < \underline{\eta}$,
- *(b)* $\frac{\partial \zeta_i}{\partial \nu} \geq 0$ *if* $\ln(\alpha\varphi) \geq -2(1+\eta)$. *Moreover, if* $\ln(\alpha\varphi) < -2(1+\eta)$ *holds, we have* $\frac{\partial \zeta_i}{\partial \nu} \geq 0$ *if* $\nu \geq \underline{\nu}$, *respectively* $\frac{\partial \zeta_i}{\partial \nu} < 0$ *if* $\nu < \underline{\nu}$.

Comparative statics for the parameters (α, φ, c_i) follow intuitively. An increase in banks' risk aversion induces higher uncertainty management effort and thus improves their managing ability. A rise in the uncertainty reduction elasticity with respect to uncertainty management φ improves the efficacy of uncertainty management and hence lowers ζ_i, whereas an increase in the marginal cost shifter c_i weakens the managing ability. However, comparative statics with respect to (η, ν) are non monotonous due to the presence of two countervailing effects: an increase in η, which captures the complementarity strength between first stage cross border investment and managing effort, lowers the uncertainty reduction ability through $\mathcal{P}(m, k_{ij})$. Under Assumption **??**, a rise in η however also lowers the degree of convexity of the uncertainty management cost function $\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}')$. For large values of η the latter effect dominates and the result follows. A similar reasoning applies to the comparative static with respect to ν. At impact an increase in ν raises uncertainty management costs, but also reduces the degree of convexity.

3.3 Portfolio Solution

Given the derivation of optimal uncertainty management effort, we restate the maximization problem of banks (P1) in an equivalent form, (P1′). We prove in the appendix that the solution to the banks' maximization problem (P1) is equivalent to the solution to

$$\max_{\{k_{ii},k_{ij},b_i\}} \mathbb{E}\left[u(e_i')|\mathcal{I}\right] \qquad s.t. \tag{P1'}$$
$$e_i' = R_{ii}^l k_{ii} + R_{ij}^l k_{ij} + r^f b_i - R^d d_i \ ,$$
$$w_i = k_{ii} + k_{ij} + b_i \ ,$$

where the variance of a per unit cross-border investment is given in Lemma 2. In Proposition 1 we characterize the optimal portfolio allocation of banks.

Proposition 1 (Optimal Portfolio Allocation)**.** *Given the optimal management of uncertainty in the second stage, the optimal portfolio allocation chosen by the bank satisfies*

$$k_{ii} = \left(1-\tilde{\rho}^2\right)^{-1}\left(\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \frac{\tilde{\rho}\tilde{\sigma}_j}{\sigma_i}\frac{\theta(\mu_j - r^f)}{\alpha\tilde{\sigma}_j^2} + \frac{\tilde{\rho}\tilde{\sigma}_j}{\sigma_i}\frac{\frac{1}{2}\zeta_i\tilde{\sigma}_\epsilon^2}{\tilde{\sigma}_j^2}\right),$$
$$k_{ij} = \left(1-\tilde{\rho}^2\right)^{-1}\left(\frac{\theta(\mu_j - r^f)}{\alpha\tilde{\sigma}_j^2} - \frac{\tilde{\rho}\sigma_i}{\tilde{\sigma}_j}\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \frac{\frac{1}{2}\zeta_i\tilde{\sigma}_\epsilon^2}{\tilde{\sigma}_j^2}\right).$$

where

$$\tilde{\sigma}_\epsilon^2 = \sigma_\epsilon^2\left[1 - \psi(1-\omega\delta)w_i r^f\right] \ ,$$
$$\tilde{\sigma}_j^2 = \sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2 \ ,$$
$$\tilde{\rho} = \frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)}{\sigma_i\tilde{\sigma}_j} \ .$$

To better understand the intuition of Proposition 1, notice first that if $\sigma_\epsilon^2 = 0$, i.e. the uncertainty in foreign investment can be perfectly eliminated, the third terms inside the second bracket of k_{ii} and k_{ij} disappear. Furthermore, the expression of $(\tilde{\sigma}_j^2, \tilde{\rho})$ will collapse to the original (σ_j^2, ρ). In this case, the solution becomes that of a standard CARA-Normal problem, with the first component denoting the baseline CARA portfolio choice characterized by the Sharpe ratio, and the second component denoting a diversification channel governed by the correlation ρ between two countries fundamentals. In this case, monetary policy affects bank's investment decision only through risk-premium, and the risk-taking channel of monetary policy is at work.

If $\sigma_\epsilon^2 \neq 0$, but $\psi = 0$, we have the case in which there is foreign investment uncertainty, but the cost of managing is exogenous. This is due to the fact that when $\psi = 0$, the cost of management does not depend on expected future profit, as can be seen from Lemma 2. In this case, the third terms appear in the expression, but the expression of $(\tilde{\sigma}_\epsilon^2, \tilde{\sigma}_j^2, \tilde{\rho})$ will collapse to the original $(\sigma_\epsilon^2, \sigma_j^2, \rho)$. We see that with the presence of uncertainty, foreign investment k_{ij} is biased downwards as the third term is always negative. Whereas the impact of domestic investment is ambiguous, as it depends on the correlation ρ. This result is intuitive, as the presence of uncertainty would always make foreign investment less attractive, therefore bank would reduce foreign lending. Whether domestic lending would be reduced depends on the diversification merit, which in turn depends on the fundamental correlation ρ. If the two countries' fundamental is positively correlated, domestic and foreign investments are substitute, thus domestic lending would increases with the presence of foreign uncertainty. If $\rho < 0$, there is complementarity between two assets as there is the merit of diversification. Therefore, domestic lending will also goes down, although to a less extent than foreign lending. In this case, monetary policy still work through risk-taking channel but does not interact with the uncertainty management.

When $\psi \neq 0$, the interaction between monetary policy and uncertainty begins to kick in, as three new channels of monetary policy is introduced. The first channel, which works through $\tilde{\sigma}_\epsilon^2$, is the *attenuation of uncertainty friction* channel. As can be seen from the expression of $\tilde{\sigma}_\epsilon^2$, the presence of the cost reduction mechanism, i.e. $\psi \neq 0$, makes the uncertainty friction less relevant. The derivative of this channel of effect with respect to interest rate is always negative, meaning that the higher the interest rate, the lower the effective uncertainty variance. This is consistent with the intuition, as higher interest rate implies higher rate-free rate and deposit rate margin, which in turn implies higher profitability from the risk-free rate increment component, as shown in $\mathbb{E}\left[\Delta \tilde{e}_i' | \mathcal{I}\right]$, and thus lower cost of management.

The second channel, which works through $\tilde{\sigma}_j^2$, is the *variance reduction* channel for foreign investment. This comes from the fact that uncertainty management has economy of scale, because the risk premium of the return adds to the expected profitability. This leads to less cost for uncertainty management and lower ex post variance after management, which further increases the investment for foreign investment. The derivative of this channel of effect with respect to interest rate is always positive, meaning that the higher the interest rate, the higher the effective fundamental variances. This is consistent with the intuition, as higher interest rate implies lower risk premium for the foreign asset. This leads to less expected profits from the risky increment component, as shown in $\mathbb{E}\left[\Delta \tilde{e}_i' | \mathcal{I}\right]$, and therefore less variance reduction effect for foreign investment.

The third channel, which works though $\tilde{\rho}$, is what we refer to as *generalized correlation structure* channel. This term reflects the de facto correlation between domestic foreign asset, which is different from the fundamental correlation ρ. The reason is that since risky returns from domestic projects can be used to lower the cost of uncertainty management of foreign investment, this creates an additional layer of correlation similar to the idea of cross-subsidization. Whether $\tilde{\rho}$ increases or decreases in the risk-free rate is not straightforward to see, as both the numerator and the denominator contains r^f. However, note that the numerator is decreasing in r^f, which means that the de facto covariance of the two assets is always decreasing in risk-free rate, and the correlation will be jointly pinned down by this new covariaince and new variance $\tilde{\sigma}_j^2$. The reason why de facto covariance is decreasing in risk-free rate is because the new layer of correlation depends on the risky return of the domestic investment captured by its risk premium. Thus the higher the risk-free rate, the weaker this new channel of covariance.

The relationship between the new transmission channels of monetary policy and the pledgeablity future profits can be seen from the following corollary.

Corollary 3 (Asset Pledgeablity). *Suppose that different components of expected bank profitability have different degree of pledgeablity, differentiated by κ_d and κ_f:*

$$\mathbb{E}\left[p(\Delta\tilde{e}_i')|\mathcal{I}\right] = \left[1-\delta+(1-\omega)\delta\right] r^m w_i + \kappa_d\theta(\mu_i - r^m)k_{ii} + \kappa_f\theta(\mu_j - r^m)k_{ij} \; .$$

where $\kappa_d \in [0,1]$ and $\kappa_f \in [0,1]$ denotes the difference in pledgeablity of risky domestic and foreign returns comparing to risk-free returns. Then for the portfolio solution, we have the following definition of the parameters:

$$\tilde{\sigma}_\epsilon^2 = \sigma_\epsilon^2\left[1-\psi(1-\omega\delta)w_i r^f\right] \; ,$$
$$\tilde{\sigma}_j^2 = \sigma_j^2 - \kappa_f\zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2 \; ,$$
$$\tilde{\rho} = \frac{\left(\rho\sigma_i\sigma_j - \frac{\kappa_d}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)}{\sigma_i\tilde{\sigma}_j} \; .$$

Finally, before we proceed to examine the implication of monetary policy on bank home bias, we state the condition to ensure the existence of a global maximum for the policy functions derived in Proposition 1. we characterize in Lemma 3 the feasible parameter space Ψ^{GM} of banks' uncertainty management cost reduction sensitivity parameter ψ. The upper bound on the managing costs sensitivity parameter is also illustrated in Figure 31.

Lemma 3. *$\Phi(\psi)$ is discontinuous at the point*

$$\psi^{dc} = \frac{\sigma_j^2}{\zeta_i\theta(\mu_j - r^m)\sigma_m^2} \; .$$

(a) If $2\rho\frac{\mu_j - r^m}{\sigma_j} = \frac{\mu_i - r^m}{\sigma_i}$, $\Phi(\psi)$ is an affine function in ψ in $\mathbb{R}_+$ if $2\frac{\sigma_i}{\sigma_j} \geq \frac{\mu_i - r^m}{\mu_j - r^m}$.

(b) If $2\rho\frac{\mu_j - r^m}{\sigma_j} \neq \frac{\mu_i - r^m}{\sigma_i}$, $\Phi(\psi)$ has a positive and a negative root, between which the function is positive. Thus, there exists an upper bound $\overline{\psi}^{GM}$ on ψ, such that Φ is strictly positive in the set

$\Psi^{GM} \equiv \left[0, \overline{\psi}^{GM}\right)$. The upper bound is given by

$$\overline{\psi}^{GM} = \Gamma\left(\left[\rho\sigma_j(\mu_i - r^m) - \sigma_i(\mu_j - r^m)\right] + \left(\left[\rho\sigma_j(\mu_i - r^m) - \sigma_i(\mu_j - r^m)\right]^2 + (\mu_i - r^m)^2(1-\rho^2)\sigma_j^2\right)^{\frac{1}{2}}\right),$$

with $\Gamma \equiv \frac{2\sigma_i}{\zeta_i \theta \sigma_m^2 (\mu_i - r^m)^2}$. $\overline{\psi}^{GM} < \psi^{dc}$

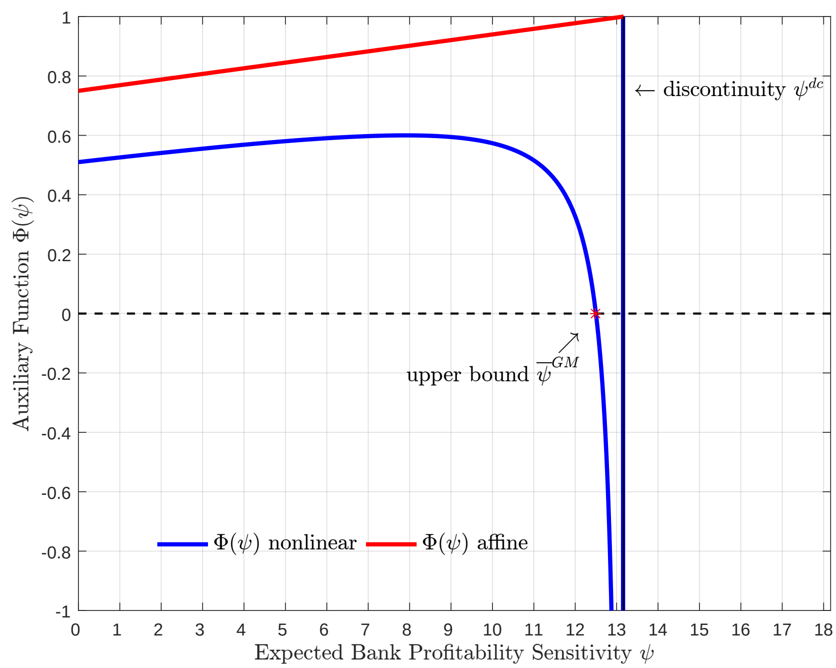

FIGURE 7. AUXILIARY FUNCTION $\Phi(\psi)$ AND PARAMETER SPACE OF EQUITY MANAGING IMPACT ψ.

Notes: The above figure is constructed under the following parameter values: $\theta = 0.75$, $\zeta_i = 1.20$, $\mu_i = \mu_j = 0.25$, $\sigma_i = \sigma_j = 1.00$, $\sigma_m = 0.75$, $r^m = 0.10$. The affine functional specification uses consequently $\rho = 0.50$, whereas the nonlinear specification imposes $\rho = 0.70$.

The first statement in Lemma 3 provides a condition under which the auxiliary function Φ is affine in ψ and strictly positive. Consequently, the sensitivity of the cost function with respect to expected bank profitability is unrestricted in this case. The second statement of Lemma 3 considers the case in which Φ is nonlinear in ψ. In this case, the solution describes a global maximum if $\psi < \overline{\psi}^{GM}$. The necessity of the upper bound is required to prevent banks from exploiting uncertainty management activities and taking advantage of the cross-border information friction. From Corollary **??** we know that uncertainty management activities follow an inverse *S*-shape in cross-border investment. banks thus find it optimal to choose an allocation on the increasing returns to scale part if the sensitivity of the cost reduction with respect to expected profitability is large. In the light of the previous argument, the derived upper bound $\overline{\psi}^{GM}$ hence precisely limits banks uncertainty management incentives.

3.4 Monetary Policy and Home Bias

Based on the optimal bank portfolio characterization from Proposition 1, we now define the theoretical counterpart to our empirical bank home bias measure. To do so, we fist impose two assumptions, which simplify the analysis of home bias fluctuations without changing the model propagation itself fundamentally.

Assumption 2 (Safe Asset Provision). *Safe assets are provided by country i, i.e. risk free asset holdings are domestic from the perspective of country i, not from the perspective of country j.*

Under Assumption 2, the theoretical counterpart to the empirical home bias measure for country i is given by

$$\mathcal{HB}_i = 1 - \frac{1 + \frac{w_j}{w_i}}{1 + \frac{k_{jj}}{k_{ij}}} \, . \tag{10}$$

It can be seen from the previous equation (10) that our home bias measure essentially boils down to relating two ratios: it strictly decreases in the ratio of initial bank wealth $\frac{w_j}{w_i}$, and strictly increases in the ratio of investments into the counterparty country j, i.e. $\frac{k_{jj}}{k_{ij}}$. As the safe asset is domestic from the perspective of country i, the home bias measure is independent from risk-free asset holdings. Therefore, the measure only reflects preferences over *productive assets* and is not affected by the demand for safe assets.[8] In Appendix C.10, we derive theoretical bank home bias measures when relaxing Assumption 2 and numerically show how the subsequent results depend on the applied home bias measure. Before stating the first main result on how monetary policy shapes bank home bias, we constrain in Assumption 3 the fundamental model parameters across countries.

Assumption 3 (Symmetry between Countries). *The fundamental model parameters of both countries are equal, i.e. $\mu \equiv \mu_i = \mu_j$, $\sigma \equiv \sigma_i = \sigma_j$, $\zeta \equiv \zeta_i = \zeta_j$ and $w \equiv w_i = w_j$ holds.*

Assumption 3 eliminates the role of cross country heterogeneity for the determination of home bias. It thus allows to isolate the effects being of interest, namely the interaction of cross-border information frictions and monetary policy. Assumptions 2 and 3 are necessary to analytically characterize bank home bias fluctuations in our model environment.

Apart from these two assumptions, we have the following lemma to ensure that the model prediction is consistent with general stylized facts regarding cross-border lending.

[8] The incentives of investors to hold safe assets when the economic uncertainty is high have been addressed by the flight to safety (FTS) literature. Caballero and Farhi (2018) discuss the consequences of safe asset shortage and the role of public debt. Brunnermeier and Huang (2018) further highlight international capital flows to advanced economies as search of safe assets, as the ability to provide safe asset is not uniform across countries. Baele et al. (2020) empirically document FTS episodes for many countries and document the appreciation of safe asset countries' currencies. However, in our paper we restrict the analysis to the case in which only one country is able to provide safe assets, and additionally abstract from exchange rate variations. As a result, the demand for safe assets is not a crucial driver of home bias fluctuations.

Lemma 4 (Constraints for Empirical Relevance). *Under Assumption 3, there exist upper bounds for ρ and ψ, below which the solution to the portfolio problem has the following properties:*

(a) $k_{ii} = k_{jj} \geq k_{ij} = k_{ji} \geq 0$,

(b) $1 - \psi(1-\omega\delta)r^f w_i = 1 - \psi(1-\omega\delta)r^f w_j \geq 0$.

The equalities in both statements of Lemma 4 arise from Assumption 3 on symmetry. Statement (a) captures the stylized fact that for the vast majority of countries, domestic bank lending exceeds cross-border lending. Additionally, both lending positions are bounded away from zero, i.e. we abstract from short selling opportunities. Moreover, statement (b) is a necessary condition for expected bank profitability to be positive, i.e. banks are not exposed to bankruptcy. Based on the previous assumptions, we are ready to present the key theoretical result of this section in Proposition 2. We graphically illustrate Proposition 2 in Figure 8.

Proposition 2 (Bank Home Bias and Monetary Policy). *Denote $\delta = \frac{d_i}{w_i}$ as the deposit to asset ratio, ω the mark-down on deposit rate that captures the pass-through of risk-free rate to deposit rate, and w the amount of banks' total loanable wealth. Under Assumptions 2 and 3, the following results hold:*

1. *If $\omega = \delta^{-1}$, monetary policy tightening unambiguously increases bank home bias.*[9]
2. *If $\omega < \delta^{-1}$, there exists a unique value $\tilde{w}^*$ which defines a separating line $\omega^N(w_i)$ in the (w_i, ω) space*

$$\omega^N(w_i) = \frac{1}{\delta}\left(1 - \frac{\tilde{w}_i^*}{w}\right) .$$

   (a) If $\omega > \omega^N(w)$, i.e. $(1-\omega\delta)w < \tilde{w}^*$, monetary policy tightening raises bank home bias.

   (b) If $\omega < \omega^N(w)$, i.e. $(1-\omega\delta)w > \tilde{w}^*$, monetary policy tightening reduces bank home bias.

   (c) On this line, monetary policy does not affect home bias.

Proposition 2 summaries the state-dependence nature of the impact of monetary policy on bank home bias. Statement (a) depicts a special extreme case, in which the pass-through elasticity from the monetary policy to the deposit rate equals the inverse leverage ratio. This yield the results that the risk-free increment component of $\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]$ becomes zero, meaning that taking into consideration the size of the deposit, the bank earns nothing after they repay their depositors if all wealth is invested in risk-free assets. This is an upper bound for the deposit rate pass-through, because once ω exceeds this level, bank capital will be eroded. As a consequence, optimal domestic and cross border portfolio holdings will be independent

[9] If we allow for cross country heterogeneity in fundamental parameters instead of assuming Assumption 3, a sufficient condition for home bias to increase would be given by $\rho\frac{\sigma_j}{\sigma_i} < 1$.

of banks' total balance sheet size w. This implies that cross border lending necessarily decreases in response to a monetary policy tightening. Additionally, as domestic bank lending is less negatively affected by the aforementioned change in monetary policy, bank home bias increases.

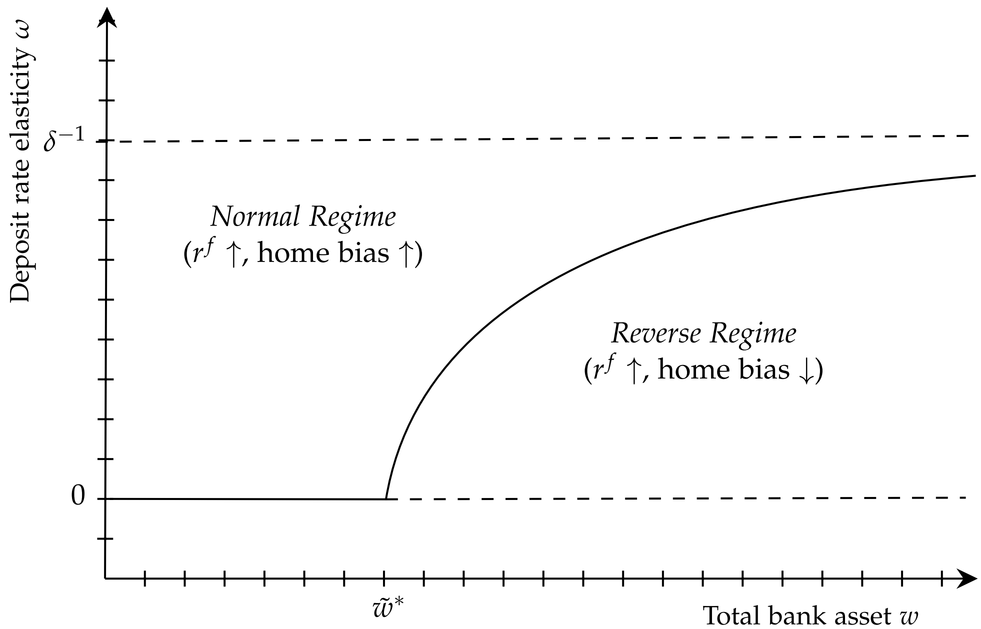

FIGURE 8. GRAPHICAL ILLUSTRATION OF BANK HOME BIAS REGIMES ACCORDING TO PROPOSITION 2.

Statement (b) characterizes a more general case, in which the pass-through elasticity from monetary policy to the deposit rate is strictly smaller than the inverse leverage ratio. Two regimes of bank home bias regimes emerge under this scenario: (i) a *normal regime* in which a monetary policy tightening increases bank home bias, and (ii) a *reversal regime* in which a monetary policy tightening decreases bank home bias. As it can be seen from Figure 8, the latter regime is more likely to arise when the deposit rate elasticity ω is low, which is the case if the monetary policy rate is close to the ZLB. In addition, for a given deposit elasticity ω, shifting from the normal to the reversal regime is more likely if banks dispose a higher amount of loanable wealth w. The reasoning for this is as follows: if the banking sector disposes over a sufficient amount of loanable wealth, a tightening in monetary policy has according to Corollary 1 ambivalent effects on expected bank profitability. The mechanical effect, i.e. the effect on profitability when keeping the portfolio composition unchanged in response to a policy change, increases the profit margin arising from risk-free rate arbitrage and respectively decreases the profit margin on risky asset holdings. If the former channel is sufficiently strong, i.e. ω sufficiently low, a monetary policy tightening increases expected profitability, which in turn induced larger uncertainty management activities. This leads to a relatively stronger increase in cross-border lending activities compared to domestic lending activities, which in turn suppresses bank home bias. If, however, disposable wealth is rather small, i.e. $w < w^*$, a monetary policy tightening decreases bank profitability at the ZLB, such that cross-border lending decreases and home bias goes up.

Based on Proposition 2, our model has the following predictions on the interplay between cross sectional heterogeneity of the banking sector and bank home bias fluctuations as a reaction to a change in monetary policy.

Corollary 4 (Testable Predictions)**.** *Under the same set of assumptions as in Proposition 2, the following statements hold:*

(a) For a given deposit rate elasticity ω, banks with larger balance sheet w are more likely to decrease their home bias in response to a monetary policy tightening.

(b) Banks with larger leverage ratio δ are less likely to decrease their home bias in response to a monetary policy tightening.

The proof of Corollary 5 is straightforward. Statement (a) follows as ω^N is an increasing function of w, whereas statement (b) follows as ω^N is a decreasing function of δ. Statement (a) of Corollary 5 highlights the role of large globally operating banks in driving recent empirical home bias trends. The larger the balance sheet of banks are, the more likely they are to decrease home bias in response to a monetary policy tightening. As a consequence, the cross-sectional size distribution of banks within an economy turns out to be a crucial driver of aggregate bank home bias fluctuations. In other words, merging and acquisition among banks that affect the banking sector size distribution may have an impact on international lending decisions. Furthermore, a larger leverage ratio shrinks the size of the *ZLB region* as it puts downward pressure on the expected bank profitability in reaction to a monetary policy tightening. To improve financial stability, regulators have recently implemented tighter leverage ratio requirements pushing down the leverage ratio δ. In the light of our theoretical results, such a policy induce in fact a higher likelihood for expansionary monetary policy close to the zero lower bound to increase bank home bias.

Before concluding on this section, we provide a sensitivity analysis on the predictions of Proposition 2 by removing step by step the key frictions of our model. This allows to assess the contribution of each friction in driving bank home bias fluctuations.

Corollary 5 (Frictional Decomposition of Home Bias-Monetary Policy Interaction)**.** *Assume that $\frac{k_{jj}}{k_{ij}} > -1$. Then, under Assumption 2 the following statements hold.*

(a) Removal Expected Profitability Friction: If $\psi = 0$, i.e. banks' uncertainty management activities do no longer depend on expected profitability, home bias increases in the ratio of banks

loanable wealth $\frac{w_i}{w_j}$. Furthermore, a monetary policy tightening (weakly) increases home bias if $\rho \in \left[\underline{\rho}^{NF}, \overline{\rho}^{NF}\right]$, where the correlation bounds are given by

$$\underline{\rho}^{NF} = -\frac{\zeta_i}{\zeta_j}\frac{\sigma_i}{\sigma_j}, \quad \text{and} \quad \overline{\rho}^{NF} = \frac{\sigma_i}{\sigma_j}. \tag{11}$$

If additionally the symmetry Assumption 3 is imposed, the bounds cover the entire support of ρ, such that a monetary tightening unambigously increases bank home bias. Lastly, home bias increases in the size of cross-border information frictions σ_ϵ^2, in the inverse uncertainty management ability ζ, and in the fundamental correlation of assets if the net risk premium on cross border asset holdings is positive.

(b) *Removal Cross-Border Information Friction: If $\sigma_\epsilon^2 = 0$, a monetary policy tightening does not affect home bias. In this case, home bias is solely driven by the ratio of loanable wealth. If we additionally impose the symmetry Assumption 3, home bias is always zero.*

The first statement of Corollary 5 provides the benchmark level of home bias when removing the expected profitability friction on bank lending. Home bias depends in this case on the fundamental productivity processes, cross-border uncertainty, uncertainty management abilities, initial wealth and monetary policy. A monetary policy tightening increases home bias in this case if the fundamental correlation among assets lies within a certain range. Additionally, home bias is increases in the size of the domestic balance sheet sector, and decreases in the size of the counterparty banking sector. Finally, the inverse managing ability of banks as well as cross-border information frictions drive up home bias.

When removing the cross border information friction, both countries invest the same amount into country j, such that home bias in turn solely depends on the ratio of foreign to domestic loanable wealth. In case both countries are additionally symmetric in term of their fundamental model parameters, home bias is equal to zero and is therefore insensitive to monetary policy. This decomposition exercise shows that cross-border information frictions are key in generating sizable fluctuations of bank home bias. In contrast, the expected profitability friction, arising through asymmetric interest pass-through in response to monetary policy changes, acts as an amplifier of the information friction in cross-border lending, and as an amplifier or stabilizer of domestic lending depending on the generalized correlation structure.

3.5 Connection to Reversal Rates

The reversal interest rate concept proposed by Brunnermeier and Koby (2018) defines an effective lower bound on the monetary policy rate, below which accommodative monetary policy has a contractionary effect on bank lending. While the reversal rate is originally applied to the analysis of a closed economy, in a two country open economy setup, a sufficient (not necessary) condition for bank home bias to increase in interest rate cut is that there exist two reversal rates, or a *reversal rate corridor*. The first rate is domestic lending reversal rate, denoted as rr^d, and the other is that of foreign lending, denoted as rr^f, as illustrated in Figure 9.

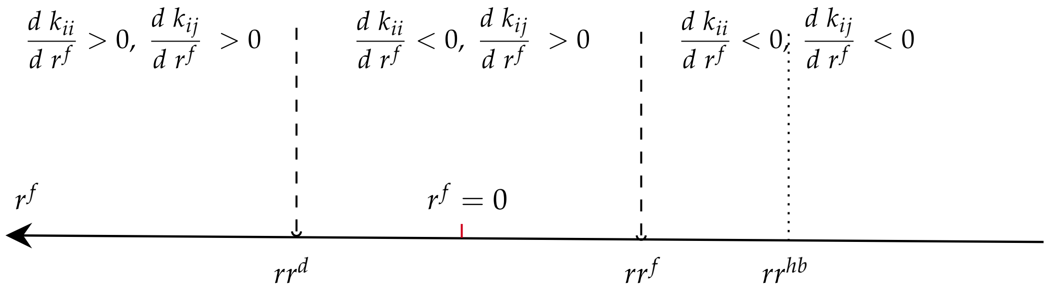

Figure 9. Graphical Illustration of Reversal Rates.

As can be seen from the figure, if the reversal rate corridor exists, i.e. $rr^d < rr^f$ is satisfied, then if the risk-free rate falls into this region, i.e. $r^f \in [rr^d, rr^f]$, a further cut on the risk-free rate would stimulate domestic lending but surppress foreign lending, causing a *composition effect* in bank's asset allocation. This substitution from foreign lending to domestic lending can happen without significant changes in the total quantity of credit supplied by the bank. Our model thus points out a novel consequence of the reversal rate concept: it does not only affect the quantity of credit, but also its composition across countries. Note that if this is the case, the reversal rate for bank home bias, denoted as rr^{hb}, would lie even further to the right of the foreign lending reversal rate rr^f.

The existence of the reversal rate corridor depends on the fundamental parameters of the model. First of all, if there is no endogenous cost reduction, i.e. $\psi = 0$, both domestic and foreign lending will depend linearly on the risk-free rate. In this case, there is no reversal rate in the sense that the impact of the interest rate on lending quantity does not vary with the level of the interest rates. This is intuitive, considering the fact that in this case banks' liability side, in particular the deposit, are completely disconnected from the asset side. Therefore, banks' investment decision is independent of its cost of funding.

When $\psi \neq 0$, i.e. management cost depends on future profits, the liability and asset side of bank's balance sheet are no longer independent, and the bank needs to take into consideration the deposit quantity and price when making investment decisions. Unlike Brunnermeier and Koby (2016), our link here in this model is not generated by an exogenous regulatory constraint; rather, it is the *endogenous* response of banks when facing market conditions that values future profits as collateral. Therefore, our results suggest that the regulation on risk weighted capital requirement maybe not the only factor contributing to the existence of reversal rate. The reversal rate for domestic and foreign lending is not straightforward, as the three aforementioned channels introduced by $\psi \neq 0$ all contribute to the effect of monetary policy rate. To decompose the effect, we refer to the difference in pledgeablity assumption in Corollary 3. We can see that if $\kappa_d = \kappa_f = 0$, i.e. the only pledgeable asset is risk-free return, the effect of risk-free rate on portfolio holding is still linear. If we further introduce generalized correlation structure by assuming $\kappa_d \neq 0$, there is possibility for a reversal rate, as the quantity of investment is now a non-linear function in r^f. As a reduction in risk-free rate decreases the generalized correlation $\tilde{\rho}$, this could lead to less investment in foreign asset and more investment in domestic asset, provided the uncertainty friction on foreign asset is large enough, thereby gives rise to the reversal rate corridor. Furthermore, if we introduce instead the variance reduction channel of foreign asset, i.e. $\kappa_f \neq 0$, the policy function also becomes non-linear in r^f, due to the fact that the reduction in risk-free rate leads to an strengthening of the variance channel and boost investment in foreign asset. In this case, the existence of reversal rate corridor depends on the underlying correlation of the fundamentals.

3.6 Further Discussion

Bank-equity home bias disparity. In section 2, we have documented empirical evidence that equity home bias and bank home fluctuations have stopped to comove in the aftermath of the Great Recession. Specifically, as bank home bias sharply and permanently increases, equity home bias continues to fall. Our model is able to reconcile and shed light on the mechanism behind these findings. Whereas both banks and equity investors face cross border information frictions, the profitability channel is unique to the banking sector and key to reconcile this puzzle. In the case of symmetric model parameters, an expansionary monetary policy increases bank home bias at the ZLB according to Proposition 2. On the contrary, when removing the expected profitability friction on the bank lending channel, our model environment can be reinterpreted as the portfolio choice of equity investors. In this case, expansionary monetary policy decreases equity home bias according to Corollary 5. As a consequence, our model demonstrates that a low interest rate environment has vastly different implications for bank and equity investment decisions. The former faces tighter financing constraints due to asymmetric interest rate pass-through, while the latter is unaffected by or benefits from long lasting low interest rate episodes.

4 Dynamic Extension

In this section, we sketch a dynamic extension of the analytical model in Section 3. The merit of this extension is to understand the impact of endogenous uncertainty management on precautionary saving behavior of banks in an incomplete market, and the impact of forward guidance in the sense of a pre-determined path of interest rate.

4.1 Setup

Dynamic banking problem: First stage. Given that the interim stage management problem is defined in the same fashion as in the static model, we can directly go to the first stage, where bank's maximization objective is given by

$$
\begin{aligned}
V_t(w_{i,t}) \equiv & \max_{\{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\}} u(\pi_{i,t}) + \beta \mathbb{E}_t V_{t+1}(w_{i,t+1}) \\
s.t. \quad & \pi_{i,t} + (1+\tau)\left(k_{ii,t+1} + k_{ij,t+1}\right) + b_{i,t} = d_{i,t+1} - R^d_t d_{i,t} + R^l_{ii,t} k_{ii,t} + R^l_{ij,t} k_{ij,t} + R^m_{t-1} b_{i,t-1} \ , \\
& b_{i,t} \geq \lambda w_{i,t} \ ,
\end{aligned}
$$

where $\pi_{i,t}$ denotes bankers' dividend stream which they return to their household family income. Additionally, τ resembles a regulatory wedge, respectively λ a liquidity requirement. The former can be interpreted as a risk weighted capital requirement, where the weight is uniform across both investment opportunities. The state variable is defined by

$$
w_{i,t} \equiv d_{i,t+1} - R^d_t d_{i,t} + R^l_{ii,t} k_{ii,t} + R^l_{ij,t} k_{ij,t} + R^m_{t-1} b_{i,t-1} \ .
$$

This setup is based on the incomplete model of Angeletos and Calvet (2006), but differs in three major ways. First of all, as the utility function is that of the banks, as opposed to households in Angeletos and Calvet (2006), there are a series of adjustments to adapt the setup to banks. To begin with, the bank is leveraged. Therefore, when defining the state variable of total wealth to invest, the household only considers their current period financial and non-financial income, but banks also take into consideration the current period deposit income, net off the last period dividend payments, which we denoted as Δd_{t+1}. Furthermore, the investment activities of bank are subject to a series of restrictions. In this model, we capture captiral requirement by τ and liquidity requirement by λ.

Second, Angeletos and Calvet (2006) has only one productive asset, whereas we have an open economy setup with two productive assets, one for domestic country and one for foreign. Therefore, additional constraints need to be imposed on the Euler equation and production function to ensure that the equilibrium exists and is well defined.

Third and most importantly, although the market is still incomplete in our model, the variance of the investment is endogenous. It can be reduced by paying a pecuniary cost. In Angeletos and Calvet (2006), the authors also discuss an extension by adding a market of risky financial asset. Nevertheless, the assets are assumed to be in zero net supply and no risk premia and thus serves only as a hedging tool. Our setup is similar to this extension in the sense that in addition to domestic asset (productive capital), there exists another risky asset, i.e. foreign asset, that can be used to hedge market incompleteness. However, this asset is not in zero net supply, and the variance is no longer exogenous, as we allow the agents to pay a cost to reduce the uncertainty variance. Whereas the risky financial assets in Angeletos and Calvet (2006) play a role on precautionary saving only through affecting the *ex post* definition of shock variance, in our model, the role of the international asset on precautionary saving is more subtle and will be further discussed.

The definition below characterize a *perfect foresight equilibrium*, in which the the representative bank perfectly anticipates the sequence of risk free monetary policy rates $\{R^m\}_{t\in[1,\infty)}$ set by the central bank.

Definition 1 (Equilibrium Concept). *A rational expectation incomplete markets equilibrium consists of a collection of state contingent plans $\{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\}_{t=0}^{\infty}$ such that*

1. $\{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\}_{t=0}^{\infty}$ *maximizes the utility of the bankers located in each country (i, j).*
2. *bankers have perfect foresight on the sequence $\{r_t^m\}_{t=0}^{\infty}$.*
3. *the central bank allows to arbitrary hold or borrow reserves given r_t^m.*

Solution Guess. Using the properties of the CARA-Normal framework, we solve the model by the method of undetermined coefficient with a linear guess on the policy functions

$$V_t(w_{i,t}) = u(J_{i,t}(w_{i,t})) = u(\gamma_{i,t}w_{i,t} + \eta_{i,t}) , \quad \pi_{i,t} = \hat{\gamma}_{i,t}w_{i,t} + \hat{\eta}_{i,t} ,$$

where $\gamma_{i,t}, \hat{\gamma}_{i,t} \in \mathbb{R}_+$ and $\eta_{i,t}, \hat{\eta}_{i,t} \in \mathbb{R}$ are non-random coefficients. We can then rewrite the expectation of the value function as

$$\mathbb{E}_t V_{t+1}(w_{i,t+1}) = -\frac{1}{\alpha} e^{-\alpha(\gamma_{i,t+1}\mu_{w_{i,t+1}} + \eta_{t+1}) + \frac{1}{2}\alpha^2\gamma_{i,t+1}^2\sigma_{w_{i,t+1}}^2} = V_{t+1}\left(\mu_{w_{i,t+1}} - \frac{1}{2}\alpha\gamma_{i,t+1}\sigma_{w_{i,t+1}}^2\right) .$$

With respect to the Euler equation, we can then write

$$u'(\pi_{i,t}) = \beta R_{t-1}^m u'(J_{i,t+1}(\mu_{w_{i,t+1}} - \frac{1}{2}\alpha\gamma_{i,t+1}\sigma_{w_{i,t+1}}^2))\gamma_{i,t+1} .$$

The problem can then be rewritten as

$$\begin{aligned} V_t(w_{i,t}) \equiv & \max_{\{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\}} u(\pi_{i,t}) + \beta \mathbb{E}_t V_{t+1}(w_{i,t+1}) \\ s.t. \quad & \pi_{i,t} = w_{i,t} - (1+\tau)\left(k_{ii,t+1} + k_{ij,t+1}\right) - b_{i,t} , \\ & b_{i,t} \geq \lambda w_{i,t} , \end{aligned}$$

4.2 Simplified Model: Without Endogenous Cost

Under the joint normal distribution assumption from the static case, we obtain an expression for the distribution of the state variable $w_{i,t}$:

$$
\begin{aligned}
w_{i,t+1} \sim \mathcal{N}\left(\Delta d_{t+1} + \mu_i k_{ii,t+1} + \mu_j k_{ij,t+1} + R^m_{t-1} b_{ii,t}, \quad \sigma_i^2 k_{ii,t+1}^2 + k_{ij,t+1}^2 \left[\sigma_j^2 + \sigma_{ij,m}^2\right] + 2k_{ii,t+1}k_{ij,t+1}\rho\sigma_i\sigma_j\right) \\
\equiv \mathcal{N}\left(\mu_{w_{i,t+1}}, \sigma^2_{w_{i,t+1}}\right) \ ,
\end{aligned}
$$

where *uncertainty shock variance* is now defined as $\sigma_{ij,m}^2 \equiv \frac{\zeta_i \sigma_m^2}{k_{ij,t+1}}$. Note that here μ_i, μ_j denote the mean gross return on the projects, not net returns anymore.

4.2.1 Dynamic Choices

Lemma 5 (Dynamic choices)**.** *The dynamic portfolio choice is given by*

$$
\begin{aligned}
k_{ii,t+1} &= \frac{1}{1-\rho^2}\left[\frac{\mu_i - (1+\tau)R^m_{t-1}}{\alpha\gamma_{i,t+1}\sigma_i^2} - \rho\frac{\sigma_j}{\sigma_i}\frac{\mu_j - (1+\tau)R^m_{t-1}}{\alpha\gamma_{i,t+1}\sigma_j^2} + \frac{1}{2}\rho\frac{\sigma_j}{\sigma_i}\frac{\zeta_i\sigma_m^2}{\sigma_j^2}\right] \ , \\
k_{ij,t+1} &= \frac{1}{1-\rho^2}\left[\frac{\mu_j - (1+\tau)R^m_{t-1}}{\alpha\gamma_{i,t+1}\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\mu_i - (1+\tau)R^m_{t-1}}{\alpha\gamma_{i,t+1}\sigma_i^2} - \frac{1}{2}\frac{\zeta_i\sigma_m^2}{\sigma_j^2}\right] \ , \\
b_{i,t} &= (1-\gamma_t)w_{i,t} - \eta_t + \frac{1}{\alpha}\ln\gamma_t - (1+\tau)k_{ii,t+1} - (1+\tau)k_{ij,t+1} \ .
\end{aligned}
$$

and the log Euler equation is given by

$$
\mathbb{E}_t\left[\pi_{i,t+1}\right] - \pi_{i,t} = \frac{1}{\alpha}\ln\left(\beta R^m_{t-1}\right) + \frac{\alpha}{2}var(\pi_{i,t+1})
$$

Discussion on precautionary saving. The form of the Euler equation is the same as standard incomplete market Euler equation with the presence of precautionary saving, i.e. expected growth of consumption is increasing in the variances of future consumption. However, note that the composition of future consumption variance, which is proportional to future wealth variance, is already been transformed in the first stage uncertainty management problem. In other words, without the first stage management, the variance is defined as

$$
var(w_{i,t+1}) = \sigma_i^2 k_{ii,t+1}^2 + k_{ij,t+1}^2\left[\sigma_j^2 + \sigma_m^2\right] + 2k_{ii,t+1}k_{ij,t+1}\rho\sigma_i\sigma_j,
$$

whereas with the uncertainty management,

$$
var(w_{i,t+1}) = \sigma_i^2 k_{ii,t+1}^2 + k_{ij,t+1}^2\left[\sigma_j^2 + \frac{\zeta_i\sigma_m^2}{k_{ij,t+1}}\right] + 2k_{ii,t+1}k_{ij,t+1}\rho\sigma_i\sigma_j.
$$

Therefore, under this setup, the agents optimize between second stage management and first stage precautionary saving, because the management activity has an impact on the degree of market incompleteness. In this sense, the agents can *alter* the level of market incompleteness that they need to cope with. First stage management affects the degree of market incompleteness through two channels: changing the absolute size of asset variance (through reducing uncertainty shock variance), and changing the *de facto* correlation between assets returns by changing the size of the independent component that is uncertainty. Given the level of portfolio allocation, the management always reduces precautionary saving, as it lowers future wealth variances. If taking into consideration the portfolio size and composition adjustment, we can see that managing (an decrease in the ζ_i) always increases holdings of foreign asset, and the impact on domestic asset depends on $\rho\frac{\sigma_j}{\sigma_i}$. Thus, the overall impact on the degree of market incompleteness, reflected by the total variance of wealth, is ambiguous.

Discussion on forward guidance. In this subsection, we study the existence of a steady state under the current setup. To do so, we derive sufficient conditions on fundamental model parameters which ensure both *existence* as well as *uniqueness*.

4.2.2 Steady State

Lemma 6 (Zero correlation case: $\rho = 0$)**.** *When $\rho = 0$, the correlation between both assets are zero, there exists a unique steady state in the model if and only if*

$$
\begin{aligned}
&0 \le \zeta_i < 2\min_{R^m}\left(\frac{\mu_j - (1+\tau)R^m}{\alpha\gamma\sigma^2_{m_{ij}}}\right) , \\
&\zeta_i\sigma_i\sigma^2_{m_{ij}} = \zeta_j\sigma_j\sigma^2_{m_{ji}} , \\
&0 > -\frac{1}{2}\left(\frac{(\mu_i - (1+\tau))^2}{\sigma_i^2} + \frac{(\mu_j - (1+\tau))^2}{\sigma_j^2}\right) > \ln\beta , \\
&1 > \frac{(\mu_i - (1+\tau))}{\sigma_i^2} + \frac{(\mu_j - (1+\tau))}{\sigma_j^2} , \\
&0 \le \frac{\zeta_i^2}{4} < \frac{\sigma_j^2}{(\sigma^2_{m_{ij}})^2}\frac{1}{\alpha^2}\left[\frac{2(1+\tau) - \mu_i}{\sigma_i^2} + \frac{2(1+\tau) - \mu_j}{\sigma_j^2}\right] ,
\end{aligned}
$$

First two conditions guarantee the existence. The first condition ensures one common Euler equation for both countries in the presence of uncertainty, which is equivalent to imposing $\sigma^2_{w_i} = \sigma^2_{w_j}$. The second inequality is to ensure the equilibrium risk-free rate lie within the interval $\left[1, \beta^{-1}\right)$ by guarantee that at the left limit of $R^m = 1$, the LHS of the Euler equation is larger than that of the LHS. At the left hand limit $R^m = \beta^1$, RHS is always larger than LHS as RHS is negative as long as $\sigma^2_{w_i}$ is non-negative, whereas LHS is zero in this case. Given that both sides of the Euler equation is continuous in R^m in this interval, these conditions guarantee the existence of an equilibrium level of R^m.

The third and fourth conditions guarantee the uniqueness by ensuring the derivative of the LHS of the Euler equation is always smaller than that of the RHS in the given interval.

The last condition is imposed to guarantee the positivity of the level asset holding, as we do not allow for short selling in this model. Remember that uncertainty shock management works in our open economy is equivalent to a reduction in the risk premium. Hence, as long as there is positive uncertainty shock variance, i.e. $\sigma^2_{m_{ij}} > 0$, ζ_i cannot exceed a certain threshold value. Otherwise, the risk premium would be driven down to a negative number such that the representative bank i would like to hold short positions of firms located in country j. This completes the conditions for the equilibrium existence and uniqueness.

Lemma 7 (Symmetric case)**.** *When the two countries are symmetric, there exists a unique steady state in the model if and only if*

$$\begin{aligned}
&\zeta \leq \min_{R^m} 2\left[(1-\rho)\frac{\mu-(1+\tau)R^m}{\alpha\gamma\sigma_m^2}\right] , \\
&0 > -\frac{1}{(1+\rho)^2}\frac{(\mu-(1+\tau))^2}{\sigma^2} > \ln\beta , \\
&1 > \frac{2(1+\tau)}{(1+\rho)^2}\frac{(\mu-(1+\tau))}{\sigma^2} + \frac{\alpha}{2}\frac{\rho\zeta\sigma_m^2}{(1+\rho)^2}\frac{(1+\tau)-\mu}{\sigma^2} .
\end{aligned}$$

4.3 Complete Model

[PRELIMINARY, COMING SOON]

4.4 Calibration

[PRELIMINARY, COMING SOON]

4.5 Dynamics of Bank Home Bias

[PRELIMINARY, COMING SOON]

5 Empirical Evidence

In this section, we focus on the case of United States, for which we have quarterly data, and perform structural analysis using structural VAR (SVAR) approach. The goal is to investigate the determinants of cross-border lending preferences by examining the impulse responses of bank home bias to identified shocks.

5.1 Econometric Specification

The model is a standard vector autoregression model given by

$$\mathbf{y_t} = A_0 + A_1\mathbf{y_{t-1}} + \cdots + A_p\mathbf{y_{t-p}} + \mathbf{u_t} \quad t = 1, \cdots, T,$$

where y_t is an $k \times 1$ vector of endogenous variables, A_i are $k \times k$ coefficient matrices at lag i, and u_t are reduced-form errors. We assume that $u_t = \mathcal{S}\epsilon_t$, where ϵ_t is a vector containing structural shocks. Since structural shocks are assumed to be independent and of unit variance, the identification boils down to pinpoint the matrix $\mathcal{S}$, or a column of the matrix, so that we can perform analysis on the reaction of bank home bias to the structural shock.

The sample period is from 2001 Q4 to 2019 Q4, stopping before 2020 to exclude the pandemic. The key variables in the model include bank home bias and the usual sets of macro variables: real GDP, inflation, and monetary policy rate. Real GDP and inflation are in log level, and since our sample includes a period of zero federal funds rate, we take the Wu-Xia shadow monetary policy rate developed by Wu and Xia (2016) as our monetary policy rate. Under this specification, the variables are given by $y_t = \{$*Real GDP*, *Inflation*, *Shadow Policy Rate*, *Bank Home Bias*$\}$. Since our data is in quarterly frequency, we take four lags, i.e. $p = 4$.

In addition to this baseline specification, we add to the model *Real Total Asset* and *Return on Asset*, which help capture the channel of transmission of the monetary shock through banking sector characteristics. This augmented set of variable for the identification of monetary policy shock would be $y_t = \{$*Real GDP*, *Inflation*, *Shadow Policy Rate*, *Real Total Asset of Banks*, *Return on Asset of Banks*, *Bank Home Bias*$\}$.

For the identification of uncertainty shocks, we add to the baseline specification two additional variables: *domestic uncertainty* and *foreign uncertainty*. The details on the construction of domestic and foreign uncertainty can be found in Appendix A.4. The set of variables used for the identification of uncertainty shock are thus given by $y_t = \{$*Domestic Uncertainty*, *Foreign Uncertainty*, *Real GDP*, *Inflation*, *Shadow Policy Rate*, *Bank Home Bias*$\}$.

5.2 Monetary policy shock

We start with the identification of monetary policy shock. The baseline identification method we use is the short run identification à la Christiano et al. (1999). As a robustness check, we also use the proxy identification method of monetary policy shock developed by Gertler and Karadi (2015)[10].

The results, as shown in Figure 10, suggest that monetary policy shock first increases then suppresses bank home bias, implying that the impact of monetary policy on bank home bias might involve multiple channels. Part of the decrease in bank home bias, as suggested by the

[10] More detailed explanation on the identification scheme can be found in Appendix B.

impulse response, might be due to an subsequent increase in bank profitability. The results still hold if we drop the banking sector characteristics from the model. The forecast error variance decomposition is given in Figure 19 in the Appendix.

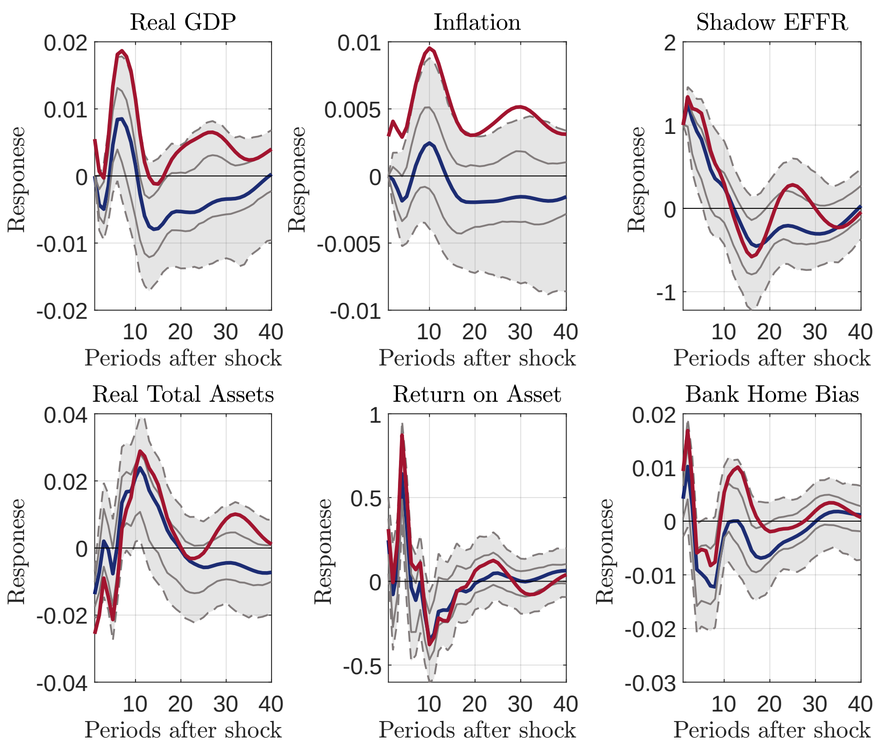

Figure 10. Impulse Response to monetary shock.

Notes: Blue line is the impulse responses from short run identification. Shaded area is 95% confidence level. Red line is the impulse responses from proxy identification. Sample period is from 2001 Q3 to 2019 Q3.

As a robustness check, we replace the total asset variable by different components of the balance sheet. In particular, we want to study whether the initial increase in bank home bias is just due to an increase in the holdings of safe asset, indicating a shift in risk preferences rather than geographic preference. In Figure 22 in the appendix, we show the result of a monetary policy shock with the total real asset being replaced by two subcategories, namely *Loans* and *Fed Funds and Reverse Repos*. We see that the initial increase in bank home bias is not accompanied by a corresponding increase in Fed Funds; rather, when home bias goes down, the holding of Fed Funds goes up. On the contrary, Loans go up slightly on impact. These results imply that there is indeed a shifting in preferences for domestic versus foreign loans, rather that just a flight to safety.

5.3 Uncertainty shock

We now proceed to the identification of uncertainty shocks. As we have discussed in previous section, uncertainty in our dataset is not one but two variables, since we decompose it into *Domestic Uncertainty* and *Foreign Uncertainty*. This decomposition allows us to pin down which uncertainty accounts for the more variations of home bias. The baseline identification method we use is short run identification method à la Bloom (2009), in which the uncertainty shock is assumed to be the only shock that can affect all the other variables contemporaneously. This assumption is consistent with the intuition, as uncertainty is a forward-looking variable that captures agents' expectation of future events. The second method we use is the max share identification à la Uhlig (2003). The idea is to identify uncertainty shock as the shock that can maximally explain the forecast error variances of the uncertainty indicator variable over certainty periods, so the identification method does no rely on particular assumption on the contemporaneous responses. As will be seen from the results, the results yield by these two identification methods do not differ by a large margin[11].

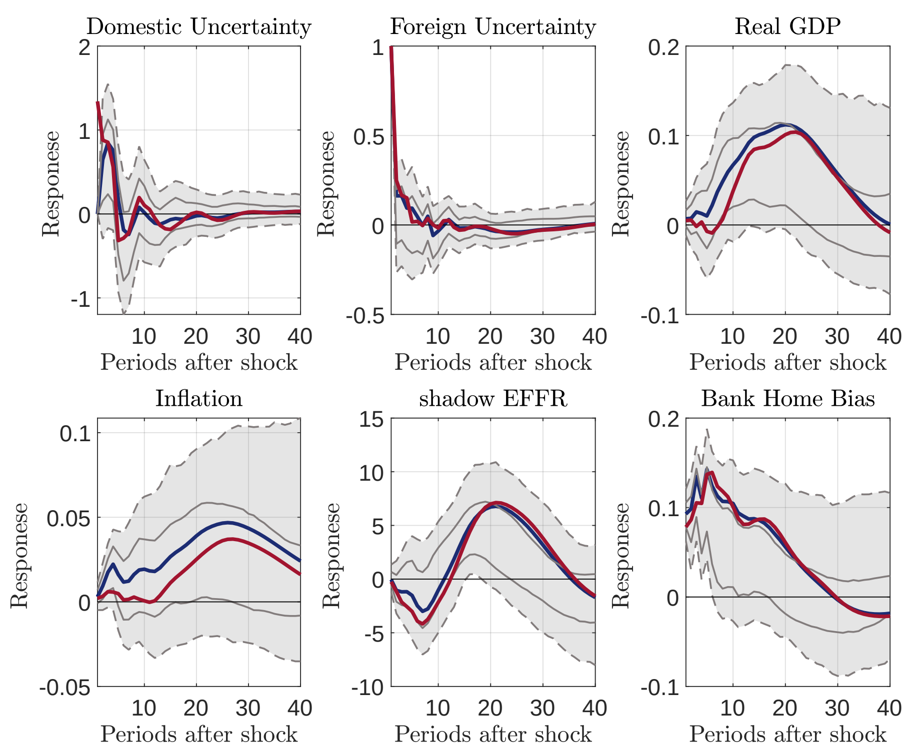

FIGURE 11. IMPULSE RESPONSE TO FOREIGN UNCERTAINTY SHOCK.

Notes: Blue line is the impulse responses from short run identification. Shaded area is 95% confidence level. Red line is the impulse responses from max share identification. Sample period is from 2001 Q3 to 2019 Q3.

[11]More detailed explanation of the identification methods can be found in Appendix B.

As it can be seen from Figure 11, we find that foreign uncertainty shock is a strong driver of bank home bias, inducing significant increase in bank home bias. The forecast error variance decomposition (FEVD) in Figure 24 shows that it explains up to half of the FEVD of bank home bias. The results are robust to replacing macro variables by balance sheet variables in the model. When applying the same identification method to domestic uncertainty shock, however, the response of bank home bias is not significant, as shown in Figure 25. This asymmetry responses to foreign and domestic uncertainty shock might be reconciled by the fact that domestic uncertainty shock induces both a substitution effect and a wealth effect effect. When foreign uncertainty goes up relative to domestic uncertainty, banks shift their investment to domestic market. However, when the domestic uncertainty is on a high level, presumably the overall financial situation faced by the banks also deteriorates. Therefore, although the substitution channel implies that more loans should be granted to foreign borrowers, the banks are not able to do so as the loan generating ability of the bank is compromised.

As a robustness check, we again replace the macro variables with balance sheet components and check whether the home bias increase after foreign uncertainty shock is due to an increase in safe asset holdings. Figure 29 shows that an increase in home bias after a foreign uncertainty shock does not translate into an increase in Fed Funds and Reverse Repo holdings, and that loan level does not drop in response. This confirms that home bias again is not a direct reflection of asset category reshuffling, but rather a change in the preference for location.

6 Conclusion

This paper provides new evidence on the variation of bank home bias for the past two decades and proposes a unified framework to study the impact of monetary policy on banks' international lending behavior, with the presence of endogenous uncertainty friction. To motivate our analysis, we first document structural empirical evidence that *preferences* of globally operating banks over domestic and cross-border lending behavior are significantly affected by uncertainty. Additionally, the effects of monetary policy are ambiguous as two opposite forces are present: On the one hand, expansionary monetary policy decreases the risk-free rate and thus increases domestic and cross-border bank lending. On the other hand, if the risk-free rate is sufficiently low, expansionary monetary policy decreases bank profitability, lowers risk management activities, and hence may increase home bias. In a second step, we integrate these findings into a tractable two-country small open economy model, which features uninsurable aggregate production risk. We characterize the effects of monetary policy on bank home bias by a dichotomy of two regimes: in the *normal regime*, an expansionary monetary policy decreases home bias. On the contrary, in the *zero lower bound regime*, an expansionary monetary policy increases home bias as a bank profitability channel interacts with the risk management of foreign uncertainty frictions. Our model allows us to reconcile recent differences in the observed trends of equity and bank home bias. Finally, we extend our model to a dynamic setup and seek to quantify the contribution of expansionary monetary policy through quantitative easing and forward guidance on bank home bias. Our analysis has relevant implications for the design of optimal monetary policy in currency unions.

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A Appendix I: Variable and Data

A.1 Home Bias Index

Two country illustration. In order to illustrate the bank home bias index, we use the subsequent two country example. The pie chart in Figure 12 displays the composition of the total worldwide investment, where investment into the domestic country A is colored in blue and that into the foreign country B in yellow. Out of the total investment, the part financed by country A's banks is the part inside the inner circle. In other words, the size of the inner circle reflects the size of total assets of country A's banks. We can see that part of their investment goes into the domestic country (the blue part), and the remainder goes into foreign country (the yellow part). The outer part of the circle is the investment of county B's bank, which also consists of investment into both countries.

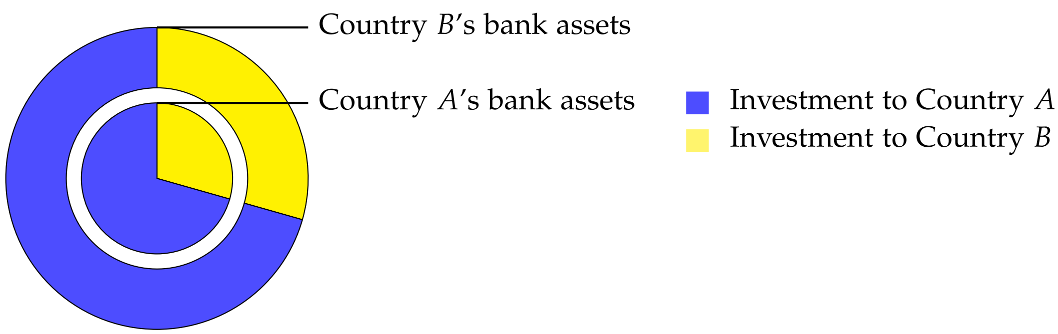

FIGURE 12. ILLUSTRATION OF ZERO HOME BIAS BASED ON TWO COUNTRY EXAMPLE.

Had country A's bank exhibited no home bias, the composition of bank asset portfolio should be the same as the world's composition. This is exactly the case in Figure 12, as the ratio between domestic investment and foreign investment inside the circle is exactly the same as the composition of the world. However, if domestic banks have perfect home bias, their assets could be completely invested into domestic country. As can be seen in Figure 13, the inner circle now contains only the blue part, indicating that all of country A's banks' assets are domestic. Country B's total bank assets, represented by the outer part of the circle, are still divided into a blue and a yellow part, indicating that country B's banks still diversify their investments.

According to equation (1), home bias of country A is defined as

$$\mathcal{HB}_A = 1 - \frac{\frac{A_f}{A_d + A_f}}{\frac{A_f + B_d}{B_d + B_f + A_d + A_f}} ,$$

where A_f denotes the investment into country A financed by country B' banks (the blue part

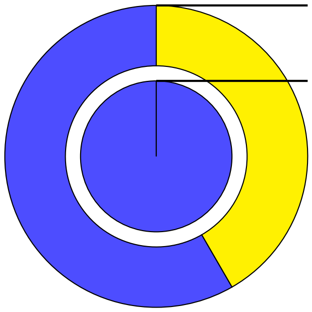

FIGURE 13. ILLUSTRATION OF UNIT HOME BIAS BASED ON TWO COUNTRY EXAMPLE.

in the inner circle in Figure 12), and A_d by the domestic bank (the blue part in the inner circle in Figure 12). Correspondingly, B_f is the investment to country B financed by country A, and B_d is financed by country B.[12]

A.2 Variables for Bank Home Bias

This section documents the construction of the bank home bias index, including data sources, data processing, and variable definitions.

Construction of Domestic Lending. For domestic lending, we use the variables from IMF International Financial Statistics (IFS) dataset. The entity that classify as bank in this data set is *Other Depository Corporations*, and according to the newest (as of January 2020) *International Financial Statistics: Introductory Notes*, the domestic assets consists of three components: *Claims*

[12]Note that an alternative way to define the home bias index is based on comparing to what extent the domestic investment share is too high in domestic country's bank assets. The definition is given by

$$\mathcal{HB}'_d = \frac{\frac{A_d}{A_d+A_f}}{\frac{A_d+B_f}{B_d+B_f+A_d+A_f}} - 1.$$

The two measures can be linked by the relationship

$$\mathcal{HB}'_d = \frac{S}{1-S}\mathcal{HB}_d.$$

where $S = \frac{B_d+A_f}{B_d+B_f+A_d+A_f}$ is the ratio of investment into the foreign country relative to the worldwide investment. A more detailed explanation can be found in the Appendix C. This dual index reflects the flip side of high bank home bias: foreign assets being underrepresented in domestic bank's asset portfolio implies that domestic banks have an overly large market share within the domestic country. This can be seen by comparing Figure 12 and Figure 13, the latter of which shows that country A's own banking sector is the only creditor to country A's investments. The consequences are twofold. First of all, a high market share may lead to a higher market power. Here we treat the competition within the domestic banking sector as constant, i.e. there are no bank mergers or new entrants, resulting in a different degree of interest rate pass-through. Second of all, a high reliance on domestic banks over-proportionally exposes the country's economy to domestic banking sector risk. If the domestic banking sector experiences negative shocks, e.g. an exogenous shock that destroys bank capital, the impact on the real economy could be substantially larger than in the case in which there is low home bias.

on Central Bank, *Claims on Central Government*, and *Claim on Other Sector*. These three variables are available for most countries. After obtaining these variables, we convert the value to US dollar in order to have a consistent comparison across countries.

Construction of Foreign Lending. For foreign lending data, we turn to the Locational Banking Statistics (LBS) dataset from Bank for International Settlements. Two issues to be resolved when using LBS dataset is first, defining the nationality of banks and second, classifying what counts as foreign lending. In LBS, one can specify the parent country, the reporting country, and the counterpart country. This gives rises to two possibility of identifying a country's banking sector: the bank that is owned by the shareholder of the nationality, and the banks that currently resides in side the country. In practice, we go for the second definition. This is because once one specify the parent country, the recipient country is only available as a total sum instead of in country-wise form. Therefore, our classification of bank is location-oriented, instead of nationality-oriented.

In terms of the definition of foreign lending, we cite the newest (as of July 2019) *Reporting guidelines for the BIS international banking statistics*. According to this report, *cross-border lending* includes the lending activities in which the two parties involved resides in different countries, as opposed to *local lending*, in which borrower and lender are in the same country. *Foreign lending* and *Domestic Lending*, on the other hand, are defined in a different manner. Foreign lending refers to the lending in which the recipient is different from the nationality of the lending bank. Consequently, cross-border lending and foreign lending overlaps to a large degree, but there are certain differences when it comes to banks foreign branches.

In our research, the lending behavior we seek to capture is closer to the definition of foreign lending. However, as stated previously, we are only able to define banks based on location instead of nationality, due to data limitation. Thus we proceed to define our **foreign lending** as the *cross-border lending conducted by these banks resides in that country*.

This is obviously only a proxy to the true foreign lending. Nevertheless, we think the difference will not sabotage our main conclusions. Comparing to the foreign lending definition of BIS, our measure misclassify the lending to foreign countries done by a foreign branch as domestic, and the lending to home countries by foreign branch as foreign. To put things into perspective, if the French Bank BNP Paribas has a foreign branch in Germany, our measure would classify its lending to Mercedes Benz as domestic, while its lending to Renault foreign. However, as long as these two cancels out to some extent, our measure would still be fairly close to the true foreign lending. Furthermore, since foreign branches usually consist of a fairly small share of the banking sector, the extent to which this proxy may affect our results is limited. Thus in this research, we use the word cross-border lending and foreign lending interchangeably.

Construction of Bank Home Bias. After obtaining domestic and foreign lending data from IFS and LBS, we merge them to form a dataset with complete bank portfolios. The merged final dataset contains 32 countries, which covers major developed countries and several developing countries. Recall the definition of home bias:

$$\text{Home Bias of Country } i = 1 - \frac{A_i}{B_i},$$

where

$$A_i = \frac{a_i^1}{a_i^2} == \frac{\text{Cross-border Claims of Country } i}{\text{Cross-border Claims of Country } i + \text{Domestic Claims of Country } i},$$

and

$$B_i = \frac{b_i^1}{b_i^2} == \frac{\text{World Foreign Lending}_i}{\text{World Total Lending}}.$$

This measurement seeks to capture home bias as a deviation from a benchmark, measured as the ratio between the foreign share of a country's bank portfolio, A_i, and the foreign share of a benchmark world portfolio B_i respective to country i. For example, if United State banks investment 80% of their claims domestically ($A_{US} = 1 - 80\% = 20\%$), it does not necessarily reflect a high home bias: It might as well be the case that most of the world's investment opportunities occur in the US. It is the deviation that counts as bias. That's why we need a world benchmark to determine whether the bias exists.

Using this panel of countries as *world*, we compute the total amount of lending (both domestic and foreign) as *World Total Lending*. The question is then to determine what counts as *World Foreign Lending*. One might think that the most straightforward way to define it is to sum the foreign lending of each country and use it as the total amount of foreign lending in this world. However, we believe that this approach does not correctly achieve our goal. One reason is that this measure would be the same to all countries. More importantly, it measures *de facto* foreign lending, instead of what *de jure* foreign lending in an ideal world of full diversification, given each countries demand for credit.

For this reason, we adopt the following country-specific measurement for *World Foreign Lending*. For a given country i, we compute the total claims, both domestic and foreign, of all the countries other than country i. This serves as a proxy for all the money invested to the world excluding country i. It is a proxy because in order to obtain the exact number, we still need to a) substract from it the amount the rest of the world invested to countries i (included in the foreign lending of the other countries) and b) add to it the amount country i invested to other countries (country i's foreign lending). Since we do not have the liability side of the investment, a) is not directly computable. However, a) and b) being two measurement errors that go into opposite directions alleviates this measurement problem. Furthermore, if a countries foreign investment equals the foreign investment it receives, these two term can perfectly cancelled out.

A.3 Variables for Equity Home Bias

Construction of cross-border investment. For cross-border investment, we use data from Coordinated Portfolio Investment Survey (CPIS) dataset developed by IMF. The dataset gives detailed decomposition of each country's foreign equity holding on a yearly basis, and one can specify both the origin and destination of the investment. Therefore, we can directly compute each countries' asset holding by specifying the recipient to be the rest of the world.

Construction of domestic investment. To compute the size of domestic investment, i.e. domestic investors' holding of domestic equities, we proceed in three steps. Take country i for example. First, we collect data on the stock market capitalization of country i, which is the total size of its stock market. Second, we compute how much of country i's equity is held by foreign investors. This is done by aggregating over all the other countries' holding of country i's equity. Lastly, we obtain domestic investor's holding of domestic equity as the difference between the two.

The stock market capitalization data is obtained from the World Bank. Two data series are used to construct this sample, namely *Market capitalization of listed domestic companies (% of GDP)* and *Stock Market Capitalization To GDP (%)*. The former stops at the year 2017, while the latter have data up until 2019. However, the latter time series has missing value at the beginning of the sample period. The values of these two series do not differ by a very large amount. Therefore, for each country, we compare the data from these two sources and choose the one with longer available periods to ensure largest possible coverage. We then multiply this ratio with GDP data to obtain the final values.

Since the construction of home bias requires a clear definition of the *world* as a benchmark,

Construction of equity home bias. Recall that the construction of home bias requires a clear definition of the *world* as the benchmark. In the case of equity home bias, after obtaining data from World Bank and IMF and merging the datasets, we obtain a final dataset of 41 countries, which contains all the 32 countries in our bank home bias dataset except for three countries: Bahamas, South Korea, and Russia. However, many of these countries contain long period of missing values and might render the weighted average computation unreliable. Therefore, we reduce this large sample to a smaller one in which all countries have complete data until 2018. The sample consists of 26 countries, and contains all the 32 countries in bank home bias dataset except for 7 countries: Bahamas, Cyprus, Denmark, Finland, Italy, South Korea, Netherlands, Russia, and Sweden. We refer to the former one as large sample, and the latter as small sample. We use small sample for the computation of our equity home bias and keep the large sample to check the robustness.

To obtain the equity home bias, again we need to compute

$$\text{Home Bias of Country } i = 1 - \frac{A_i}{B_i}.$$

For A_i, the computation is done by dividing total cross-border equity holding with the sum of cross-border and domestic equity holding. For B_i, the computation method is the same as that of bank home bias.

A.4 Uncertainty Variables

World uncertainty index. The main dataset we use to capture uncertainty is the World Uncertainty Index (WUI) developed by Ahir et al. (2018), an index based on word-counting method and is available for many countries in the world. As one of our goal is to distinguish domestic uncertainty from foreign uncertainty, the broad coverage of this measure proves to be crucial for our research. We take the World Uncertainty Index measurement for country i as the *domestic uncertainty* indicator. For *foreign uncertainty*, we construct it in two different methods. The first method is to compute directly the weighted world average uncertainty without country i as the foreign uncertainty for country i. The second method is to regress the total weighted world average uncertainty on country i's uncertainty and take the residual to be the foreign uncertainty to country i. The latter methods by construction generates foreign uncertainty that is uncorrelated to domestic uncertainty, while the former allows for correlation between domestic and foreign uncertainty. For the U.S., foreign uncertainty pinned down by the two methods are highly correlated. For smaller countries, these two measures might differ by a larger margin.

Economic policy uncertainty index. Economic Policy Uncertainty (EPU) index, developed by Baker et al. (2016), is an index based on newspaper coverage frequency. The data is available for less countries than World Uncertainty Index, so we keep it as our secondary measure for domestic and world uncertainty.

Other uncertainty measurement. For the United States, we have more detailed available measurement of domestic uncertainty, including Jurado et al. (2015)'s uncertainty measurement, and Berger et al. (2020)'s measurement of implied volatility.

A.5 Home Bias Data

See in next pages.

Table 1. Annual Bank Home Bias.

Sample / Time	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
By Country																			
Australia	0.91	0.90	0.87	0.88	0.87	0.87	0.86	0.87	0.89	0.87	0.86	0.86	0.86	0.82	0.83	0.85	0.84	0.84	0.84
Austria	0.70	0.69	0.68	0.60	0.56	0.52	0.50	0.53	0.55	0.56	0.60	0.61	0.62	0.64	0.65	0.67	0.68	0.67	0.68
Bahamas									0.01	0.01	0.02	0.03	0.05	0.06	0.06	0.07	0.06	0.06	0.06
Belgium	0.43	0.41	0.37	0.33	0.34	0.32	0.33	0.39	0.42	0.44	0.46	0.47	0.47	0.52	0.53	0.57	0.60	0.59	0.60
Brazil		0.96	0.96	0.97	0.96	0.96	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.97	0.97	0.97	0.96	0.96
Canada	0.90	0.90	0.90	0.90	0.89	0.88	0.87												
Chile		0.93	0.97	0.96	0.96	0.96	0.95	0.96	0.97	0.95	0.95	0.95	0.94	0.93	0.93	0.95	0.95	0.94	0.91
Cyprus								0.40	0.41	0.47	0.51	0.65	0.69	0.68	0.73	0.74	0.75	0.73	0.70
Denmark	0.83	0.81	0.81	0.81	0.80	0.78	0.79	0.81	0.82	0.84	0.83	0.80	0.75	0.75	0.74	0.74	0.76	0.74	0.71
Finland	0.66	0.72	0.72	0.76	0.74	0.74	0.74	0.76	0.63	0.54	0.58	0.56	0.54	0.56	0.62	0.81	0.77	0.62	0.63
France	0.66	0.65	0.59	0.54	0.52	0.54	0.56	0.58	0.58	0.59	0.61	0.60	0.59	0.60	0.61	0.62	0.58	0.56	0.57
Germany	0.67	0.65	0.63	0.59	0.56	0.52	0.51	0.55	0.59	0.66	0.68	0.66	0.65	0.65	0.67	0.68	0.68	0.68	0.71
Greece			0.85	0.83	0.84	0.79	0.74	0.65	0.69	0.74	0.72	0.70	0.71	0.71	0.73	0.79	0.85	0.78	0.73
Indonesia										0.97	0.97	0.96	0.97	0.96	0.97	0.97	0.96	0.97	0.97
Ireland	0.39	0.37	0.35	0.34	0.35	0.38	0.41	0.39	0.40	0.47	0.49	0.48	0.47	0.47	0.48	0.49	0.48	0.42	0.42
Italy	0.85	0.86	0.85	0.85	0.83	0.82	0.83	0.83	0.84	0.85	0.84	0.86	0.87	0.86	0.86	0.86	0.85	0.84	0.83
Japan	0.84	0.84	0.84	0.81	0.80	0.77	0.77	0.78	0.78	0.78	0.77	0.74	0.73	0.72	0.73	0.73	0.73	0.72	0.72
Luxembourg	0.04	0.04	0.05	0.05	0.07	0.07	0.10	0.11	0.14	0.16	0.19	0.16	0.15	0.18	0.23	0.27	0.28	0.27	0.29
Malaysia							0.91	0.92	0.91	0.90	0.90	0.90	0.90	0.88	0.89	0.90	0.90	0.91	0.90
Mexico			0.98	0.97	0.95	0.96	0.96	0.95	0.97	0.97	0.98	0.98	0.98	0.97	0.97	0.96	0.97	0.97	0.97
Netherlands	0.63	0.62	0.61	0.59	0.56	0.55	0.59	0.64	0.63	0.62	0.65	0.64	0.60	0.58	0.59	0.61	0.61	0.59	0.59
Norway	0.93	0.92	0.92	0.92	0.88	0.86	0.83	0.83	0.84	0.82	0.78	0.80	0.77	0.75	0.75	0.77	0.78	0.77	0.75
Panama		0.42	0.43	0.43	0.43	0.41	0.39	0.39	0.40	0.40	0.42	0.42	0.44	0.44	0.47	0.50	0.53	0.53	0.53
Philippines																0.90	0.90	0.90	0.90
Portugal	0.76	0.76	0.74	0.74	0.75	0.76	0.76	0.76	0.75	0.79	0.80	0.82	0.81	0.81	0.83	0.84	0.84	0.83	0.82
Russia															0.80	0.83	0.85	0.86	0.85
South Africa									0.87	0.87	0.87	0.86	0.86	0.84	0.87	0.88	0.88	0.88	0.84
South Korea				0.96	0.96	0.96	0.94	0.94	0.95	0.94	0.95	0.94	0.93	0.92	0.92	0.92	0.93	0.93	0.93
Spain	0.83	0.83	0.83	0.82	0.83	0.83	0.84	0.85	0.86	0.87	0.86	0.86	0.85	0.84	0.84	0.80	0.78	0.75	0.74
Sweden	0.80	0.79	0.75	0.73	0.68	0.66	0.66	0.67	0.67	0.67	0.65	0.66	0.64	0.64	0.66	0.64	0.66	0.71	0.71
Turkey	0.87	0.91	0.91	0.92	0.91	0.90	0.89	0.90	0.93	0.95	0.96	0.96	0.97	0.96	0.96	0.95	0.94	0.92	0.93
United States	0.84	0.82	0.81	0.81	0.79	0.77	0.77	0.77	0.74	0.75	0.79	0.81	0.82	0.82	0.82	0.82	0.83	0.82	0.83

Table 2. Annual Equity Home Bias for Small Sample of Countries.

Sample / Time	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
By Country																			
Australia	0.83	0.81	0.83	0.85	0.82	0.82	0.79	0.77	0.80	0.79	0.75	0.75	0.72	0.70	0.69	0.68	0.67	0.64	0.60
Austria	0.39	0.48	0.50	0.52	0.58	0.60	0.62	0.47	0.50	0.49	0.43	0.44	0.41	0.35	0.36	0.42	0.38	0.35	0.31
Belgium	0.55	0.47	0.47	0.55	0.50	0.50	0.44	0.34	0.40	0.43	0.42	0.44	0.42	0.42	0.45	0.38	0.35	0.30	
Brazil	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.96	0.94	0.96	0.96	0.96	0.96
Canada	0.68	0.79	0.72	0.74	0.74	0.72	0.73	0.68	0.71	0.72	0.70	0.67	0.64	0.61	0.54	0.57	0.53	0.50	
Chile	0.93	0.91	0.89	0.88	0.85	0.79	0.76	0.79	0.75	0.77	0.76	0.75	0.70	0.66	0.63	0.63	0.65	0.63	0.54
France	0.79	0.76	0.72	0.69	0.67	0.66	0.67	0.65	0.65	0.62	0.64	0.61	0.60	0.59	0.60	0.59	0.58	0.58	
Germany	0.67	0.59	0.62	0.59	0.56	0.51	0.53	0.49	0.46	0.48	0.48	0.49	0.51	0.47	0.44	0.43	0.44	0.41	0.33
Greece	0.98	0.96	0.95	0.94	0.93	0.92	0.90	0.81	0.86	0.81	0.69	0.83	0.91	0.84	0.68	0.69	0.76	0.75	0.77
Indonesia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98
Japan	0.88	0.88	0.89	0.87	0.88	0.86	0.84	0.84	0.79	0.80	0.78	0.78	0.81	0.70	0.71	0.69	0.70	0.67	0.52
Malaysia	0.99	0.99	0.99	0.99	0.99	0.98	0.97	0.94	0.93	0.94	0.93	0.93	0.92	0.90	0.88	0.87	0.87	0.86	0.81
Malta	0.99	0.95	0.90	0.82	0.83	0.79	0.77	0.73	0.73	0.71	0.57	1.28	-0.34	-0.00	-0.03	-0.00	-0.00	0.00	0.01
Mexico			1.00	0.98	0.98	0.98	0.99	0.99	0.98	0.98	0.97	0.96	0.94	0.93	0.92	0.91	0.89	0.89	0.88
Norway	0.56	0.47	0.49	0.52	0.52	0.53	0.50	0.35	0.31	0.35	0.28	0.24	0.22	0.19	0.17	0.20	0.19	0.19	0.16
Philippines	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99
Poland	0.99	0.99	0.99	0.99	0.98	0.96	0.94	0.95	0.95	0.94	0.94	0.94	0.94	0.92	0.83	0.87	0.88	0.86	0.84
Portugal	0.81	0.79	0.80	0.75	0.63	0.56	0.53	0.21	0.43	0.32	0.03	0.63	0.61	0.51	0.50	0.50	0.53	0.48	
Slovenia									0.77	0.70	0.63	0.60	0.59	0.60	0.54	0.51	0.48	0.53	0.53
South Africa	0.83	0.86	0.86	0.90	0.89	0.91	0.91	0.88	0.88	0.86	0.84	0.84	0.84	0.84	0.82	0.85	0.86	0.84	0.83
Spain	0.86	0.87	0.88	0.87	0.86	0.85	0.88	0.89	0.91	0.88	0.89	0.87	0.81	0.77	0.68	0.64	0.59	0.57	0.52
Turkey	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
United States	0.68	0.68	0.65	0.65	0.60	0.57	0.55	0.57	0.55	0.54	0.49	0.48	0.46	0.43	0.40	0.40	0.38	0.38	
By Group																			

Notes:. We do not report the home bias for Luxembourg, Ireland, and Panama.

Table 3. Annual Equity Home Bias for Large Sample of Countries.

Sample / Time	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
By Country																			
Australia	0.83	0.81	0.83	0.85	0.83	0.82	0.79	0.77	0.80	0.79	0.75	0.75	0.72	0.70	0.69	0.68	0.67	0.64	0.62
Austria	0.39	0.48	0.50	0.52	0.58	0.60	0.62	0.47	0.50	0.49	0.43	0.44	0.41	0.36	0.36	0.42	0.38	0.35	0.31
Belgium	0.55	0.47	0.47	0.55	0.50	0.50	0.44	0.34	0.40	0.43	0.42	0.44	0.42	0.42	0.45	0.38	0.35	0.30	
Brazil	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.96	0.94	0.96	0.96	0.96	0.96
Bulgaria	1.07	1.00	1.00	0.99	0.99	0.98	0.97	0.99	0.94	0.90	0.94	0.92							
Canada	0.69	0.79	0.72	0.74	0.75	0.72	0.73	0.68	0.72	0.73	0.70	0.68	0.64	0.61	0.55	0.57	0.54	0.50	
Chile	0.93	0.91	0.89	0.88	0.85	0.79	0.76	0.79	0.75	0.77	0.76	0.75	0.70	0.66	0.63	0.63	0.65	0.63	0.54
China															0.98	0.97	0.96	0.95	0.93
Croatia																			
Denmark	0.62	0.65	0.61	0.62	0.59	0.53	0.56	0.67	0.46	0.48	0.53	0.40							
Estonia	0.98	0.97	0.93	0.88	0.80	0.64	0.59	0.77	0.52	0.44	0.39	0.32							
Finland	0.87	0.80	0.67	0.62	0.57	0.51	0.49	0.74	0.18	0.04	0.38	0.35							
France	0.79	0.77	0.72	0.69	0.68	0.66	0.67	0.65	0.66	0.63	0.64	0.61	0.60	0.59	0.60	0.59	0.58	0.59	
Germany	0.67	0.59	0.62	0.59	0.56	0.51	0.54	0.49	0.47	0.49	0.48	0.50	0.52	0.48	0.45	0.43	0.45	0.41	0.37
Greece	0.98	0.96	0.95	0.94	0.93	0.92	0.90	0.81	0.86	0.81	0.69	0.83	0.91	0.84	0.68	0.69	0.76	0.75	0.77
Hungary		0.97	0.97	0.94	0.91	0.82	0.77	0.66	0.66	0.61	0.64	0.66	0.63	0.53	0.58	0.64	0.66	0.66	0.65
Indonesia	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98
Italy	0.68	0.62	0.56	0.57	0.56	0.51	0.56	0.68	0.48	0.46	0.45	0.35	0.32	0.36					
Japan	0.89	0.88	0.89	0.88	0.88	0.86	0.84	0.85	0.80	0.80	0.78	0.78	0.81	0.71	0.71	0.70	0.71	0.68	0.61
Latvia						0.89	0.85	0.83		0.51	0.25	0.32							
Lithuania										0.72	0.72	0.66							
Malaysia	0.99	0.99	0.99	0.99	0.99	0.98	0.97	0.94	0.93	0.94	0.93	0.93	0.92	0.90	0.88	0.87	0.87	0.86	0.81
Malta	0.99	0.95	0.90	0.82	0.83	0.79	0.77	0.73	0.73	0.71	0.57	1.28	-0.34	-0.00	-0.03	-0.00	-0.00	0.00	0.01
Mexico			1.00	0.98	0.98	0.98	0.99	0.99	0.98	0.98	0.97	0.96	0.94	0.93	0.92	0.91	0.89	0.89	0.88
Netherlands	0.48	0.44	0.33	0.28	0.33	0.36	0.45	0.30	0.30	0.33	0.33	0.30	0.28	0.25	0.21	0.21	0.24		
Norway	0.56	0.47	0.49	0.52	0.52	0.53	0.50	0.35	0.31	0.35	0.28	0.24	0.22	0.19	0.17	0.20	0.19	0.19	0.17
Philippines	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99
Poland	0.99	0.99	0.99	0.99	0.98	0.96	0.94	0.95	0.95	0.94	0.94	0.94	0.94	0.92	0.83	0.87	0.88	0.86	0.84
Portugal	0.81	0.79	0.80	0.75	0.63	0.56	0.53	0.21	0.43	0.32	0.03	0.63	0.61	0.51	0.50	0.50	0.53	0.48	
Romania	0.99	0.99	1.00	1.00	0.99	0.98	0.97	0.95	0.95	0.94	0.92								0.92
Slovenia									0.77	0.70	0.63	0.60	0.59	0.60	0.54	0.51	0.48	0.53	0.53
South Africa	0.83	0.86	0.86	0.90	0.89	0.91	0.91	0.88	0.89	0.86	0.84	0.84	0.84	0.85	0.82	0.85	0.86	0.84	0.84
Spain	0.86	0.87	0.88	0.87	0.86	0.85	0.88	0.89	0.91	0.88	0.89	0.87	0.82	0.77	0.68	0.64	0.59	0.57	0.53
Sweden	0.65	0.63	0.55	0.58	0.57	0.55	0.59	0.66	0.42	0.50	0.58	0.48							
Turkey	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
United Kingdom	0.72	0.72	0.65	0.65	0.60	0.57	0.59	0.67	0.47	0.56	0.61	0.52							
United States	0.75	0.75	0.72	0.71	0.67	0.64	0.63	0.65	0.62	0.62	0.59	0.57	0.53	0.53	0.52	0.52	0.50	0.48	

Notes:. We do not report the home bias for Cyprus, Luxembourg, Ireland, and Panama.

B Appendix II: Empirical Evidence

B.1 Stylized Facts

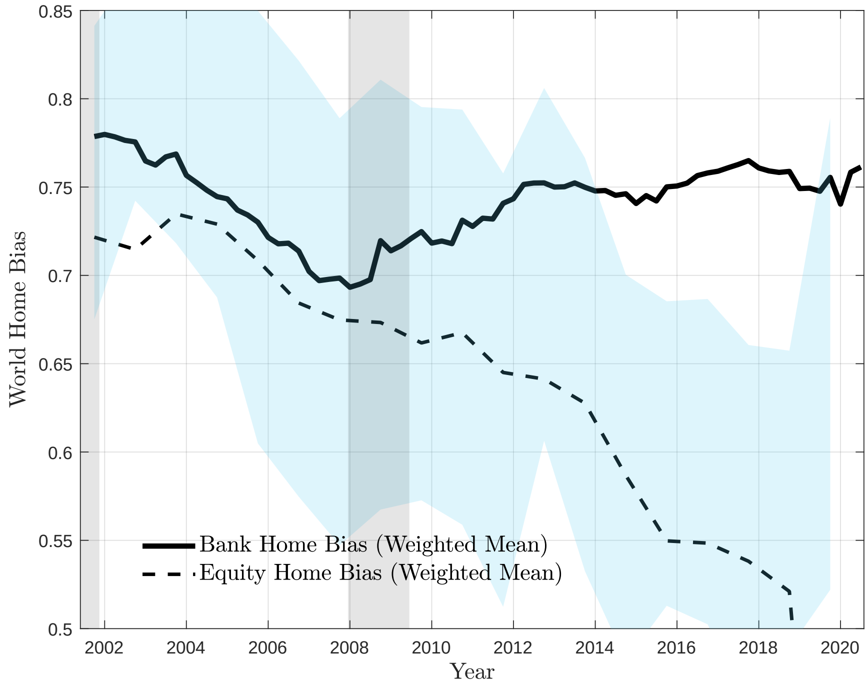

FIGURE 14. WORLD BANK HOME BIAS VS. WORLD EQUITY HOME BIAS.

Note: The solid line shows the average level of bank home bias weighted by total bank asset, as in Figure 2. The dash line shows the average equity home bias weighted by GDP computed in small sample. The blue shaded area is the [25, 50] quantile of the equity home bias panel dataset. For the equity home bias values of each country, see Table 1.

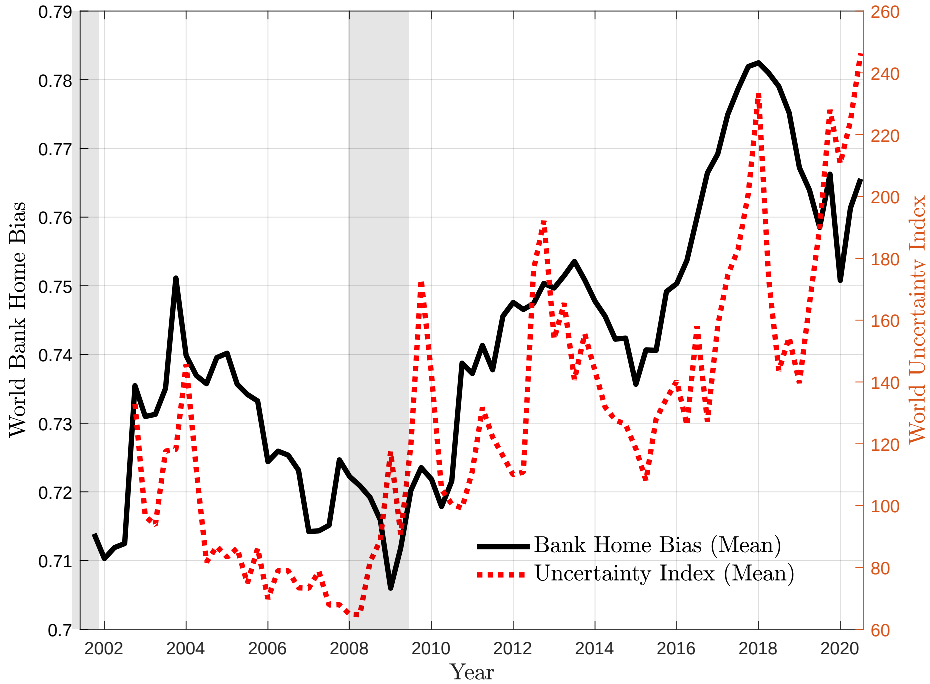

Figure 15. Mean World Bank Home Bias and Uncertainty (Lagged).

Note: The solid line shows the unweighted average level of bank home bias. The red dash line shows the unweighted average Economic Policy Uncertainty index, lagged by 4 quarters.

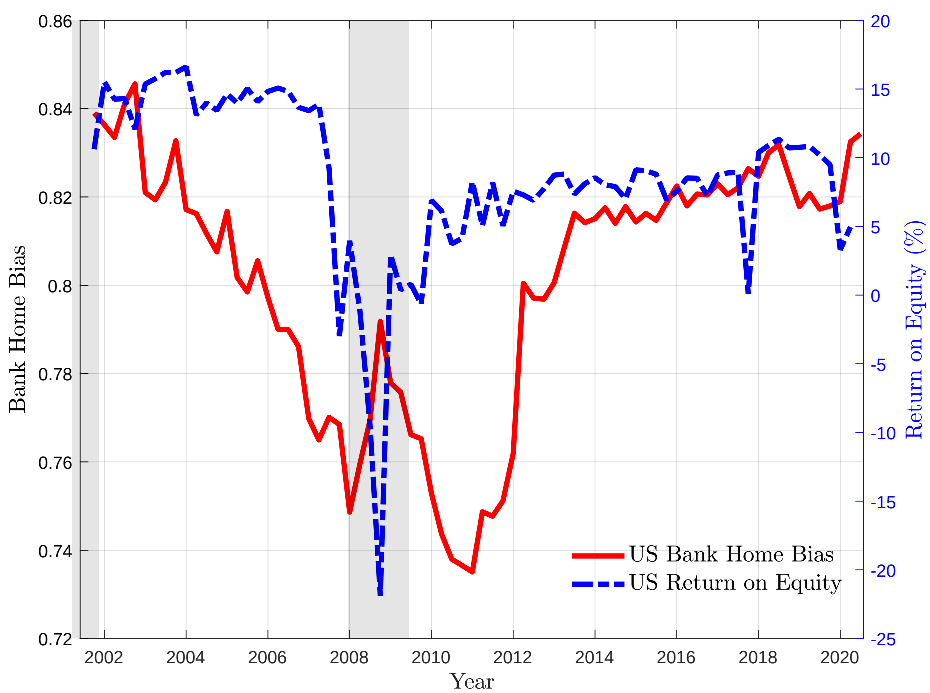

Figure 16. US Bank Home Bias and Return on Equity.

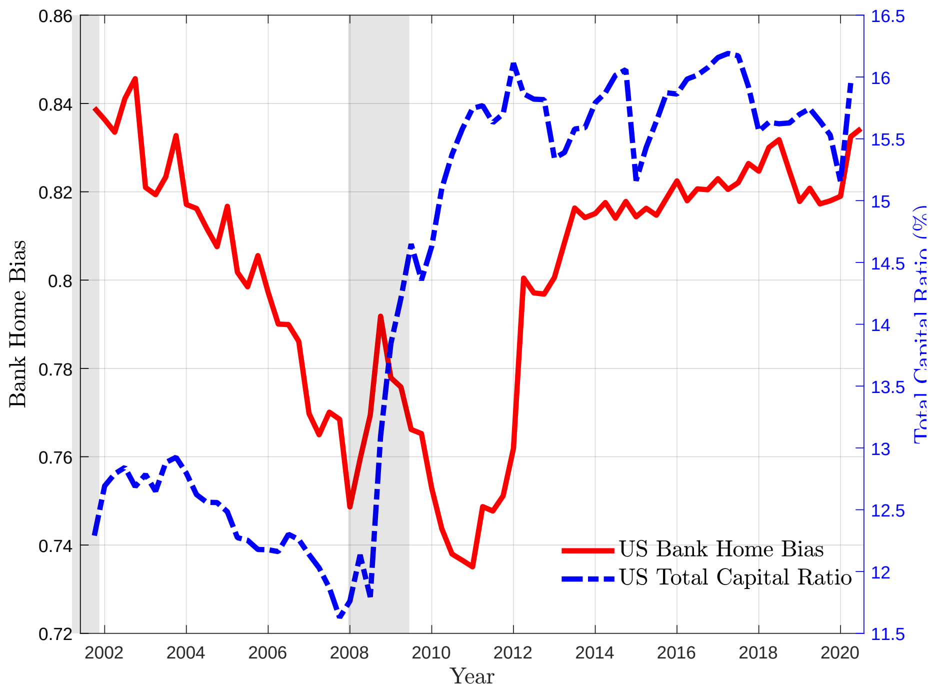

Figure 17. US Bank Home Bias and Total Capital Ratio.

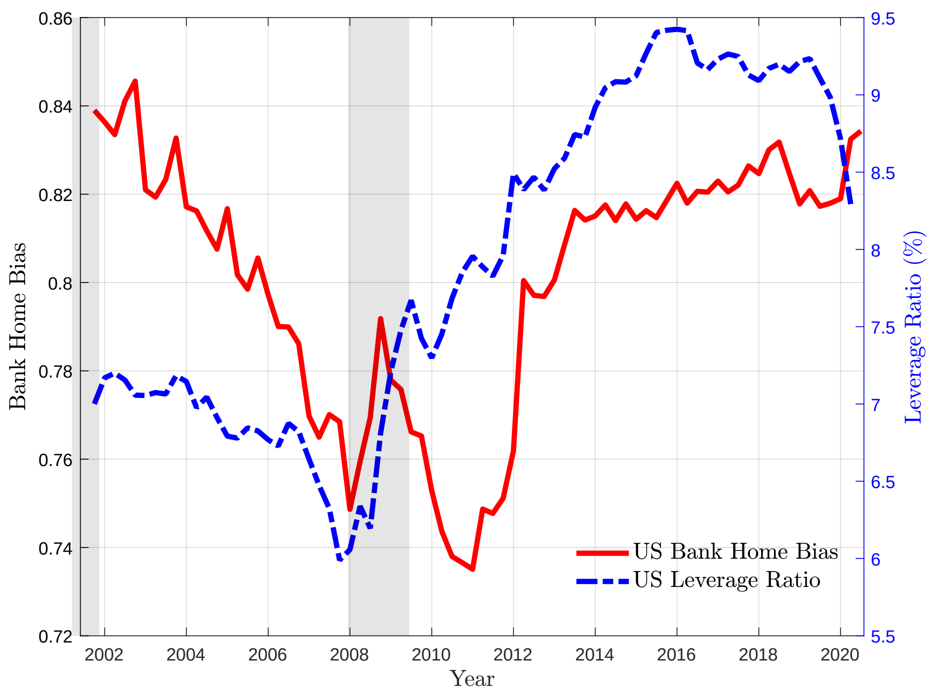

Figure 18. US Bank Home Bias and Leverage Ratio.

B.2 SVAR of Monetary Policy Shock

VAR Model setup. The model is a standard auto regression model given by

$$\mathbf{y_t} = A_0 + A_1\mathbf{y_{t-1}} + \cdots + A_p\mathbf{y_{t-p}} + \mathbf{u_t} \quad t = 1, \cdots, T,$$

and u_t are reduced-form errors given by $u_t = \mathcal{S}\epsilon_t$. We assume that ϵ_t is the vector of structural shock, i.e. it contain shocks that are independent with each other and we assume that the sizes of structural shocks are normalized. Therefore, the var-covar matrix of the residuals, Σ, is a matrix pinned down by $\Sigma = \mathcal{S}\mathcal{S}'$. Identifying structural shock can thus be achieved by exploiting the information in Σ.

Identification methods. For monetary policy, we opt for two identification methods. The first one is the conventional Christiano et al. (1999) method of short run identification method. The second one is the proxy identification method introduced by Gertler and Karadi (2015). The first identification method relies on the recursive identification assumption that monetary policy shock does not have contemporaneous effect on output and inflation; or rather, monetary policy only responses contemporaneous to the shocks to these two macroeconomic variables. By this identification assumption, it suffices to assume that $\mathcal{S}$ is lower-triangular. It can thus be obtained by doing Cholesky decomposition to the matrix Σ.

One might find the identification assumption is to restrictive, due to the fact that the contemporaneous responses from output and inflation to monetary policy might exist due to reasons such as the agents have forward-looking expectation regarding the factors that drive the monetary policy changes. Therefore, we adopt a second identification method, namely the proxy identification of monetary policy in Gertler and Karadi (2015). The proxy identification method assumes the existence of an instrument variable Z_t, which satisfies

$$E\left[\mathbf{Z}_t\epsilon_t^{p'}\right] = \phi, \quad E\left[\mathbf{Z}_t\epsilon_t^{q'}\right] = \mathbf{0}$$

where $\epsilon_t^{p'}$ is the structural shock of interest, and $\epsilon_t^{q'}$ are all the other structural shocks. As shown by the equations, such an instrument variable can be used to identify the shock of interest as it is not correlated with other shocks. The key is thus to obtain a reliable proxy for monetary policy shock, and the authors argue that one ideal variable to serve this purpose is the policy news shock identified at very high frequency. Intuitively, around a thirty-minute window of Federal Reserve's policy announcement in the regular meetings by Federal Open Market Committee (FOMC), the responses of the various interest rates in the market should capture the full impact of the monetary policy change, given the fact that no economic fundamental would vary in such a short window. Therefore, the unexpected changes in the interest rates, in particular the fed funds future rates, captures the policy news shock. It serves as an ideal proxy for monetary policy shocks as it is exogenous to the system but highly correlated to the shock.

Since the data for proxy variables provided by Gertler and Karadi (2015) ends in the year 2012, we need access to a longer data period for high frequency data for the identification of monetary policy in our sample. To this end, we use an extended sample of monetary policy news shocks in Nakamura and Steinsson (2018), which contains the news shock obtained from fed funds future. We compare this sample with that of Gertler and Karadi (2015) and confirm that prior to 2012 the two data series are highly correlated, indicating that the same identification assumption should be valid throughout our data sample from 2000 to 2012. Note that in our sample, neither the short run identification method nor the proxy identification method yield the conventional responses of a monetary policy shock, i.e. it suppress output and inflation. This is due to the fact that our data sample contains a very special crisis period, in which unprecedented monetary expansion policies were implemented to combat the crisis, whereas monetary policy contraction is viewed as a strong signal for recovery. This is the potential cause for the unconventional responses from the economic variable. Once we restrict the sample to longer period pre-crisis, the results are the same as Gertler and Karadi (2015).

FEVD results (short-run identification).

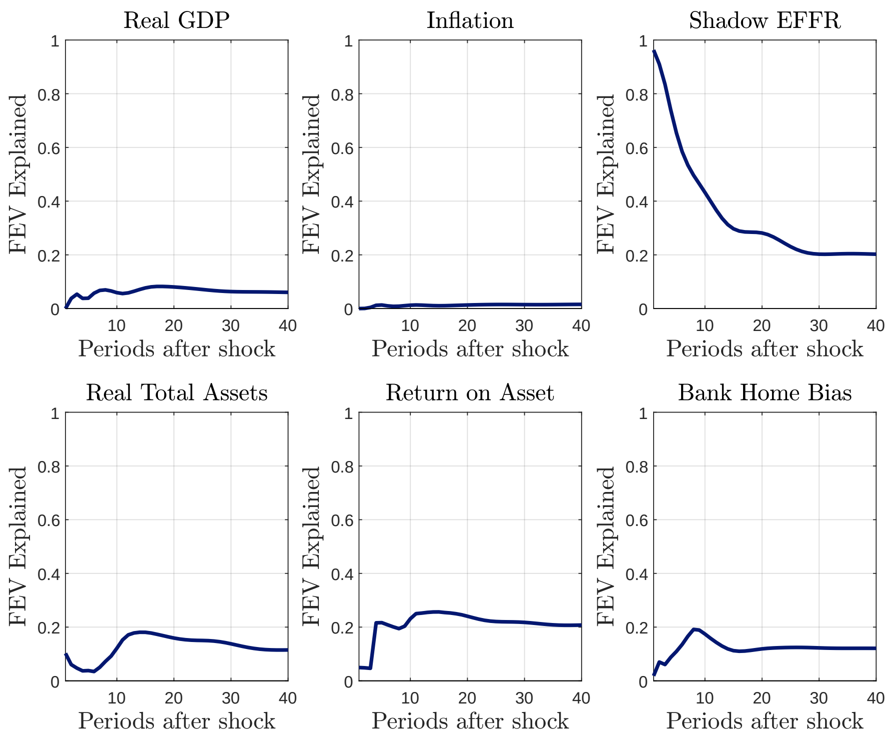

Figure 19. FEVD to monetary shock.

Impulse responses of monetary policy shock: With key variables.

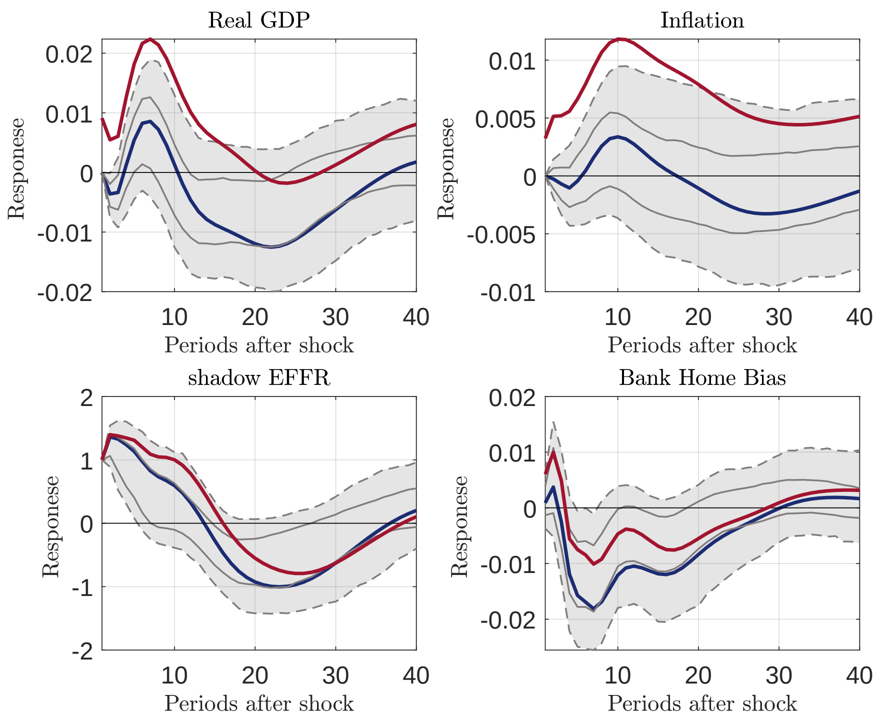

Figure 20. Impulse Response to monetary shock.

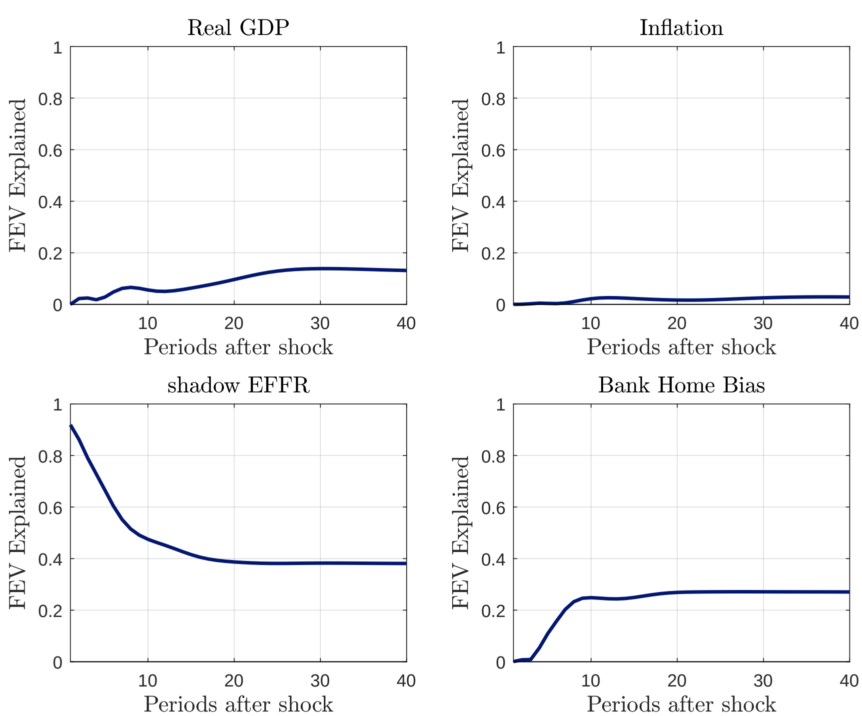

Figure 21. FEVD to foreign monetary shock.

Impulse responses of monetary policy Shock: With decomposition.

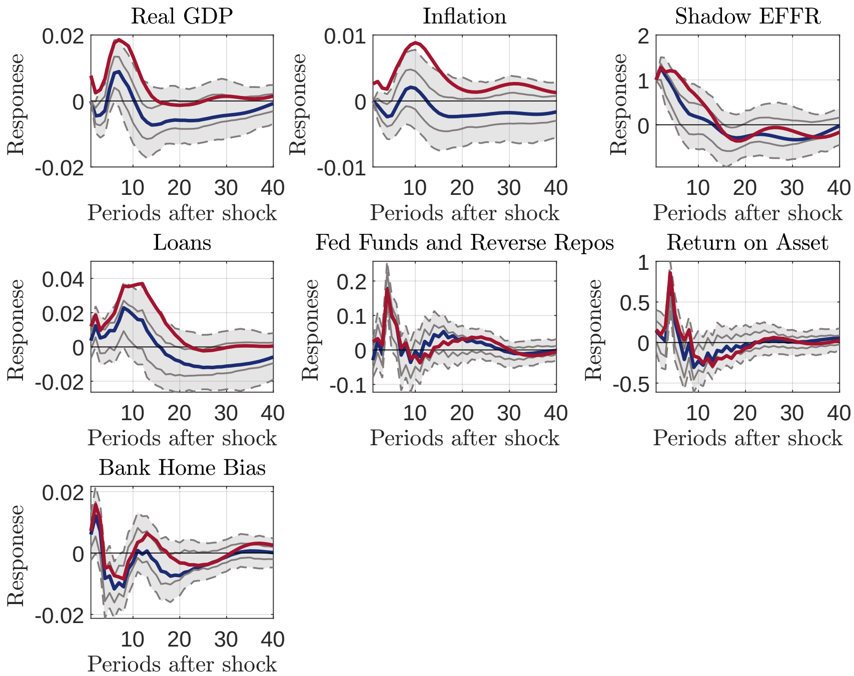

Figure 22. Impulse Response to monetary shock.

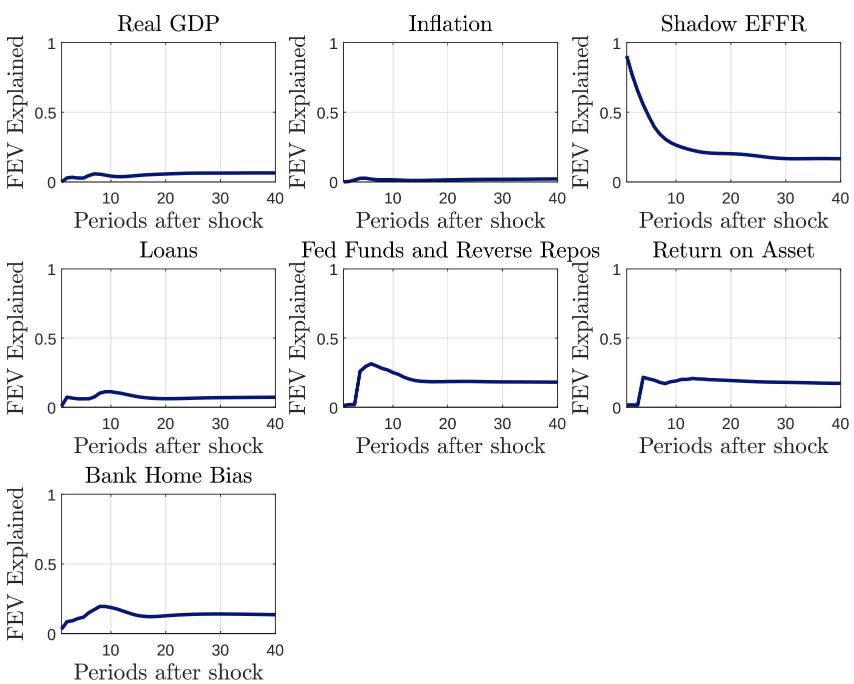

Figure 23. Impulse Response to monetary shock.

B.3 SVAR of Uncertainty Shock

Identification methods. To identify uncertainty shock, we also use two identification methods to cross-check its validity. For the first method, we go for the similar set up of Bloom (2009) and make short run identification assumptions. Since this identification technique requires restricting the contemporaneous responses of variables, which might not be ideal for uncertainty indices as they contain forward looking component, we also go for a second identification method, namely the max share identification developed in Uhlig (2003).

The identification assumption for the first approach is as follows. We assume that uncertainty shocks, due to its forward-looking nature, should instantaneously affects on the other variables, whereas the other shocks such as monetary policy shocks would not have a contemporaneous impact on uncertainty. This assumption requires that uncertainty variables is ranked at the beginning of the vector of variables. The respective column defined is obtained by doing Cholesky decomposition to the var-covariance matrix Σ.

The identification assumption for the second approach is different from the first one in the sense that we do not put restrictions on the contemporaneous response. The aim is to identify a shock that has the maximum explanatory power over the forecast error variance decomposition. The shock identified is not independent from the other shocks in the sense that it can be the combination of multiple underlying shocks, since the only criterion is to identify the most influential shocks to uncertainty, or in our case, domestic uncertainty and foreign uncertainty respectively.

The identification proceeds as follows. We seek to pin down one column vector s^* from the $\mathcal{S}$ matrix which explains as much as possible of the forecast error variance of foreign uncertainty (respectively domestic uncertainty). However, instead of directly looping through all feasible vector to look for s^*, we obtain it indirectly by looking for a vector q of an orthonormal matrix Q, which is essentially a rotation matrix. Note that any matrix $\bar{\mathcal{S}}$ that satisfies $\Sigma = \bar{\mathcal{S}}\bar{\mathcal{S}}'$ can be represented as the multiplication of the Cholesky decomposition of Σ, denoted as $\mathbf{S}$, and an orthonormal matrix Q, i.e. $\tilde{\mathcal{S}} = \mathbf{S}Q$. The h step ahead forecast error of Y_t can thus be written as

$$\mathbf{y}_{t+h} - E_{t-1}\mathbf{y}_{t+h} = \sum_{l=0}^{h} A_l \mathbf{S} Q \epsilon_{t+h-l},$$

and the FEV share of variable i due to shock j at horizon h is given by

$$\Omega_{i,j}(h) = \frac{\sum_{l=0}^{h} A_{i,l}\mathbf{S}qq'\mathbf{S}'A'_{i,l}}{\sum_{l=0}^{h} A_{i,l}\Sigma_u A'_{i,l}}.$$

The identification goal is therefore to find a vector q that can explain the most of the FEV share of one shock up to k period,

$$\max_{q} \sum_{h=0}^{k} \Omega_{i,j}(h)_{ii}$$
$$\text{s.t.} \quad q'q = 1.$$

The optimal vector s^* is then pinned down by multiplying q with matrix $\mathbf{S}$, i.e. $s^* = \mathbf{S}q$.

In our result, we specify the maximization problem to be over one period (one quarter), and the results are robust to changing the maximization problem to longer periods. We apply this method to domestic and foreign uncertainty and obtain domestic uncertainty shock and foreign uncertainty shock respectively.

FEVD results (short-run identification).

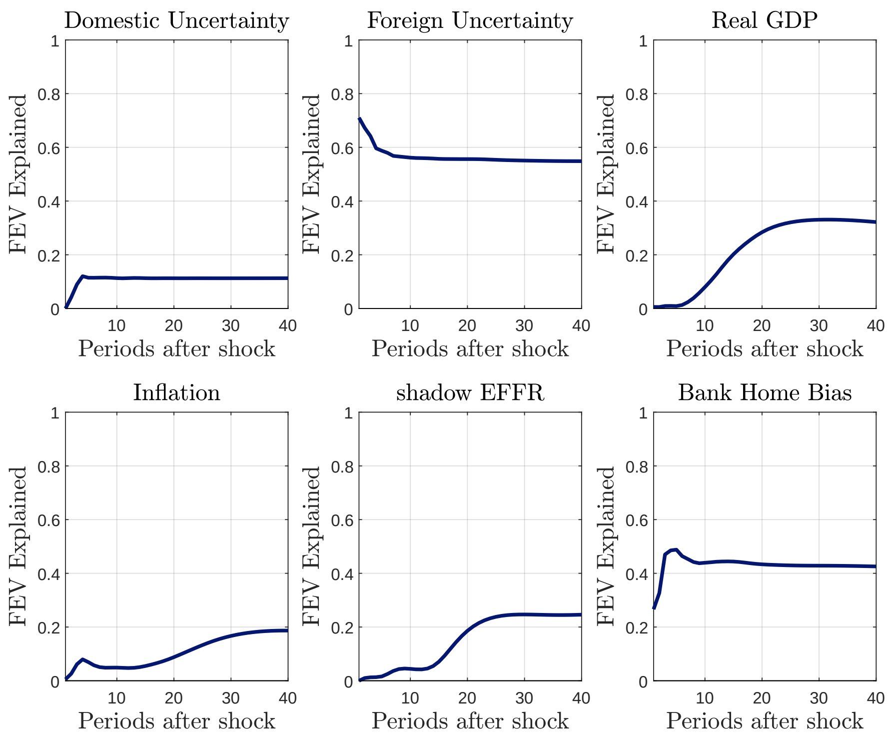

Figure 24. FEVD to foreign uncertainty shock.

Impulse responses of uncertainty shock: Domestic.

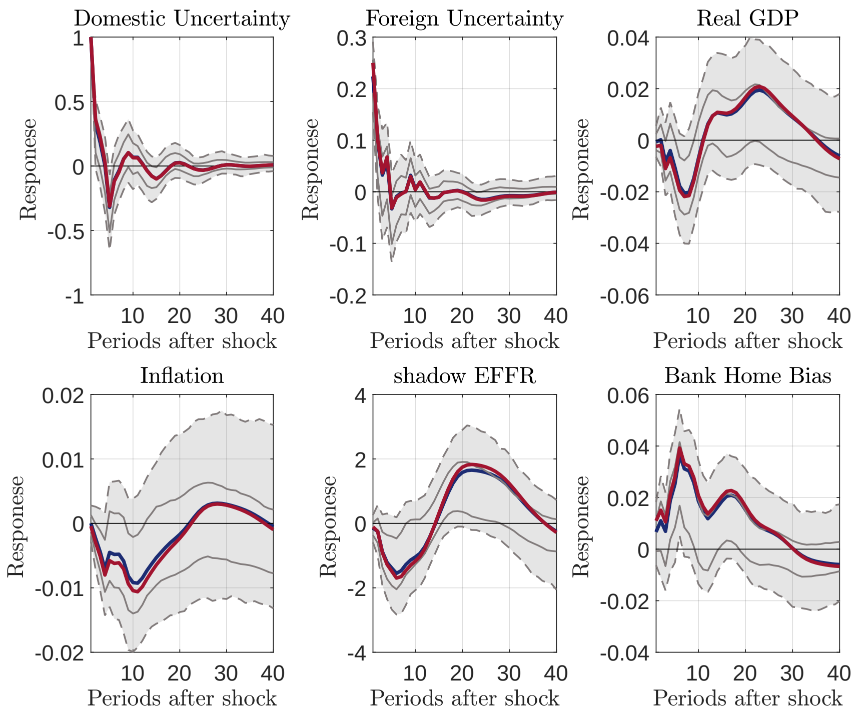

Figure 25. Impulse Response to foreign uncertainty shock.

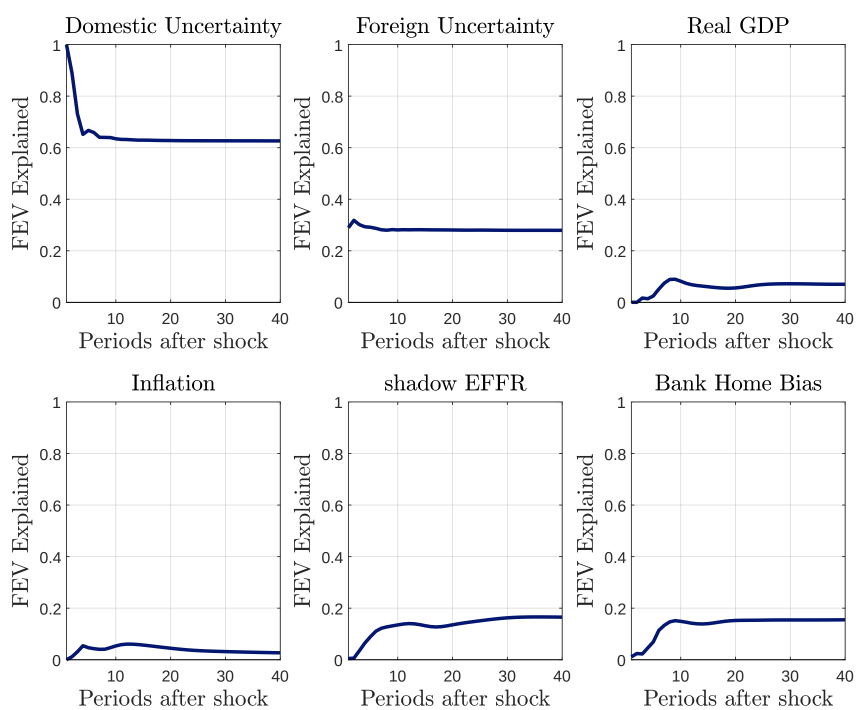

Figure 26. FEVD to foreign uncertainty shock.

Impulse responses of uncertainty shock: With only key variable.

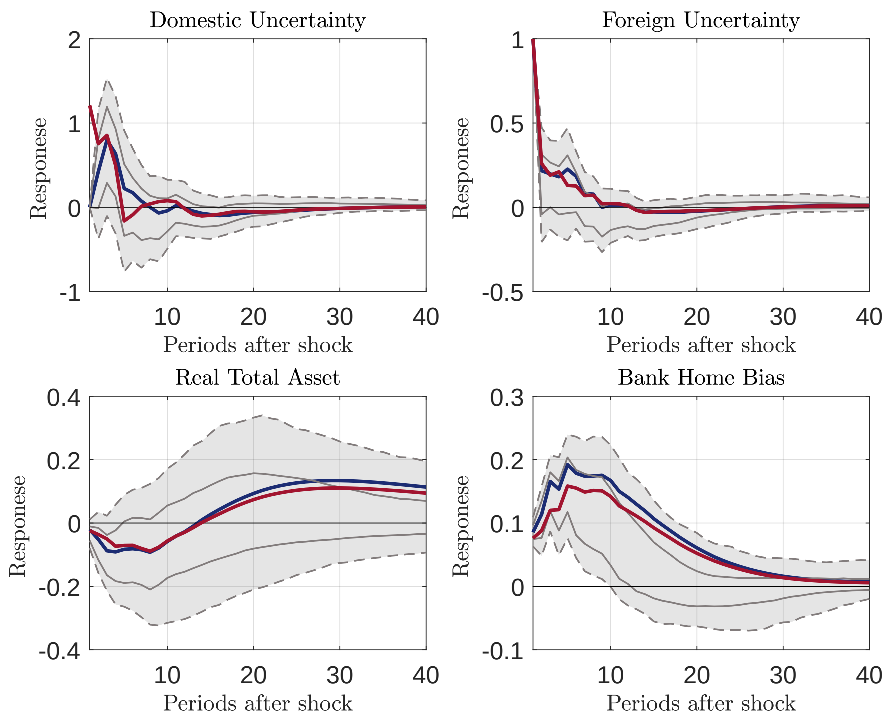

Figure 27. Impulse Response to foreign uncertainty shock.

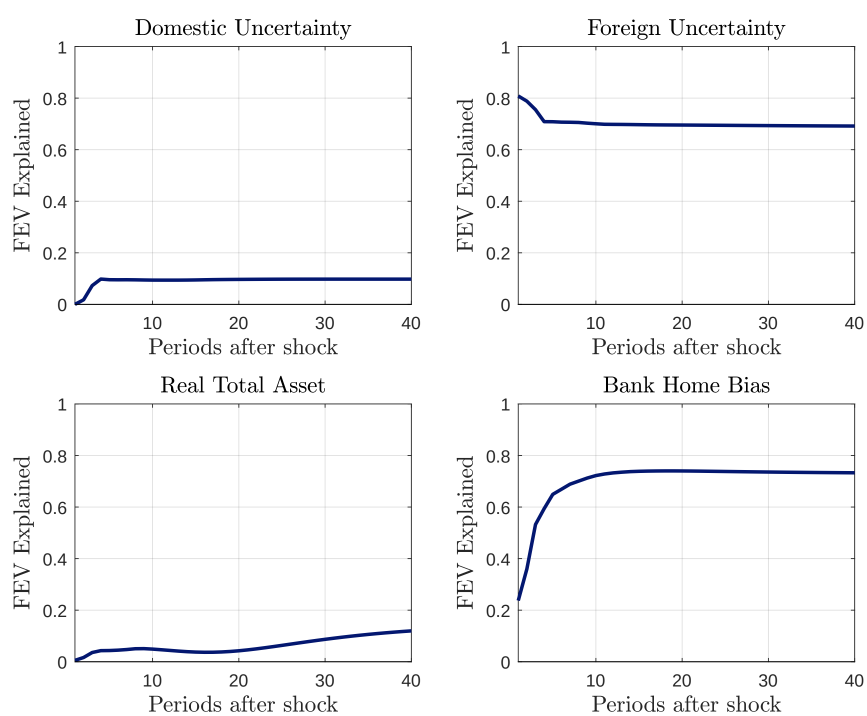

Figure 28. FEVD to foreign uncertainty shock.

Impulse responses of uncertainty shock: With asset classes decomposition.

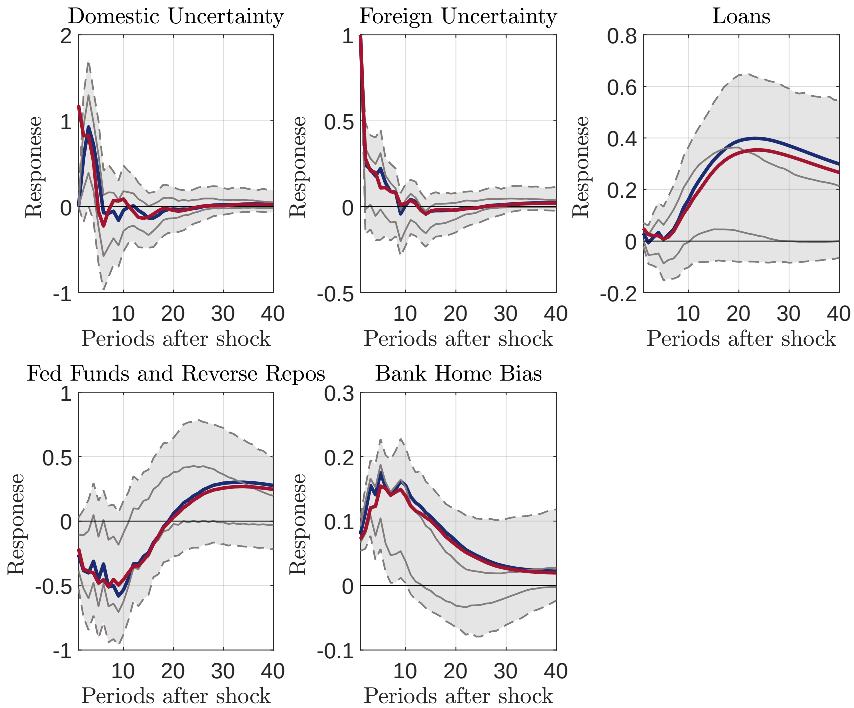

Figure 29. Impulse Response to foreign uncertainty shock.

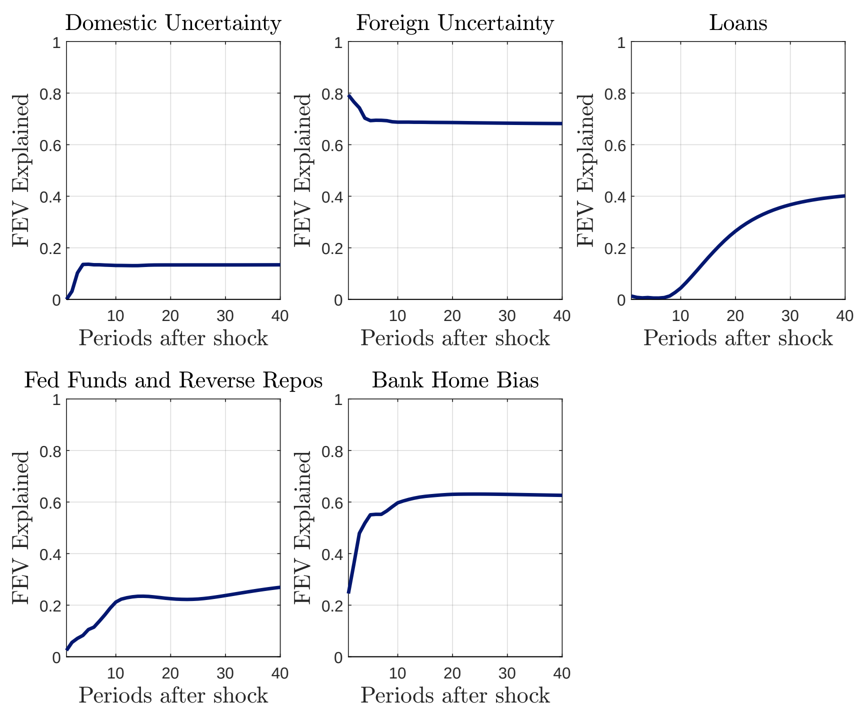

Figure 30. FEVD to foreign uncertainty shock.

C Appendix III: Static Model Derivations and Proofs

C.1 Auxiliary Lemmas

As stated previously, our static bank environment relies on an underlying CARA-Normal structure. We thus first characterize the distribution of terminal period equity in Lemma 8.

Lemma 8 (Distribution of Terminal Equity). *Terminal equity e_i' follows a Normal distribution, i.e. $e_i' \sim \mathcal{N}(\mu_{e_i'}, \sigma^2_{e_i'})$. Under Assumption 4 (b), its mean and variance are given by*

$$\mu_{e_i'} = (1+r^m)e_i + (1-\omega)r^m d_i + \theta(\mu_i - r^m)k_{ii} + \theta(\mu_j - r^m)k_{ij} - \mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i{}') \,,$$
$$\sigma^2_{e'} = \sigma_i^2 k_{ii}^2 + \left(\sigma_j^2 + \sigma_\epsilon^2\big(1-\mathcal{P}(m,k_{ij})\big)^2\right)k_{ij}^2 + 2\rho\sigma_i\sigma_j k_{ii}k_{ij} \,,$$

where (μ_i, μ_j) are defined according to

$$\mu_i \equiv (1-\xi)\mu_{z_i} - 1 \,, \quad \text{and} \quad \mu_j \equiv (1-\xi)\mu_{z_j} - 1 \,.$$

The expected bank profitability before uncertainty management activities is given by

$$\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right] = (1-\omega\delta)\, r^m w_i + \theta(\mu_i - r^m)k_{ii} + \theta(\mu_j - r^m)k_{ij} \,. \tag{12}$$

The mean of terminal equity increases in the risk premium of investment projects, i.e. it increases in θ and decreases in ξ. The effects of a tightening of monetary policy are *ex ante* ambiguous as multiple channels simultaneously impact expected profitability. On the one hand, an increase in r^f decreases the risk premium and hence suppresses both domestic as well as cross-border lending and thus expected profitability. On the other hand, an increase in r^f raises the returns on risk-free asset holdings, i.e. on the part $w_i - k_{ii} - k_{ij}$ of initial wealth which is hold as central bank reserves. Additionally, monetary policy also acts on the liability side of the balance sheet because of interest rate pass-through from the monetary policy rate to the deposit rate. For the effect of contractionary monetary policy on the equity mean to be positive, it is required that either there is little pass-through from the monetary policy rate to the deposit rate, i.e. ω is low, or the bank is not highly leveraged, δ is low, such that $(1-\omega\delta) > 0$ is satisfied. In this case, we say that there is a risk-free rate arbitrage, meaning that under this circumstances, banks earns profit simply through collecting deposit and put them into safe asset. The return on the safe asset is sufficient to cover all deposit payment.

Lemma 9 (Upper Limit Bank Profitability Sensitivity). *$\Phi(\psi)$ is discontinuous at the point*

$$\psi^{dc} = \frac{\sigma_j^2}{\zeta_i \theta (\mu_j - r^f) \sigma_\epsilon^2} \; .$$

(a) If $2\rho \frac{\mu_j - r^m}{\sigma_j} = \frac{\mu_i - r^m}{\sigma_i}$ holds, $\Phi(\psi)$ is an affine function in ψ which lies in $\mathbb{R}_+$ if $2\frac{\sigma_i}{\sigma_j} \geq \frac{\mu_i - r^m}{\mu_j - r^m}$.

(b) If on the contrary $2\rho \frac{\mu_j - r^m}{\sigma_j} \neq \frac{\mu_i - r^m}{\sigma_i}$ holds, $\Phi(\psi)$ has a positive and a negative root, in which interval the function is positive. Thus, there exists a parameter set $\Psi^{GM} \equiv \left[0, \overline{\psi}^{GM}\right)$ on which Φ is strictly positive, and decreasing in ρ at $\psi = 0$. The upper bound $\overline{\psi}^{GM} < \psi^{dc}$ is given by

$$\overline{\psi}^{GM} = \Gamma \left(\left[\rho \sigma_j (\mu_i - r^m) - \sigma_i (\mu_j - r^m) \right] + \left(\left[\rho \sigma_j (\mu_i - r^m) - \sigma_i (\mu_j - r^m) \right]^2 + (\mu_i - r^m)^2 (1 - \rho^2) \sigma_j^2 \right)^{\frac{1}{2}} \right) ,$$

with $\Gamma \equiv \frac{2\sigma_i}{\zeta_i \theta \sigma_\epsilon^2 (\mu_i - r^m)^2}$ holds.

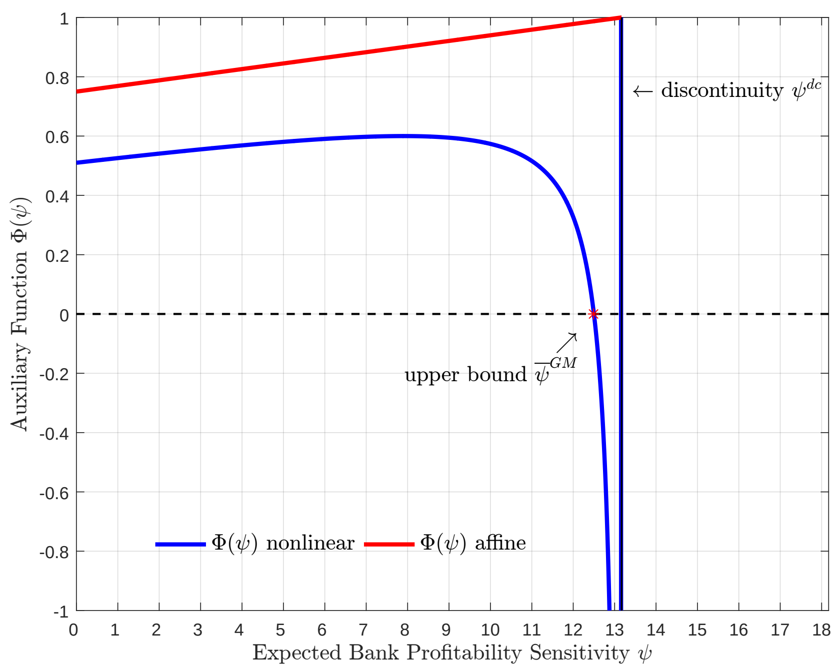

Figure 31. Auxiliary Function $\Phi(\psi)$ and Parameter Space of Equity Managing Impact ψ.

Notes: The above figure is constructed under the following parameter values: $\theta = 0.75$, $\zeta_i = 1.20$, $\mu_i = \mu_j = 0.25$, $\sigma_i = \sigma_j = 1.00$, $\sigma_\epsilon = 0.75$, $r^m = 0.10$. The affine functional specification uses consequently $\rho = 0.50$, whereas the nonlinear specification imposes $\rho = 0.70$.

C.2 Lemma 1

Proof Lemma 8

To determine the initial distribution of terminal period equity e_i' from the perspective of bankers when determining their portfolio choices, we proceed in two steps: First, we solve for the entrepreneurs maximization problem to determine the gross capital returns from production. Second, we solve for the Nash bargaining outcome.

Proof. Part I: Entrepreneurial Problem
To begin with, entrepreneurs in country i maximize profits Π_i

$$\max_{\{l_i,k_i\}} \Pi_i(l_i,k_i) = A_i k_i l_i^{\xi} - w l_i - R_i k_i \ . \tag{13}$$

The corresponding first order condition with respect to labor reads $\xi A_i k_i l_i^{\xi-1} = w$. Hence, the profits accruing from physical capital are given by

$$\Pi_i(k_i) = (1-\xi)\, A_i k_i l_i^{\xi} - R_i k_i = \left[(1-\xi) A_i l_i^{\xi} - R_i\right] k_i \tag{14}$$

As labor is supplied inelastically and equals unity, we obtain that $R_{ii} = (1-\xi) z_i$, due to symmetry respectively $R_{ij} = (1-\xi) z_j$.

Part II: Bargaining Problem
We denote the total surplus of the match between a banker and an entrepreneur by $\mathcal{S}$. It is composed out of two components, the banker surplus $\mathcal{S}^b$ and the entrepreneurial surplus $\mathcal{S}^e$. For an investment in country i, the former is given by $\mathcal{S}^b_{ii} = R^l_{ii} - R^f$. This is due to the fact, that we implicitly assume that the banker has sufficiently large funds at her disposal to satisfy her optimal choices for both risky assets. As a result, her outside opportunity is characterized by risk free central bank reserve holdings with pay off R^f. Similarly, the entrepreneurial outside option is to not produce such that her surplus is $S^e_{ii} = R_{ii} - R^l_{ii}$. The Nash bargaining problem is then written as

$$\max_{\{R^l_{ii}\}} \left(R^l_{ii} - R^f\right)^{\theta} \left(R_{ii} - R^l_{ii}\right)^{1-\theta} \quad , \quad s.t. \quad \mathcal{S} \equiv R_{ii} - R^f \ . \tag{15}$$

As standard, the first order condition to the bargaining problem (15) is given by

$$\theta \left(R^l_{ii} - R^f\right)^{\theta-1} \left(R_{ii} - R^l_{ii}\right)^{1-\theta} = (1-\theta) \left(R^l_{ii} - R^f\right)^{\theta} \left(R_{ii} - R^l_{ii}\right)^{-\theta} \ .$$

The previous equation can be rewritten as $\theta\mathcal{S} = R^l_{ii} - R^f$ and $(1-\theta)\mathcal{S} = R_{ii} - R^l_{ii}$. It is also standard and straightforward to verify the second order condition. As a result, we obtain

$$R_{ii}^{l} = \theta(R_{ii} - R^{f}) + R^{f} = \theta\big((1-\xi)z_i - R^{f}\big) + R^{f} \;, \tag{16}$$

and by symmetry considerations analogously

$$R_{ij}^{l} = \theta(R_{ij} - R^{f}) + R^{f} = \theta\big((1-\xi)z_j - R^{f}\big) + R^{f} \;. \tag{17}$$

Having equations (16) and (17) at hands, we can state terminal period equity e_i' as

$$\begin{aligned}
e_i' &= R_{ii}^{l}k_{ii} + \Big(R_{ij}^{l} + \epsilon_j\left(1-\mathcal{P}(m,k_{ij})\right)\Big)k_{ij} + R^{f}b_i - R^{d}d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i') \\
&= R_{ii}^{l}k_{ii} + \Big(R_{ij}^{l} + \epsilon_j\left(1-\mathcal{P}(m,k_{ij})\right)\Big)k_{ij} + R^{f}\left(d_i + e_i - k_{ii} - k_{ij}\right) - R^{d}d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i') \\
&= R^{f}e_i + \left(R_{ii}^{l} - R^{f}\right)k_{ii} + \left(R_{ij}^{l} - R^{f} + \epsilon_j\left(1-\mathcal{P}(m,k_{ij})\right)\right)k_{ij} + (R^{f} - R^{d})d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i') \\
&\approx R^{f}e_i + \theta\big(r_{ii}^{l} - r^{f}\big)k_{ii} + \Big(\theta\big(r_{ij}^{l} - r^{f}\big) + \epsilon_j\left(1-\mathcal{P}(m,k_{ij})\right)\Big)k_{ij} + (1-\omega)r^{f}d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i') \;,
\end{aligned}$$

where r^f denotes the net monetary policy rate, respectively (r_{ii}^l, r_{ij}^l) net asset rates. The latter two are defined by $r_{ii}^l \equiv (1-\xi)z_i - 1$, respectively $r_{ij}^l \equiv (1-\xi)z_j - 1$. The second equality follows from a substitution of the initial period budget constraint. The third equation collects terms whereas the final equation makes use of a first order Taylor approximation around $r^f = 0$ such that $r^d \approx \omega r^f$ follows. We denote mean and variances of net asset rates by

$$\mu_i \equiv (1-\xi)\mu_{z_i} - 1 \;, \qquad \sigma^2(r_{ii}^l) \equiv (1-\xi)^2\sigma_{z_i}^2 \;, \tag{18}$$

$$\mu_j \equiv (1-\xi)\mu_{z_j} - 1 \;, \qquad \sigma^2(r_{ij}^l) \equiv (1-\xi)^2\sigma_{z_j}^2 \;. \tag{19}$$

Under Assumption 4, it is then evident that terminal equity follows a Normal distribution with mean

$$\mu_{e_i'} = (1+r^f)e_i + \theta\big(\mu_i - r^f\big)k_{ii} + \theta\big(\mu_j - r^f\big)k_{ij} + (1-\omega)r^f d_i - \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i') \tag{20}$$

and variance

$$\sigma_{e_i'}^2 = \sigma_i^2 k_{ii}^2 + \Big(\sigma_j^2 + \sigma_\epsilon^2\left(1-\mathcal{P}(m,k_{ij})\right)^2\Big)k_{ij}^2 + 2\rho\sigma_i\sigma_j k_{ii}k_{ij} \;, \tag{21}$$

which completes the derivation of Lemma 8. □

C.3 Lemma 2

Assumption 4 (Tractability). *The following assumptions hold.*

(a) Risk reduction and management cost elasticities $(\varphi, \eta, \lambda, \chi, \nu)$ relate to each other according to

$$2\frac{(1+\eta)\chi + \varphi\nu}{\chi + 2\varphi} = 1 \quad \textit{and} \quad \lambda = \frac{\chi + 2\varphi}{2\varphi} .$$

(b) The variances of the fundamental technology shocks are given by

$$\sigma_{z_i}^2 = \frac{1}{\theta^2(1-\xi)^2}\sigma_i^2 , \quad \textit{and} \quad \sigma_{z_j}^2 = \frac{1}{\theta^2(1-\xi)^2}\sigma_j^2$$

Proof Lemma ??

Proof. To begin with, we impose for a positive and finite cross border investment level k_{ij} that the risk reduction function $\mathcal{P}(m, k_{ij})$ is subject to the following restrictions

(i) $\mathcal{P}(m, k_{ij}) \in (-\infty, 1]$, where $\lim_{m\to 0} \mathcal{P}(m, k_{ij}) = -\infty$ and $\lim_{m\to\infty} \mathcal{P}(m, k_{ij}) = 1$.

(ii) $\frac{\partial \mathcal{P}(m,k_{ij})}{\partial m} > 0$, $\frac{\partial^2 \mathcal{P}(m,k_{ij})}{\partial m^2} < 0$, $\frac{\partial \mathcal{P}(m,k_{ij})}{\partial k_{ij}} < 0$ and $\frac{\partial^2 \mathcal{P}(m,k_{ij})}{\partial m \partial k_{ij}} > 0$.

Restriction (i) provides conditions on the support of $\mathcal{P}(m, k_{ij})$. If bankers invest zero effort in risk managing activities, uncertainty σ_ϵ^2 is scaled up. On the contrary, if bankers invest infinite effort into risk managing activities, uncertainty can be reduced to zero. Moreover, we assume that the risk reduction function is strictly increasing and strictly concave in the effort level m. We also assume that the risk reduction of a given effort m decreases in the risky cross border investment level k_{ij} and that risky cross border investment and effort behave in a *complementary* manner.

Contrary, the cost function associated with risk management, $\mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i')$, has the subsequent properties

(iii) $\mathcal{C}(0, k_{ij}, \Delta\tilde{e}_i') = \mathcal{C}(m, 0, \Delta\tilde{e}_i') = \mathcal{C}_m(0, k_{ij}, \Delta\tilde{e}_i') = 0$.

(iv) $\frac{\partial \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i')}{\partial m} > 0$, $\frac{\partial^2 \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i')}{\partial m^2} > 0$, $\frac{\partial \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i')}{\partial k_{ij}} \gtrless 0$, and $\frac{\partial^2 \mathcal{C}(m,k_{ij},\Delta\tilde{e}_i')}{\partial m \partial k_{ij}} \gtrless 0$.

Property (iii) states that effort costs only arise if the effort level and cross border investment are positive. Additionally, the cost function is strictly convex in its first argument, increasing or decreasing in its second argument, and complementary or substitutable in both of its arguments.

Due to the CARA-Normal structure, one can state the risk management objective of (P1) as

$$\max_{\{m\}} -\frac{1}{2}\alpha\sigma_\epsilon^2 \Big(1 - \mathcal{P}(m, k_{ij})\Big)^2 k_{ij}^2 - \mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i') , \tag{P2'}$$

Taking the first order condition, we get

$$\mathcal{C}_m(m, k_{ij}, \Delta\tilde{e}_i') = \alpha\sigma_\epsilon^2\Big(1 - \mathcal{P}(m, k_{ij})\Big)k_{ij}^2\mathcal{P}_m(m, k_{ij}) \ . \tag{22}$$

To ensure that the solution characterizes indeed a maximum, we verify by means of the second order condition

$$-\mathcal{C}_{mm}(m, k_{ij}, \Delta\tilde{e}_i') + \alpha\sigma_\epsilon^2\Big(1 - \mathcal{P}(m, k_{ij})\Big)k_{ij}^2\mathcal{P}_{mm}(m, k_{ij}) - \alpha\sigma_\epsilon^2 k_{ij}^2\mathcal{P}_m^2(m, k_{ij}) < 0 \ .$$

To rule out the boundary case $m = 0$, we need to ensure that the following inequality holds

$$\alpha\sigma_\epsilon^2\Big(1 - \mathcal{P}(0, k_{ij})\Big)k_{ij}^2\mathcal{P}_m(0, k_{ij}) > \mathcal{C}_m(0, k_{ij}, \Delta\tilde{e}_i') \ ,$$

which is trivially satisfied if $\mathcal{P}_m(0, k_{ij}) > 0$ given our initial assumptions on the variance scaling function as well as the cost function. Differentiating equation (22) and applying the implicit function theorem, we obtain the following comparative statics for optimal monitoring effort.

Lemma 10 (Optimal Monitoring Effort)**.** *The comparative statics are as follows*

$$\frac{dm^*}{d\alpha} = \Omega_\alpha > 0 \ , \quad \frac{dm^*}{d\sigma_{\epsilon_t}^2} = \Omega_{\sigma_\epsilon^2} > 0 \ , \quad \frac{dm^*}{dk_{ij}} = \Omega_k \gtrless 0 \ ,$$

where the auxiliary parameters are given by

$$\begin{aligned}
\Omega_\alpha &= \frac{\sigma_\epsilon^2(1-\mathcal{P})k_{ij}^2\mathcal{P}_m}{\mathcal{C}_{mm} + \alpha\sigma_\epsilon^2 k_{ij}^2\Big(\mathcal{P}_m^2 - (1-\mathcal{P})\mathcal{P}_{mm}\Big)} \ , \\
\Omega_{\sigma_\epsilon^2} &= \frac{\alpha(1-\mathcal{P})k_{ij}^2\mathcal{P}_m}{\mathcal{C}_{mm} + \alpha\sigma_\epsilon^2 k_{ij}^2\Big(\mathcal{P}_m^2 - (1-\mathcal{P})\mathcal{P}_{mm}\Big)} \ , \\
\Omega_k &= \frac{\alpha\sigma_\epsilon^2\left[-\mathcal{P}_m\mathcal{P}_k k_{ij}^2 + 2(1-\mathcal{P})\mathcal{P}_m k_{ij} + (1-\mathcal{P})\mathcal{P}_{mk}k_{ij}^2\right] - \mathcal{C}_{mk} - \mathcal{C}_{m,\Delta\tilde{e}_i'}\frac{\partial\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}{\partial k_{ij}}}{\mathcal{C}_{mm} + \alpha\sigma_\epsilon^2 k_{ij}^2\Big(\mathcal{P}_m^2 - (1-\mathcal{P})\mathcal{P}_{mm}\Big)} \ .
\end{aligned}$$

The optimal managing activity m^* increases both in the coefficient of absolute risk aversion α and in the uncertainty variance σ_ϵ^2. Contrary, the sign of the comparative statics with respect to the first stage investment k_{ij} is arbitrary. This is due to the assumption, that managing costs may be increasing in initial investments.

Next, we solve the risk management problem parametrically. To do so, we first restate the parametric forms specified in the main text:

$$\mathcal{P}(m, k_{ij}) = 1 - m^{-\varphi}k_{ij}^{\eta} \ , \quad \text{and} \quad \mathcal{C}(m, k_{ij}, \Delta\tilde{e}_i') = \frac{1}{\chi}c_i^{\lambda}\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\lambda} m^{\chi}k_{ij}^{\nu} \ ,$$

where $\{\varphi, \eta\}$ denote the elasticities of the *effective* variance scaling factor $1-\mathcal{P}(m, k_{ij})$ with respect to managing activity m, respectively first stage investment k_{ij}. Similarly, $\{\chi, \nu\}$ denote the elasticities of the cost function with respect to m, respectively k_{ij}. Under the previous parametric forms, we can rewrite the first order condition (22) as

$$
\begin{aligned}
& c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\lambda} m^{\chi-1} k_{ij}^{\nu} = \alpha\varphi\sigma_\epsilon^2 m^{-2\varphi-1} k_{ij}^{2(1+\eta)} \, , \\
\Leftrightarrow & m^* = \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{1}{\chi+2\varphi}} c_i^{-\frac{\lambda}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} \, .
\end{aligned} \tag{23}
$$

Resubstitution into the objective function (P2′) results in the following certainty equivalent

$$
\mathbb{CE}\left(m^*, k_{ij}\right) = -\frac{1}{2}\alpha\sigma_\epsilon^2 (m^*)^{-2\varphi} k_{ij}^{2(1+\eta)} - \frac{1}{\chi} c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\lambda} (m^*)^{\chi} k_{ij}^{\nu} \, .
$$

Using the explicit expression from equation (23), we can simplify to

$$
\begin{aligned}
\mathbb{CE}\left(m^*, k_{ij}\right) =& -\frac{1}{2}\alpha\sigma_\epsilon^2 \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{-2\varphi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{-2\varphi[(2(1+\eta)-\nu]+2(\chi+2\varphi)(1+\eta)}{\chi+2\varphi}} \\
& - \frac{1}{\chi} c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\lambda} \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{-\frac{\lambda\chi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda\chi}{\chi+2\varphi}} k_{ij}^{\frac{\chi[2(1+\eta)-\nu]+\nu(\chi+2\varphi)}{\chi+2\varphi}} \\
=& -\frac{1}{2}\left(\alpha\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} \varphi^{\frac{-2\varphi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}} \\
& - \frac{1}{\chi}\left(\alpha\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} \varphi^{\frac{\chi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}} \\
=& -\left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}} \left(\frac{1}{2}\varphi^{-1}+\frac{1}{\chi}\right) \\
=& -\frac{\chi+2\varphi}{2\varphi\chi}\left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}} \, .
\end{aligned}
$$

Under Assumption 4, the previous expression maps into the imposed form of manageable risk from Lemma **??** if

$$
\zeta_i \equiv \frac{\chi+2\varphi}{\chi}\left(\alpha\varphi\right)^{-\frac{2\varphi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}} \, , \quad \text{and} \quad \sigma_\epsilon^2 \equiv \left(\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} \, .
$$

As a result, we obtain

$$
\mathbb{CE}\left(m^*, k_{ij}\right) = -\frac{1}{2}\alpha\zeta_i\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)\sigma_\epsilon^2 k_{ij} \tag{24}
$$

and the manageable risk result of Lemma **??** follows. Notice that the inverse managing ability ζ_i is a functional of risk aversion α, the marginal cost shifter c_i, and the elasticities $\{\chi, \varphi, \lambda\}$ of the cost function and the effective variance scaling factor w.r.t. managing activity. Based on

Assumption 4 we impose the following equality

$$\frac{2\left[(1+\eta)\chi+\nu\varphi\right]}{\chi+2\varphi}=1\Leftrightarrow\chi=\frac{2\varphi(1-\nu)}{1+2\eta}\,,$$
$$\frac{2\lambda\varphi}{\chi+2\varphi}=1\Leftrightarrow\chi=2\varphi(\lambda-1)\,.$$

On behalf of the two previous identities, we obtain in a straightforward manner

$$\chi=\frac{\varphi(\lambda-\nu)}{1+\eta}\,.$$

In order to be consistent with the general assumptions on the variance scaling function as well as the cost function, we need to impose the following parameter space

$$\varphi>\frac{1+2\eta}{2(1-\nu)}=\frac{1}{2(\lambda-1)}=\frac{1+\eta}{\lambda-\nu}\,,\quad 0<\nu<1\,,\eta>0\,,\lambda=1+\frac{\chi}{2\varphi}>1$$

where the inequality is due to the strict convexity of the costs function in managing activity, i.e. $\chi>1$. Substituting in for χ, we can rewrite managing ability as

$$\zeta_i(\varphi,\eta,\nu,\alpha,c_i)=\left(\frac{2(1+\eta)-\nu}{1-\nu}\right)(\alpha\varphi)^{-\frac{1+2\eta}{2(1+\eta)-\nu}}c_i\,,$$

where the previous equality follows from

$$\frac{\chi+2\varphi}{\chi}=\frac{\frac{2\varphi(1-\nu)}{1+2\eta}+2\varphi}{\frac{2\varphi(1-\nu)}{1+2\eta}}=\frac{2\varphi(1-\nu)+2\varphi(1+2\eta)}{2\varphi(1-\nu)}=\frac{2(1+\eta)-\nu}{1-\nu}\,,$$
$$-\frac{2\varphi}{\chi+2\varphi}=-\frac{2\varphi}{\frac{2\varphi(1-\nu)}{1+2\eta}+2\varphi}=-\frac{2\varphi(1+2\eta)}{2\varphi(1-\nu)+2\varphi)(1+2\eta)}=-\frac{1+2\eta}{2(1+\eta)-\nu}\,.$$

□

C.4 Equivalence

Equivalence of Maximization Problems

Proof. To prove the equivalence result, we show the equality of first order conditions for both objectives (P1) and (P1′). We start out with the latter problem. Terminal equity under problem (P1′) is given by

$$\begin{aligned} e_i' &= R_{ii}^l k_{ii} + R_{ij}^l k_{ij} + R^m b_i - R^d d_i \\ &= R_{ii}^l k_{ii} + R_{ij}^l k_{ij} + R^m (d_i + e_i - k_{ii} - k_{ij}) - R^d d_i \\ &= (1 + r^f) e_i + \theta(r_{ii}^l - r^f) k_{ii} + \theta(r_{ij}^l - r^f) k_{ij} + (1 - \omega) r^f d_i \, . \end{aligned}$$

As in Lemma 8, terminal equity is normally distributed with the following mean and variance

$$\begin{aligned} \mu_{e_i'} &= (1 + r^f) e_i + \theta(\mu_i - r^f) k_{ii} + \theta(\mu_j - r^f) k_{ij} + (1 - \omega) r^f d_i \, , \\ \sigma_{e_i'}^2 &= \sigma_i^2 k_{ii}^2 + \left(\sigma_j^2 + \zeta_i (1 - \psi \mathbb{E}\left[\Delta \tilde{e}_i' | \mathcal{I} \right]) \frac{1}{k_{ij}} \sigma_\epsilon^2 \right) k_{ij}^2 + 2 \rho \sigma_i \sigma_j k_{ii} k_{ij} \, . \end{aligned}$$

Additionally, expected bank profitability is given by

$$\mathbb{E}\left[\Delta \tilde{e}_i' | \mathcal{I} \right] = \left[1 - \delta + (1 - \omega) \delta \right] r^f w_i + \theta(\mu_i - r^f) k_{ii} + \theta(\mu_j - r^f) k_{ij} \, .$$

Following the standard routine, the objective function of bankers writes under the CARA-Normal framework as

$$\max_{\{k_{ii}, k_{ij}, b_i\}} \mathbb{E}\left[u(e_i') | \mathcal{I} \right] = -\frac{1}{\alpha} e^{-\alpha(\mu_{e_i'} - \frac{1}{2}\alpha \sigma_{e_i'}^2)} \, . \tag{25}$$

FOC's Problem (P1′). The first order conditions to (25) are given by

$$\begin{aligned} \{k_{ii}\} \quad & -\alpha\theta(\mu_i - r^f) + \frac{1}{2}\alpha^2 \left[2\sigma_i^2 k_{ii} - \zeta_i \psi \theta(\mu_i - r^f) \sigma_\epsilon^2 k_{ij} + 2\rho\sigma_i\sigma_j k_{ij} \right] = 0 \, , \\ \{k_{ij}\} \quad & -\alpha\theta(\mu_j - r^f) + \frac{1}{2}\alpha^2 \left[2\sigma_j^2 k_{ij} - \zeta_i \psi \theta(\mu_j - r^f) \sigma_\epsilon^2 k_{ij} + \zeta_i (1 - \psi \mathbb{E}\left[\Delta \tilde{e}_i' | \mathcal{I} \right]) \sigma_\epsilon^2 + 2\rho\sigma_i\sigma_j k_{ii} \right] = 0 \, . \end{aligned}$$

Rearranging the previous equations results in

$$k_{ii} = \frac{\theta(\mu_i - r^f)}{\alpha \sigma_i^2} - \frac{k_{ij}}{\sigma_i^2} \left[\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f) \sigma_\epsilon^2 \right] \, , \tag{26}$$

$$k_{ij} = \frac{\theta(\mu_j - r^f)}{\alpha \left(\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f) \sigma_\epsilon^2 \right)} - k_{ii} \frac{\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f) \sigma_\epsilon^2}{\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f) \sigma_\epsilon^2} - \frac{\zeta_i}{2} \frac{\sigma_\epsilon^2 \left(1 - \psi(1 - \omega\delta) r^f w_i \right)}{\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f) \sigma_\epsilon^2} \, . \tag{27}$$

FOC's Problem (P1). With respect to problem (P1), let us first restate the distribution of terminal equity derived in Lemma 8. It follows a Normal distribution with mean and variance

$$\mu_{e_i'} = (1-r^f)e_i + \theta(\mu_i - r^f)k_{ii} + \theta(\mu_j - r^f)k_{ij} + (1-\omega)r^f d_i - \frac{1}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda} m^{\chi}k_{ij}^{\nu} ,$$
$$\sigma_{e_i'}^2 = \sigma_i^2 k_{ii}^2 + \sigma_j^2 k_{ij}^2 + \sigma_\epsilon^2 m^{-2\varphi} k_{ij}^{2(1+\eta)} + 2\rho\sigma_i\sigma_j k_{ii}k_{ij} .$$

The first order condition w.r.t. domestic investment k_{ii} is given by

$$-\alpha\theta(\mu_i - r^f) - \alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda-1} m^{\chi}k_{ij}^{\nu} + \frac{1}{2}\alpha^2\left[2\sigma_i^2 k_{ii} + 2\rho\sigma_i\sigma_j k_{ij}\right] = 0 . \quad (28)$$

Correspondingly, the first order condition w.r.t. cross border investment k_{ij} is given by

$$-\alpha\theta(\mu_j - r^f) - \alpha\psi\theta(\mu_j - r^f)\frac{\lambda}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda-1} m^{\chi}k_{ij}^{\nu} + \alpha\frac{\nu}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda} m^{\chi}k_{ij}^{\nu-1}$$
$$+\frac{1}{2}\alpha^2\left[2\sigma_j^2 k_{ij} + 2(1+\eta)\sigma_\epsilon^2 m^{-2\varphi}k_{ij}^{1+2\eta} + 2\rho\sigma_i\sigma_j k_{ii}\right] = 0 . \quad (29)$$

Finally, optimal risk management is characterized by

$$\alpha c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda} m^{\chi-1}k_{ij}^{\nu} - \alpha^2\varphi\sigma_\epsilon^2 m^{-2\varphi-1}k_{ij}^{2(1+\eta)} = 0 . \quad (30)$$

The first order condition with respect to optimal risk management activity m results in the optimal monitoring effort (23)

$$m^* = \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{1}{\chi+2\varphi}} c_i^{-\frac{\lambda}{\chi+2\varphi}}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}}$$

Based on the previous equation we obtain

$$\begin{aligned}
&\alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda-1} m^{\chi}k_{ij}^{\nu} \\
=&\alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}c_i^{\lambda}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda-1}\left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{-\frac{\lambda\chi}{\chi+2\varphi}}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{-\frac{\lambda\chi}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)\chi-\nu\chi+(\chi+2\varphi)\nu}{\chi+2\varphi}} \\
=&\alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}\left(\alpha\varphi\right)^{\frac{\chi}{\chi+2\varphi}}\sigma_\epsilon^2 c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}}\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}-1} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}} \\
=&\alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}\left(\alpha\varphi\right)^{\frac{\chi}{\chi+2\varphi}}\sigma_\epsilon^2 c_i k_{ij} ,
\end{aligned}$$

where the last equality follows from Assumption 4 (a). The previous equation can be rewritten such that

$$\alpha\psi\theta(\mu_i - r^f)\frac{\lambda}{\chi}(\alpha\varphi)^{\frac{\chi}{\chi+2\varphi}}\sigma_\epsilon^2 c_i k_{ij} = \alpha^2\psi\theta(\mu_i - r^f)\frac{\lambda\varphi}{\chi}(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}}\sigma_\epsilon^2 c_i k_{ij}$$
$$= \alpha^2\psi\theta(\mu_i - r^f)\frac{\chi+2\varphi}{2\chi}(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\sigma_\epsilon^2 k_{ij}$$
$$= \frac{1}{2}\alpha^2\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2 k_{ij}\ .$$

As a result, equation (28) writes

$$-\alpha\theta(\mu_i - r^f) + \frac{1}{2}\alpha^2\left[2\sigma_i^2 k_{ii} - \zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2 k_{ij} + 2\rho\sigma_i\sigma_j k_{ij}\right] = 0\ ,$$

and thus corresponds to the first order condition of problem (P1'). In a similar spirit, we obtain

$$\alpha\psi\theta(\mu_j - r^f)\frac{\lambda}{\chi}c_i^\lambda\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\lambda-1} m^\chi k_{ij}^\nu = \frac{1}{2}\alpha^2\zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2 k_{ij}$$

Additionally, we have

$$\alpha\frac{\nu}{\chi}c_i^\lambda\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^\lambda m^\chi k_{ij}^{\nu-1}$$
$$=\alpha\frac{\nu}{\chi}c_i^\lambda\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^\lambda\left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{-\frac{\lambda\chi}{\chi+2\varphi}}\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{-\frac{\lambda\chi}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)\chi - \nu\chi + (\nu-1)(\chi+2\varphi)}{\chi+2\varphi}}$$
$$=\alpha\frac{\nu}{\chi}\left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{\chi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}}\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{\frac{2[(1+\eta)\chi+\varphi\nu]}{\chi+2\varphi}-1}$$
$$=\alpha^2\frac{\nu\varphi}{\chi}(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2$$

Finally, we obtain

$$\alpha^2(1+\eta)\sigma_\epsilon^2 m^{-2\varphi} k_{ij}^{1+2\eta}$$
$$=\alpha^2(1+\eta)\sigma_\epsilon^2\left(\alpha\varphi\sigma_\epsilon^2\right)^{-\frac{2\varphi}{\chi+2\varphi}} c_i^{\frac{2\lambda\varphi}{\chi+2\varphi}}\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)^{\frac{2\lambda\varphi}{\chi+2\varphi}} k_{ij}^{-2\varphi\frac{2(1+\eta)-\nu}{\chi+2\varphi}} k_{ij}^{1+2\eta}$$
$$=\alpha^2(1+\eta)(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2 k_{ij}^{\frac{-4(1+\eta)\varphi + 2\varphi\nu + (1+2\eta)(\chi+2\varphi)}{\chi+2\varphi}}$$
$$=\alpha^2(1+\eta)(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2\ ,$$

where the last equality follows from Assumption 4. Combining the previous two terms, we thus obtain

$$\alpha^2\frac{\nu\varphi + (1+\eta)\chi}{\chi}(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2 = \alpha^2\frac{\chi+2\varphi}{2\chi}(\alpha\varphi)^{-\frac{2\varphi}{\chi+2\varphi}} c_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2$$
$$=\frac{1}{2}\alpha^2\zeta_i\left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2$$

As a result, equation (29) writes as

$$-\alpha\theta(\mu_j - r^f) + \frac{1}{2}\alpha^2 \left[2\sigma_j^2 k_{ij} - \zeta_i \psi\theta(\mu_j - r^f)\sigma_\epsilon^2 k_{ij} + \zeta_i \left(1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2 + 2\rho\sigma_i\sigma_j k_{ii}\right] = 0\ ,$$

which corresponds in turn to the first order condition of problem (P1′). □

C.5 Corollary 1

Proof Corollary ??

Proof. From equation (23) in the proof of Lemma **??**, we know that the optimal risk management activity is given by

$$m^* = \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{1}{\chi+2\varphi}} c_i^{-\frac{\lambda}{\chi+2\varphi}} \left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} \equiv \Phi\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} ,$$

where we have defined the auxiliary parameter $\Phi \equiv \left(\alpha\varphi\sigma_\epsilon^2\right)^{\frac{1}{\chi+2\varphi}} c_i^{-\frac{\lambda}{\chi+2\varphi}} > 0$. Additionally, expected bank profitability before cost management is given by

$$\begin{aligned}\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right] &= r^f e_i + \theta(\mu_i - r^f)k_{ii} + \theta(\mu_j - r^f)k_{ij} + (1-\omega)r^f d_i \\ &= \left[1-\delta+(1-\omega)\delta\right] r^f w_i + \theta(\mu_i - r^f)k_{ii} + \theta(\mu_j - r^f)k_{ij} .\end{aligned}$$

The first order condition of optimal risk management with respect to cross border investment is given by

$$\frac{\partial m^*}{\partial k_{ij}} = \Phi\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} \left(\frac{\lambda}{\chi+2\varphi}\frac{\psi\theta(\mu_j - r^f)}{1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]} + \frac{2(1+\eta)-\nu}{\chi+2\varphi}\frac{1}{k_{ij}}\right)$$

Under part (a) of Assumption 4 we have that $\frac{\lambda}{\chi+2\varphi} > 0$, as well as $\frac{2(1+\eta)-\nu}{\chi+2\varphi} > 0$ due to $\nu \in [0,1)$. Hence, $\frac{\partial m^*}{\partial k_{ij}} > 0$ and the first statement of Corollary **??** follows.

To show the shape of optimal management activities in cross border investment, we proceed by checking the sign of the second derivative. Using the the first order condition from above, we obtain

$$\begin{aligned}\frac{\partial^2 m^*}{\partial k_{ij}^2} =& \Phi\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} \left(\frac{\lambda}{\chi+2\varphi}\frac{\psi\theta(\mu_j - r^f)}{1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]} + \frac{2(1+\eta)-\nu}{\chi+2\varphi}\frac{1}{k_{ij}}\right)^2 \\ &+ \Phi\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^{-\frac{\lambda}{\chi+2\varphi}} k_{ij}^{\frac{2(1+\eta)-\nu}{\chi+2\varphi}} \left(\frac{\lambda}{\chi+2\varphi}\frac{\psi^2\theta^2(\mu_j - r^f)^2}{\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^2} - \frac{2(1+\eta)-\nu}{\chi+2\varphi}\frac{1}{k_{ij}^2}\right)\end{aligned}$$

As $m^* > 0$, to establish concavity the following inequality has to hold

$$-\frac{\lambda}{\chi+2\varphi}\frac{\psi^2\theta^2(\mu_j - r^f)^2}{\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]\right)^2} + \frac{2(1+\eta)-\nu}{\chi+2\varphi}\frac{1}{k_{ij}^2} \geq \left(\frac{\lambda}{\chi+2\varphi}\frac{\psi\theta(\mu_j - r^f)}{1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]} + \frac{2(1+\eta)-\nu}{\chi+2\varphi}\frac{1}{k_{ij}}\right)^2 .$$

The previous equation can be restated in the following form

$$-\Xi_1 x^2 + \Xi_2 y^2 \geq \left(\Xi_1 x + \Xi_2 y\right)^2 ,$$

where we have used the definitions $\Xi_1 \equiv \frac{\lambda}{\chi+2\varphi}, \Xi_2 \equiv \frac{2(1+\eta)-\nu}{\chi+2\varphi}, x \equiv \frac{\psi\theta(\mu_j-r^f)}{1-\psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}$ and $y = \frac{1}{k_{ij}}$. Redefining $r \equiv \frac{y}{x}$, we can state for values $\psi > 0$ that

$$-\Xi_1 + \Xi_2 r^2 \geq (\Xi_1 + \Xi_2 r)^2 \ , \tag{31}$$

which can be rewritten as

$$\Xi_2(1-\Xi_2)r^2 - 2\Xi_1\Xi_2 r - \Xi_1(1+\Xi_1) \geq 0 \ . \tag{32}$$

Due to part (a) of Assumption 4, it is evident that $\Xi_1 > 0$. Subsequently, we also show that the aforementioned assumption implies that $0 < \Xi_2 < 1$. If this condition would not apply, i.e. in the case of $\Xi_2 \leq 0$ or $\Xi_2 \geq 1$, equation (31) would never hold and optimal risk management activity was a strictly convex function in cross border asset investment. To begin with, under part (a) of Assumption 4 $\Xi_2 > 0$ as $\nu \in [0,1)$. To verify the upper limit, suppose that

$$\frac{2(1+\eta)-\nu}{\chi+2\varphi} \geq 1 \Leftrightarrow 2(1+\eta)-\nu \geq \chi + 2\varphi = \frac{2\varphi(1-\nu)}{1+2\eta} + 2\varphi \ ,$$

where the last equality follows from a substitution for χ from part (a) of Assumption 4. Simplifying the right hand side, we finally arrive at

$$2(1+\eta)-\nu \geq 2\varphi\frac{2(1+\eta)-\nu}{1+2\eta} \Leftrightarrow 1 \geq \frac{2\varphi}{1+2\eta} \ .$$

Together with the assumption on the lower bound of φ from the proof of Lemma **??** this implies

$$\frac{1}{1-\nu}\left(\frac{1}{2}+\eta\right) < \varphi < \frac{1}{2}+\eta \ ,$$

which is a contradiction. As a result, we conclude that $\Xi_2 < 1$. Additionally, also recognize that we obtain an upper bound of unity for Ξ_1 as

$$\Xi_1 = \frac{\lambda}{\chi+2\varphi} = \frac{1}{2\varphi} < \frac{1-\nu}{1+2\eta} < 1 \ .$$

The second equality follows directly from part (a) of Assumption 4 by substituting $\lambda = \frac{\chi+2\varphi}{2\varphi}$. The first strict inequality follows by substituting in for φ its lower bound $\underline{\varphi} = \frac{1+2\eta}{2(1-\nu)}$, while the terminal strict inequality follows in turn from $\eta > 0$ and $\nu \in [0,1)$. As a result, part (a) of Assumption 4 imposes that $0 < \Xi_1 < 1$ and $0 < \Xi_2 < 1$.

Having the previous inequality at hands, we can then analyze the properties of the sign of the second derivative in equation (32). Due to $0 < \Xi_2 < 1$, it follows that the left hand side of (32) is a strictly convex function in r with minimum at $r^{min} = \frac{\Xi_1}{1-\Xi_2} > 0$. For all $r < r^{min}$ the left hand side of (32) strictly decreases in r, whereas for all $r > r^{min}$ it strictly increases. The left hand side takes a negative value at r^{min} as

$$\Xi_2(1-\Xi_2)\frac{\Xi_1^2}{(1-\Xi_2)^2} - 2\Xi_1\Xi_2\frac{\Xi_1}{1-\Xi_2} - \Xi_1(1+\Xi_1) = -\frac{\Xi_1^2\Xi_2}{1-\Xi_2} - \Xi_1(1+\Xi_1) < 0 \,.$$

Additionally, the left hand side of (32) is strictly negative at $r = 0$. We conclude that the left hand side is strictly positive for all $r > r_0^+$, where r_0^+ denotes the positive root to the left hand side of (32). It is given by

$$\begin{aligned} r_0^+ &= \frac{1}{2\Xi_2(1-\Xi_2)}\left(2\Xi_1\Xi_2 + \sqrt{4\Xi_1^2\Xi_2^2 + 4\Xi_2(1-\Xi_2)\Xi_1(1+\Xi_1)}\right) \\ &= \frac{\Xi_1}{1-\Xi_2}\left(1 + \sqrt{1 + \frac{(1+\Xi_1)(1-\Xi_2)}{\Xi_1\Xi_2}}\right) > r^{min} \,. \end{aligned}$$

Finally, we conclude that optimal risk management activities are strictly concave for $r > r_0^+$ and strictly convex for $r < r_0^+$, i.e. m^* has a turning point at r_0^+. Resubstitution for r gives

$$r = \frac{1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}{\psi\theta(\mu_j - r^f)k_{ij}} > r_0^+ \,.$$

As the left hand side of the previous equation is strictly decreasing in k_{ij} with limit infinity, we conclude that there exists a $\tilde{k}_{ij}$ below which m^* is strictly concave in k_{ij}, respectively above which it is strictly convex in k_{ij}. Finally, we have to check whether values of k_{ij} above the threshold value $\tilde{k}_{ij}$ are feasible. Due to the positivity of the risk management costs, we obtain an explicit upper limit by

$$1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right] \geq 0 \Leftrightarrow k_{ij}^{max} = \frac{1 - \psi\left[(1-\omega\delta)r^f w_i + \theta(\mu_i - r^f)k_{ii}\right]}{\psi\theta(\mu_j - r^f)} \,.$$

In turn, the threshold value of the turning point is characterized by

$$\frac{1 - \psi\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}{\psi\theta(\mu_j - r^f)\tilde{k}_{ij}} = r_0^+ \Leftrightarrow \tilde{k}_{ij} = \frac{1 - \psi\left[(1-\omega\delta)r^f w_i + \theta(\mu_i - r^f)k_{ii}\right]}{\psi\theta(\mu_j - r^f)(1 + r_0^+)} \,.$$

As $r_0^+ > 0$, we conclude that $\tilde{k}_{ij} < k_{ij}^{max}$ such that optimal risk management activity m^* always has a concave as well as a convex subspace in cross border investment k_{ij}.

Finally, in the case of $\psi = 0$, it is evident that m^* is a strictly increasing and concave function in k_{ij} as $x = 0$ in this case, and additionally $0 < \Xi_2 < 1$ holds. This concludes the proof of Corollary **??**. □

C.6 Corollary 2

Proof Corollary ??

Proof. The inverse bank risk managing ability ζ_i under Assumption 4 (a) is given by

$$\zeta_i = \frac{2(1+\eta)-\nu}{1-\nu}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i \,.$$

Thus, it is straightforward to see that $\frac{\partial\zeta_i}{\partial\alpha} < 0$, $\frac{\partial\zeta_i}{\partial\varphi} < 0$, and $\frac{\partial\zeta_i}{\partial c_i} > 0$ given $\nu \in [0,1)$ and $\eta > 0$. To derive the partial derivative with respect to the elasticities (η,ν), we first restate the initial equation as

$$\zeta_i = \frac{2(1+\eta)-\nu}{1-\nu} e^{-\frac{1+2\eta}{2(1+\eta)-\nu}\ln\alpha} e^{-\frac{1+2\eta}{2(1+\eta)-\nu}\ln\varphi} c_i \,.$$

As a result, we obtain

$$\begin{aligned}\frac{\partial\zeta_i}{\partial\eta} =& \frac{2}{1-\nu}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i + \frac{2(1+\eta)-\nu}{1-\nu}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i\left[-\frac{2\left(2(1+\eta)-\nu\right)-2(1+2\eta)}{(2(1+\eta)-\nu)^2}\ln\alpha\right] \\ &+ \frac{2(1+\eta)-\nu}{1-\nu}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i\left[-\frac{2\left(2(1+\eta)-\nu\right)-2(1+2\eta)}{(2(1+\eta)-\nu)^2}\ln\varphi\right] \,.\end{aligned}$$

The sign of the previous equation is positive if

$$2 - \frac{2(1-\nu)}{2(1+\eta)-\nu}\ln\left(\alpha\varphi\right) \geq 0 \,.$$

The above condition is satisfied if

$$\eta \geq \underline{\eta} \equiv \frac{\nu + (1-\nu)\ln\left(\alpha\varphi\right)}{2} - 1 \,.$$

Similarly, we obtain

$$\frac{\partial\zeta_i}{\partial\nu} = \frac{1+2\eta}{(1-\nu)^2}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i + \frac{2(1+\eta)-\nu}{1-\nu}\left(\alpha\varphi\right)^{-\frac{1+2\eta}{2(1+\eta)-\nu}} c_i\left[\frac{1+2\eta}{(2(1+\eta)-\nu)^2}\ln\left(\alpha\varphi\right)\right] \,.$$

The sign of the previous equation is positive if

$$\frac{1+2\eta}{1-\nu} + \frac{1+2\eta}{2(1+\eta)-\nu}\ln\left(\alpha\varphi\right) \geq 0 \,.$$

The above condition is satisfied if

$$\nu\left(1+\ln\left(\alpha\varphi\right)\right) \leq \ln\left(\alpha\varphi\right) + 2(1+\eta)$$

If $\ln\left(\alpha\varphi\right) \geq -2(1+\eta)$, the previous inequality is always satisfied as $\nu \in [0,1)$. On the contrary, if $\ln(\alpha\varphi) < -2(1+\eta)$, the inequality can be rewritten as

$$\nu \geq \underline{\nu} \equiv \frac{2(1+\eta)+\ln(\alpha\varphi)}{1+\ln(\alpha\varphi)} \,.$$

The right hand side of the previous equation is strictly decreasing in $\ln(\alpha\varphi)$ and takes values on $(0,1)$, such that $\frac{\partial\zeta_i}{\partial\nu} \geq 0$ if $\nu \geq \underline{\nu}$. This completes the proof of Corollary **??**. □

Relation to other Models (Think About).

- costly information acquisition: Grossman Stiglitz, in comparison to GS we allow for a gradual information acquisition, no bayesian updating and learning from eq prices,
- monitoring model
- Think about search interpretation, and reinterpret m^* as searching effort.

C.7 Corollary 3

Proof Corollary ??

Proof. As stated in the main body of the text, expected bank profitability before risk management costs is given by

$$\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right] = [1-\omega\delta]\, r^f w_i + \theta(\mu_i - r^f)k_{ii} + \theta(\mu_j - r^f)k_{ij} \ .$$

Taking the derivative with respect to r^f yields

$$\frac{\partial\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}{\partial r^f} = (1-\omega\delta)w_i - \theta(k_{ii}+k_{ij}) + \theta(\mu_i - r^f)\frac{\partial k_{ii}}{\partial r^f} + \theta(\mu_j - r^f)\frac{\partial k_{ij}}{\partial r^f} \ .$$

Using the initial period budget constraint and the assumption of equality of risk premia across investment opportunities, i.e. $\mu_i = \mu_j = \mu$, we obtain

$$\begin{aligned}\frac{\partial\mathbb{E}\left[\Delta\tilde{e}_i'|\mathcal{I}\right]}{\partial r^f} &= (1-\omega\delta-\theta)w_i + \theta b_i + \theta(\mu - r^f)\left(\frac{\partial k_{ii}}{\partial r^f} + \frac{\partial k_{ij}}{\partial r^f}\right) \\ &= (1-\omega\delta-\theta)w_i + \theta b_i + \frac{\theta(\mu - r^f)}{r^f}\left(\varepsilon_{k_{ii},r^f}k_{ii} + \varepsilon_{k_{ij}}k_{ij}\right) \ ,\end{aligned}$$

where the second equality by using the elasticity identities $\varepsilon_{k_{ii},r^f} \equiv \frac{\partial k_{ii}}{\partial r^f}\frac{r^f}{k_{ii}}$ and $\varepsilon_{k_{ij},r^f} \equiv \frac{\partial k_{ij}}{\partial r^f}\frac{r^f}{k_{ij}}$. The above equation is weakly positive if

$$\frac{b_i}{w_i} \geq \frac{\theta+\omega\delta-1}{\theta} - \frac{\mu - r^f}{r^f}\left(\varepsilon_{k_{ii},r^f}\kappa_{ii} + \varepsilon_{k_{ij}}\kappa_{ij}\right) \ ,$$

where $\kappa_{ii} \equiv \frac{k_{ii}}{w_i}$ and $\kappa_{ij} \equiv \frac{k_{ij}}{w_i}$. This completes the proof of Corollary **??**. □

C.8 Lemma 3

Proof Lemma 9

Proof. First, let us define the set Ω of auxiliary parameters by

$$\Omega \equiv \{\theta, \zeta_i, \mu_i, \mu_j, \sigma_i, \sigma_j, \sigma_\epsilon, \rho, r^m\} \ .$$

The auxiliary function (34) is given by

$$\Phi(\psi, \Omega) = 1 - \frac{1}{\sigma_i^2} \frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2} \ . \tag{33}$$

To start with, three properties of $\Phi(\psi, \Omega)$ are evident:

(i) $\Phi(0, \Omega) = 1 - \rho^2 > 0$.

(ii) $\Phi(\infty, \Omega) = \infty$ and $\Phi(-\infty, \Omega) = -\infty$.

(iii) $\Phi(\psi, \Omega)$ is discontinuous at the point $\psi^{dc} = \frac{\sigma_j^2}{\zeta_i\theta(\mu_j - r^m)\sigma_\epsilon^2}$.

The second property follows from a straightforward application of L'Hôpital's rule, i.e.

$$\lim_{\psi \to \pm\infty} \Phi(\psi, \Omega) = 1 - \lim_{\psi \to \pm\infty} \frac{1}{\sigma_i^2} \frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2\right)\zeta_i\theta(\mu_i - r^m)\sigma_\epsilon^2}{\zeta_i\theta(\mu_j - r^m)\sigma_\epsilon^2} \ .$$

To show part (a) of Lemma 9, one can rewrite equation (33) as

$$\begin{aligned}\Phi(\psi, \Omega) &= 1 - \frac{1}{\sigma_i^2} \frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2} \\ &= 1 - \frac{1}{4}\left(\frac{\mu_i - r^m}{\mu_j - r^m}\right)^2 \frac{1}{\sigma_i^2} \frac{\left(2\rho\sigma_i\sigma_j\frac{\mu_j - r^m}{\mu_i - r^m} - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2} \ .\end{aligned}$$

The terminal ratio cancels if $2\rho\sigma_i\sigma_j\frac{\mu_j - r^m}{\mu_i - r^m} = \sigma_j^2$, which can be rearranged to $2\rho\frac{\mu_j - r^m}{\sigma_j} = \frac{\mu_i - r^m}{\sigma_i}$. If the former condition applies, we can rewrite equation (33) as

$$\Phi(\psi, \Omega) = 1 - \frac{1}{4}\left(\frac{\mu_i - r^m}{\mu_j - r^m}\right)^2 \frac{1}{\sigma_i^2}\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2\right) \ .$$

The previous function is affine in ψ, strictly increasing and weakly positive on Ψ_+ if the condition $2\frac{\sigma_i}{\sigma_j} \geq \frac{\mu_i - r^m}{\mu_j - r^m}$ applies.

To show in turn part (b) of Lemma 9, recognize that equation (33) is nonlinear in ψ in the case of $2\rho\frac{\mu_j - r^m}{\sigma_j} \neq \frac{\mu_i - r^m}{\sigma_i}$. The roots of this functional are consequently characterized by

$$\sigma_i^2\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_i^2\sigma_\epsilon^2 - \left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2\right)^2 = 0$$

$$\Leftrightarrow \underbrace{-\left(\frac{1}{2}\zeta_i\theta(\mu_i - r^m)\sigma_\epsilon^2\right)^2}_{\equiv\mathcal{A}}\psi^2 + \underbrace{\zeta_i\theta\sigma_i\sigma_\epsilon^2\left(\rho\sigma_j(\mu_i - r^m) - \sigma_i(\mu_j - r^m)\right)}_{\equiv\mathcal{B}}\psi + \underbrace{(1-\rho^2)\sigma_i^2\sigma_j^2}_{\equiv\mathcal{C}} = 0\,.$$

The solutions $\psi_{1,2}$ to the previous equation are given by

$$\Gamma\left(\left[\rho\sigma_j(\mu_i - r^m) - \sigma_i(\mu_j - r^m)\right] \pm \sqrt{\left[\rho\sigma_j(\mu_i - r^m) - \sigma_i(\mu_j - r^m)\right]^2 + (\mu_i - r^m)^2(1-\rho^2)\sigma_j^2}\right)$$

where $\Gamma \equiv \frac{2\sigma_i}{\zeta_i\theta\sigma_\epsilon^2(\mu_i - r^m)^2}$ denotes a strictly positive constant. Let us denote by ψ_1 the larger of the two solutions. It is hence evident that ψ_1 strictly positive as long as $\rho \notin \{-1, 1\}$. Notice that equation (33) is strictly larger than unity if $\psi > \psi^{dc}$. As a result, we have $\psi_2 < 0 < \psi_1 < \psi^{dc}$. Denoting $\overline{\psi} \equiv \psi_1$ completes the proof of part (b) of Lemma 9. □

C.9 Proposition 1

Proof Proposition ??

Let us define the auxiliary parameters (Φ, Θ) by

$$\Phi = 1 - \frac{1}{\sigma_i^2}\frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2}\,, \tag{34}$$

$$\Theta = \frac{\sigma_j^2}{\sigma_i^2}\frac{\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^m)\sigma_\epsilon^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2}\,. \tag{35}$$

The interior candidate portfolio allocation of banks located in country i is given for domestic lending by

$$k_{ii} = \Phi^{-1}\Bigg(\underbrace{\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2}}_{\text{① Baseline CARA Effect}} - \underbrace{\Theta\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2}}_{\text{② CARA Diversification Effect}} + \underbrace{\frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\Theta\left[1 - \psi(1-\omega\delta)r^m w_i\right]}_{\text{③ Manageable Risk Amplifier}}\Bigg)\,, \tag{36}$$

and for cross border lending by

$$k_{ij} = \Phi^{-1}\Bigg(\underbrace{\frac{\theta(\mu_j - r^m)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2\right)}}_{\text{④ End. RA CARA}} - \underbrace{\Theta\frac{\sigma_i^2}{\sigma_j^2}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2}}_{\text{⑤ CARA Diversification Effect}} - \underbrace{\frac{1}{2}\zeta_i\sigma_\epsilon^2\frac{1 - \psi(1-\omega\delta)r^f w_i}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^m)\sigma_\epsilon^2}}_{\text{⑥ Manageable Risk Effect}}\Bigg)\,. \tag{37}$$

The proof of Proposition **??** proceeds in three steps. In the first step, we derive the interior critical point $k^* = (k_{ii}^*, k_{ij}^*)$. In the second step, we derive a condition which ensures that k^* is a local maximum. We finally verify that the former condition also implies that k^* is the unique global solution to problem (P1′).

Proof. Part I: Derivation of Critical Point

The first order condition of bankers' portfolio choice problem from Lemma **??** are given by equations (26) and (27):

$$k_{ii} = \frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \frac{k_{ij}}{\sigma_i^2}\left[\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right]\,,$$

$$k_{ij} = \frac{\theta(\mu_j - r^f)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2\right)} - k_{ii}\frac{\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2} - \frac{\zeta_i}{2}\frac{\sigma_\epsilon^2\left(1 - \psi(1-\omega\delta)r^f w_i\right)}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\,.$$

Resubstitution of the second equation into the first one gives

$$k_{ii} = \frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \frac{1}{\sigma_i^2}\left(\rho\sigma_i\sigma_j - \tfrac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)\left(\frac{\theta(\mu_j - r^f)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2\right)} - k_{ii}\frac{\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2} - \frac{\zeta_i}{2}\frac{\sigma_\epsilon^2\left(1 - \psi(1-\omega\delta)r^f w_i\right)}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\right)$$

Before we proceed, we define the following two auxiliary parameters:

$$\Phi \equiv 1 - \frac{1}{\sigma_i^2}\frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\,, \quad \Theta \equiv \frac{\sigma_j^2}{\sigma_i^2}\frac{\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\,.$$

Rearranging the above equation on domestic investment k_{ij} hence delivers

$$\Phi k_{ii} = \frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \Theta\frac{\theta(\mu_j - r^f)}{\alpha\sigma_j^2} + \frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\Theta\left[1 - \psi(1-\omega\delta)r^f w_i\right]\,,$$

which is equivalent to writing

$$k_{ii}^* = \Phi^{-1}\left(\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \Theta\frac{\theta(\mu_j - r^f)}{\alpha\sigma_j^2} + \frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\Theta\left[1 - \psi(1-\omega\delta)r^f w_i\right]\right)\,. \tag{38}$$

To derive the cross border investment level k_{ij}, we resubstitute equation (38) into the corresponding first order condition to obtain

$$\begin{aligned}
k_{ij} =& \frac{\theta(\mu_j - r^f)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2\right)} - \frac{\zeta_i}{2}\frac{\sigma_\epsilon^2\left(1 - \psi(1-\omega\delta)r^f w_i\right)}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2} - \frac{\sigma_i^2}{\sigma_j^2}\Theta k_{ii} \\
=& \frac{\theta(\mu_j - r^f)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2\right)} - \frac{\zeta_i}{2}\frac{\sigma_\epsilon^2\left(1 - \psi(1-\omega\delta)r^f w_i\right)}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2} \\
& - \frac{\sigma_i^2}{\sigma_j^2}\Theta\Phi^{-1}\left(\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \Theta\frac{\theta(\mu_j - r^f)}{\alpha\sigma_j^2} + \frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\Theta\left[1 - \psi(1-\omega\delta)r^f w_i\right]\right)\,.
\end{aligned}$$

The previous equation simplifies to

$$\begin{aligned}
k_{ij} =& \frac{\theta(\mu_j - r^f)}{\alpha\left(\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2\right)}\left(1 + \Phi^{-1}\frac{\sigma_i^2}{\sigma_j^4}\frac{\sigma_j^4}{\sigma_i^4}\frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\right) \\
& - \frac{1}{2}\zeta_i\sigma_\epsilon^2\frac{\left[1 - \psi(1-\omega\delta)r^f w_i\right]}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\left(1 + \Phi^{-1}\frac{\sigma_i^2}{\sigma_j^4}\frac{\sigma_j^4}{\sigma_i^4}\frac{\left(\rho\sigma_i\sigma_j - \frac{1}{2}\zeta_i\psi\theta(\mu_i - r^f)\sigma_\epsilon^2\right)^2}{\sigma_j^2 - \zeta_i\psi\theta(\mu_j - r^f)\sigma_\epsilon^2}\right) \\
& - \Phi^{-1}\Theta\frac{\sigma_i^2}{\sigma_j^2}\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2}\,.
\end{aligned}$$

Further simplifications yield

$$1+\Phi^{-1}\frac{\sigma_i^2}{\sigma_j^4}\frac{\sigma_j^4}{\sigma_i^4}\frac{\left(\rho\sigma_i\sigma_j-\frac{1}{2}\zeta_i\psi\theta(\mu_i-r^f)\sigma_\epsilon^2\right)^2}{\sigma_j^2-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2}=\Phi^{-1}\left(\Phi+\frac{1}{\sigma_i^2}\frac{\left(\rho\sigma_i\sigma_j-\frac{1}{2}\zeta_i\psi\theta(\mu_i-r^f)\sigma_\epsilon^2\right)^2}{\sigma_j^2-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2}\right)=\Phi^{-1}\,.$$

As a result, we obtain

$$k_{ij}^*=\Phi^{-1}\left(\frac{\theta(\mu_j-r^f)}{\alpha\left(\sigma_j^2-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2\right)}-\Theta\frac{\sigma_i^2}{\sigma_j^2}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\sigma_\epsilon^2\frac{1-\psi(1-\omega\delta)r^f w_i}{\sigma_j^2-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2}\right)\,, \quad (39)$$

which completes the first part of proof of Proposition **??**.

Part II: Critical Point as Global Maximum

The objective function of bankers is defined as

$$\mathcal{U}(k_{ii},k_{ij})\equiv\mathbb{E}\left[u(e_i')|\mathcal{I}\right]=-\frac{1}{\alpha}e^{-\alpha(\mu_{e_i'}-\frac{1}{2}\alpha\sigma^2_{e_i'})}\,. \quad (40)$$

k^* is a *strict local maximum* of $\mathcal{U}$ if the Hessian $\mathcal{H}\equiv D^2\mathcal{U}(k)$ is a negative definite symmetric matrix at $k=k^*$. This condition applies if and only if the two leading principal minors of $\mathcal{H}$ alternate in sign as follows: $|\mathcal{H}_1|<0$ and $|\mathcal{H}_2|>0$. The symmetric Hessian to (40) is denoted by

$$\mathcal{H}\equiv\begin{pmatrix}\mathcal{U}_{11} & \mathcal{U}_{12}\\ \mathcal{U}_{21} & \mathcal{U}_{22}\end{pmatrix}\,.$$

Moreover, let us define the following auxiliary parameters

$$\Omega_{k_{ii}}=-\alpha\theta(\mu_i-r^f)+\frac{1}{2}\alpha^2\left[2\sigma_i^2k_{ii}-\zeta_i\psi\theta(\mu_i-r^f)\sigma_\epsilon^2k_{ij}+2\rho\sigma_i\sigma_jk_{ij}\right]\,,$$
$$\Omega_{k_{ij}}=-\alpha\theta(\mu_j-r^f)+\frac{1}{2}\alpha^2\left[2\sigma_j^2k_{ij}-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2k_{ij}+\zeta_i\left(1-\psi\mathbb{E}\left[\Delta\tilde{e}_i{}'|\mathcal{I}\right]\right)\sigma_\epsilon^2+2\rho\sigma_i\sigma_jk_{ii}\right]\,.$$

The elements of the Hessian are then given by

$$\mathcal{U}_{11}=-\frac{1}{\alpha}e^{-\alpha(\mu_{e_i'}-\frac{1}{2}\alpha\sigma^2_{e_i'})}\left[\Omega_{k_{ii}}^2+\alpha^2\sigma_i^2\right]\,,$$
$$\mathcal{U}_{22}=-\frac{1}{\alpha}e^{-\alpha(\mu_{e_i'}-\frac{1}{2}\alpha\sigma^2_{e_i'})}\left[\Omega_{k_{ij}}^2+\alpha^2\left(\sigma_j^2-\zeta_i\psi\theta(\mu_j-r^f)\sigma_\epsilon^2\right)\right]\,,$$
$$\mathcal{U}_{12}=-\frac{1}{\alpha}e^{-\alpha(\mu_{e_i'}-\frac{1}{2}\alpha\sigma^2_{e_i'})}\left[\Omega_{k_{ii}}\Omega_{k_{ij}}+\alpha^2\left(\rho\sigma_i\sigma_j-\frac{1}{2}\zeta_i\psi\theta(\mu_i-r^f)\sigma_\epsilon^2\right)\right]\,.$$

It is obvious that $|\mathcal{H}_1|<0$ and $|\mathcal{H}_2|>0$ are satisfied if $\mathcal{U}_{11}<0$, $\mathcal{U}_{22}<0$ and $\mathcal{U}_{11}\mathcal{U}_{22}-\mathcal{U}_{12}^2>0$. The first condition obviously holds without further restrictions. The second condition is satisfied if $\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2 > 0$. The third condition holds if

$$\sigma_i^2 \left(\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2 \right) > \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right)^2 ,$$

which is equivalent to imposing $\Phi > 0$. Notice that in case the above inequality held with equality, the solution k^* would no longer be interior and finite, but rather located at the boundary.

To establish that k^* is a *global maximum*, we need to verify that $\mathcal{U}$ is a concave function on its entire convex domain $\mathbb{K}$, which is an open subset of $\mathbb{R}^2$. This is indeed the case if the Hessian $\mathcal{H}$ is negative semidefinite for all $k \in \mathbb{K}$. Notice that a local maximum requires a negative definite Hessian at a single interior point, whereas a global maximum requires that $\mathcal{H}$ is negative semidefinite not just at k^*, but for all $k \in \mathbb{K}$. The Hessian is negative semidefinite if every principal minor of odd order is weakly negative, and every principal minor of even order is weakly positive.

The two first order principal minors $\mathcal{U}_{11}$ and $\mathcal{U}_{22}$ are weakly negative by the above conditions. The second order principal component is weakly positive if

$$\left[\Omega_{k_{ii}}^2 + \alpha^2 \sigma_i^2 \right] \left[\Omega_{k_{ij}}^2 + \alpha^2 \left(\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2 \right) \right] \geq \left[\Omega_{k_{ii}} \Omega_{k_{ij}} + \alpha^2 \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right) \right]^2 ,$$

which can be rewritten as

$$\begin{aligned} &\alpha^2 \left(\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2 \right) \Omega_{k_{ii}}^2 + \alpha^2 \sigma_i^2 \Omega_{k_{ij}}^2 + \alpha^4 \sigma_i^2 \left(\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2 \right) \geq \\ &2\alpha^2 \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right) \Omega_{k_{ii}} \Omega_{k_{ij}} + \alpha^4 \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right)^2 . \end{aligned}$$

The left hand side of the above inequality is strictly increasing in $\sigma_j^2 - \zeta_i \psi \theta(\mu_j - r^f)\sigma_\epsilon^2$. Substituting in its lower bound from the condition $\Phi > 0$ gives

$$\alpha^2 \frac{1}{\sigma_i^2} \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right)^2 \Omega_{k_{ii}}^2 + \alpha^2 \sigma_i^2 \Omega_{k_{ij}}^2 - 2\alpha^2 \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right) \Omega_{k_{ii}} \Omega_{k_{ij}} \geq 0 ,$$

which can be rewritten as

$$\alpha^2 \left[\frac{1}{\sigma_i} \left(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta(\mu_i - r^f)\sigma_\epsilon^2 \right) \Omega_{k_{ii}} - \sigma_i \Omega_{k_{ij}} \right]^2 \geq 0 .$$

Due to the quadratic form, the above inequality is obviously satisfied for all $k \in \mathbb{K}$, such that k^* characterizes indeed an interior global maximum. This concludes the proof of Proposition **??**. □

C.10 Bank Home Bias Index

Construction of Theoretical Bank Home Bias Measure.

Our tractable setup already provides a rich enough structure which allows to define and investigate the determinants of bank home bias fluctuations.

(a) Suppose that risk free asset holdings are neutral, i.e. it is counted neither as an investment to country i or j. The home bias measure is then given by

$$\mathcal{HB}_i = 1 - \frac{\frac{k_{ij}}{w_i}}{\frac{k_{ij}+k_{jj}}{w_i+w_j}} = 1 - \frac{1+\frac{w_j}{w_i}}{1+\frac{k_{jj}}{k_{ij}}} \, .$$

(b) Suppose that risk free asset holdings are domestic investment from the perspective of both countries. The home bias measure is then given by

$$\mathcal{HB}_i^{*} = 1 - \frac{\frac{k_{ij}}{w_i}}{\frac{k_{ij}+k_{jj}+b_j}{w_i+w_j}} = 1 - \frac{1+\frac{w_j}{w_i}}{1+\frac{k_{jj}+b_j}{k_{ij}}} \, .$$

(c) Suppose that risk free asset holdings are domestic assets from the perspective of country i and foreign to j. The home bias measures are then given by

$$\mathcal{HB}_i^{**} = 1 - \frac{\frac{k_{ij}}{w_i}}{\frac{k_{ij}+k_{jj}}{w_i+w_j}} = 1 - \frac{1+\frac{w_j}{w_i}}{1+\frac{k_{jj}}{k_{ij}}} \, ,$$

$$\mathcal{HB}_j^{**} = 1 - \frac{\frac{k_{ji}+b_j}{w_j}}{\frac{k_{ii}+k_{ji}+b_j+b_i}{w_j+w_i}} = 1 - \frac{1+\frac{w_i}{w_j}}{1+\frac{k_{ii}+b_i}{k_{ji}+b_j}} \, .$$

(d) Finally, suppose the unrealistic scenario that risk free asset holdings are foreign assets from the perspective of both countries. The home bias measure is then given by

$$\mathcal{HB}_i^{***} = 1 - \frac{\frac{k_{ij}+b_i}{w_i}}{\frac{k_{jj}+k_{ij}+b_i+b_j}{w_i+w_j}} = 1 - \frac{1+\frac{w_j}{w_i}}{1+\frac{k_{jj}+b_j}{k_{ij}+b_i}} \, .$$

An alternative definition of home bias, $\mathcal{HB}_i^a$, is based on the excess domestic share. Given that the baseline measure is defined as

$$\mathcal{HB}_i = 1 - \text{foreign share}/\text{world foreign share} \, ,$$

we may define

$$\mathcal{HB}_i^a = \text{domestic share}/\text{world domestic share} - 1 \,.$$

If risk free asset holdings are classified as domestic assets from the perspective of each country as in Case (b), or classified as domestic assets to only one country as in Case (c), the relationship between both home bias measures is given by

$$\mathcal{HB}_i^a = \frac{\text{Total investment into country j}}{\text{Total investment into country i}} \times \mathcal{HB}_i \,.$$

This relationship holds approximately for Case (a) and Case (d), as long as the risk-free investment is relatively low.

C.11 Lemma 4

Proof Lemma ??

The proof of Lemma **??** proceeds in two steps. In the first step, we derive a sufficient upper bound on the correlation ρ such that cross border investment is weakly positive. In a second step, we derive upper bounds on risk management cost reduction ψ such that statements (a) and (b) follow.

Proof. PART I: SUFFICIENT CONDITION FOR POSITIVITY OF CROSS BORDER INVESTMENT

Under Assumption **??** on the symmetry of model parameters across countries, cross border investment is given by

$$k_{ij} = k_{ji} = \Phi^{-1}\left(\frac{\theta(\mu - r^m)}{\alpha\left(\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2\right)} - \Theta\frac{\theta(\mu - r^m)}{\alpha\sigma^2} - \frac{1}{2}\zeta\sigma_\epsilon^2\frac{1 - \psi(1 - \omega\delta)r^f w}{\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2}\right),$$

where the auxiliary parameters are now given by

$$\Phi = 1 - \frac{1}{\sigma^2}\frac{(\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2)^2}{\sigma^2 - \zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2},$$
$$\Theta = \frac{\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2}{\sigma^2 - \zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2}.$$

For $\psi < \overline{\psi}^{GM,s} < \psi^{dc,s}$, we know that $\Phi > 0$. As a result, cross border investments are weakly positive if the following inequality holds:

$$\frac{\theta(\mu - r^m)}{\alpha} - \frac{\theta(\mu - r^m)}{\alpha\sigma^2}\left(\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2\right) - \frac{1}{2}\zeta\sigma_\epsilon^2\left[1 - \psi(1 - \omega\delta)r^f w\right] \geq 0\,.$$

The left hand side of the previous equation is increasing in ψ, as $\mu - r^f \geq 0$ and $\omega\delta \leq 1$. As a result, a sufficient condition for cross border investment to be positive is given by

$$\frac{\theta(\mu - r^m)}{\alpha}(1 - \rho) - \frac{1}{2}\zeta\sigma_\epsilon^2 \geq 0 \Leftrightarrow \rho \leq \overline{\rho} \equiv 1 - \frac{1}{2}\frac{\alpha\zeta\sigma_\epsilon^2}{\theta(\mu - r^f)}\,. \tag{41}$$

PART II: UPPER BOUND RISK MANAGEMENT COST SENSITIVITY

To begin with, statement (b) is satisfied if the following upper bound applies

$$\psi^{(b),s} \leq \frac{1}{(1 - \omega\delta)r^f w}\,. \tag{42}$$

This upper limit ensures that cross border information frictions are always detrimental for bankers such that they cannot exploit the friction in order to better off. If $\psi = 0$ statement (b) is obviously satisfied. Contrary, if $\psi > 0$ it requires that $\omega\delta$ is either above a certain level, or ψ

below the threshold (42).

To verify statement (a), for $\psi < \overline{\psi}^{GM,s} < \psi^{dc,s}$ and thus $\Phi > 0$, domestic investment of bankers exceeds cross border investment, i.e. $k_{ii} = k_{jj} \geq k_{ij} = k_{ji}$ if the following inequality holds

$$\frac{\theta(\mu - r^m)}{\alpha\sigma^2} + \frac{1}{2}\frac{\zeta\sigma_\epsilon^2}{\sigma^2}\Theta\left[1 - \psi(1-\omega\delta)r^m w\right] \geq \frac{\theta(\mu - r^m)}{\alpha\left(\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2\right)} - \frac{1}{2}\zeta\sigma_\epsilon^2\frac{1-\psi(1-\omega\delta)r^f w}{\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2} ,$$

which can be easily rewritten as

$$-\frac{\theta(\mu - r^m)}{\alpha\sigma^2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2 + \frac{1}{2}\zeta\sigma_\epsilon^2\left[1 - \psi(1-\omega\delta)r^m w\right]\left(\frac{\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2}{\sigma^2} + 1\right) \geq 0 ,$$

Canceling terms results in

$$-\frac{\theta^2(\mu - r^m)^2}{\alpha}\psi + \frac{1}{2}\left[1 - \psi(1-\omega\delta)r^m w\right]\left((1+\rho)\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2\right) \geq 0 .$$

The previous inequality obviously holds if $\psi = 0$ or $\mu = r^f$ as $\rho \in (-1, 1)$ and $\sigma^2 > 0$. The left hand side is a quadratic polynomial in ψ, i.e. $\mathcal{A}\psi^2 + \mathcal{B}\psi + \mathcal{C}$ with corresponding coefficients

$$\begin{aligned}
\mathcal{A} &= \frac{1}{4}\zeta\theta(\mu - r^f)\sigma_\epsilon^2(1-\omega\delta)r^m w , \\
\mathcal{B} &= -\frac{\theta^2(\mu - r^m)^2}{\alpha} - \frac{1}{4}\zeta\theta(\mu - r^f)\sigma_\epsilon^2 - \frac{1}{2}(1-\omega\delta)r^m w(1+\rho)\sigma^2 , \\
\mathcal{C} &= \frac{1}{2}(1+\rho)\sigma^2 .
\end{aligned}$$

As a result, the left hand side is a strictly convex parabola in ψ. As it takes the strictly positive value $\frac{1}{2}(1+\rho)\sigma^2$ at $\psi = 0$, its two possible roots necessarily lie in $\mathbb{R}_+$. They are given by

$$\psi_{1,2}^{(a)} = \frac{\mathcal{B} \pm \sqrt{\mathcal{B}^2 - 4\mathcal{A}\mathcal{C}}}{2\mathcal{A}} .$$

The corresponding discriminant $\mathcal{D} = \mathcal{B}^2 - 4\mathcal{A}\mathcal{C}$ is given in turn by

$$\begin{aligned}
\mathcal{D} =& \frac{\theta^4(\mu - r^m)^4}{\alpha^2} + \frac{1}{16}\zeta^2\theta^2(\mu - r^f)^2(\sigma_\epsilon^2)^2 + \frac{1}{4}(1-\omega\delta)^2(r^m)^2 w^2(1+\rho)^2(\sigma^2)^2 \\
&+ \frac{1}{2}\zeta\sigma_\epsilon^2\frac{\theta^3(\mu - r^m)^3}{\alpha} + \frac{\theta^2(\mu - r^m)^2}{\alpha}(1-\omega\delta)r^m w(1+\rho)\sigma^2 \\
&+ \frac{1}{4}\zeta\theta(\mu - r^f)\sigma_\epsilon^2(1-\omega\delta)r^m w(1+\rho)\sigma^2 - \frac{1}{2}\zeta\theta(\mu - r^f)\sigma_\epsilon^2(1-\omega\delta)r^m w(1+\rho)\sigma^2
\end{aligned}$$

The right hand side of the previous expression can be simplified to

$$\frac{\theta^4(\mu-r^m)^4}{\alpha^2}+\frac{1}{16}\zeta^2\theta^2(\mu-r^f)^2(\sigma_\epsilon^2)^2+\frac{1}{4}(1-\omega\delta)^2(r^m)^2w^2(1+\rho)^2(\sigma^2)^2$$
$$+\frac{1}{2}\zeta\sigma_\epsilon^2\frac{\theta^3(\mu-r^m)^3}{\alpha}+\frac{\theta^2(\mu-r^m)^2}{\alpha}(1-\omega\delta)r^m w(1+\rho)\sigma^2-\frac{1}{4}\zeta\theta(\mu-r^f)\sigma_\epsilon^2(1-\omega\delta)r^m w(1+\rho)\sigma^2 \,,$$

which finally results in

$$\begin{aligned}\mathcal{D}=&\frac{\theta^4(\mu-r^m)^4}{\alpha^2}+\frac{1}{2}\zeta\sigma_\epsilon^2\frac{\theta^3(\mu-r^m)^3}{\alpha}+\frac{\theta^2(\mu-r^m)^2}{\alpha}(1-\omega\delta)r^m w(1+\rho)\sigma^2\\&+\left(\frac{1}{4}\zeta\theta(\mu-r^f)\sigma_\epsilon^2-\frac{1}{2}(1-\omega\delta)r^f w(1+\rho)\sigma^2\right)^2\geq 0\,,\end{aligned}$$

where the positivity follows from the quadratic expression. Let us denote the smaller root by $\psi_1^{(a),s}$ and the larger one respectively by $\psi_2^{(a),s}$. Due to the positivity of the discriminant as well as the positivity of $\mathcal{A}$ it is evident that $\psi_2^{(a),s}\geq\frac{\mathcal{B}}{2\mathcal{A}}$. The latter term is pinned down by

$$\begin{aligned}\frac{\mathcal{B}}{2\mathcal{A}}&=\frac{\frac{\theta^2(\mu-r^m)^2}{\alpha}+\frac{1}{4}\zeta\theta(\mu-r^f)\sigma_\epsilon^2+\frac{1}{2}(1-\omega\delta)r^m w(1+\rho)\sigma^2}{\frac{1}{2}\zeta\theta(\mu-r^f)\sigma_\epsilon^2(1-\omega\delta)r^m w}\\&=\frac{1}{2}\frac{1}{(1-\omega\delta)r^m w}+2\frac{\theta(\mu-r^f)}{\alpha\zeta\sigma_\epsilon^2(1-\omega\delta)r^m w}+\frac{(1+\rho)\sigma^2}{\zeta\theta(\mu-r^f)\sigma_\epsilon^2}\\&=\frac{1}{(1-\omega\delta)r^m w}\left[\frac{1}{2}+2\frac{\theta(\mu-r^f)}{\alpha\zeta\sigma_\epsilon^2}\right]+\frac{(1+\rho)\sigma^2}{\zeta\theta(\mu-r^f)\sigma_\epsilon^2}\\&\geq\frac{1}{(1-\omega\delta)r^m w}\left[\frac{1}{2}+\frac{1}{1-\rho}\right]+\frac{(1+\rho)\sigma^2}{\zeta\theta(\mu-r^f)\sigma_\epsilon^2}\geq\frac{1}{(1-\omega\delta)r^m w}\,,\end{aligned}$$

where the first inequality arises due to the correlation upper bound $\overline{\rho}$, which implies that $2\theta(\mu-r^f)\geq\frac{\alpha\zeta\sigma_\epsilon^2}{1-\rho}$. The second inequality in turn arises from $\rho>-1$. As a result, this implies that

$$\psi_2^{(a),s}\geq\frac{1}{(1-\omega\delta)r^m w}\,,$$

which violates condition (42) derived above to satisfy statement (b). As a result, we only keep $\psi_1^{(a),s}$ as possible upper bound.

The upper bound for a global maximum, i.e. $\overline{\psi}^{GM,s}$, is given under Assumption **??** by

$$\begin{aligned}\overline{\psi}^{GM,s}&=\frac{2\sigma}{\zeta\theta(\mu-r^f)^2\sigma_\epsilon^2}\left(\sigma(\mu-r^f)(\rho-1)+\sqrt{\sigma^2(\mu-r^f)^2(\rho-1)^2+\sigma^2(\mu-r^f)^2(1-\rho^2)}\right)\\&=\frac{2\sigma}{\zeta\theta(\mu-r^f)^2\sigma_\epsilon^2}\left(\sigma(\mu-r^f)(\rho-1)+\sigma(\mu-r^f)\sqrt{2(1-\rho)}\right)\\&=\frac{2\sigma^2}{\zeta\theta(\mu-r^f)\sigma_\epsilon^2}\left(\sqrt{2(1-\rho)}-(1-\rho)\right)\,.\end{aligned}$$

It is straightforward to see that $\overline{\psi}^{GM,s}$ is strictly positive as $\sqrt{(1-\rho)}\left(\sqrt{2}-\sqrt{1-\rho}\right)$ is strictly positive due to $\rho > -1$. As a result, Lemma **??** follows by the upper bound (42) and defining

$$\overline{\psi} \equiv \min\{\overline{\psi}^{GM,s}, \overline{\psi}_1^{(a),s}, \overline{\psi}^{(b),s}\} \ . \tag{43}$$

Notice that in the particular case of $\rho = \frac{1}{2}$, the conditions of statement (a) of Lemma 9 are satisfied such that $\Phi(\psi)$ is an affine function in $\mathbb{R}_+$ such that $\overline{\psi}^{GM,s}$ is not a restriction and $\overline{\psi} \equiv \min\{\overline{\psi}_1^{(a),s}, \overline{\psi}^{(b),s}\}$ applies. □

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Proof Proposition ??

Proof. Under Assumptions **??** and **??**, the model-based home bias measure is given by

$$\mathcal{HB}_i = 1 - \frac{2}{1 + \frac{k_{ii}}{k_{ij}}} \ .$$

Its comparative statics in response to a change in monetary policy are thus captured by the ratio $\frac{k_{ii}}{k_{ij}}$. Based on Proposition **??** it can be written as

$$\frac{k_{ii}}{k_{ij}} = \frac{k_{jj}}{k_{ji}} = \frac{\frac{\theta(\mu - r^m)}{\alpha\sigma^2} - \Theta\frac{\theta(\mu-r^m)}{\alpha\sigma^2} + \frac{1}{2}\frac{\zeta\sigma_\epsilon^2}{\sigma^2}\Theta\left[1 - \psi(1-\omega\delta)r^m w\right]}{\frac{\theta(\mu-r^m)}{\alpha(\sigma^2 - \zeta\psi\theta(\mu-r^m)\sigma_\epsilon^2)} - \Theta\frac{\theta(\mu-r^m)}{\alpha\sigma^2} - \frac{1}{2}\zeta\sigma_\epsilon^2\frac{1-\psi(1-\omega\delta)r^f w}{\sigma^2 - \zeta\psi\theta(\mu-r^m)\sigma_\epsilon^2}} \ .$$

Let us define auxiliary functions $(\mathcal{G}, \mathcal{F})$ as positively scaled functions of (k_{ii}, k_{ij}), i.e. such that $\frac{k_{ii}}{k_{ij}} = \frac{\mathcal{G}}{\mathcal{F}}$ applies, by

$$\mathcal{G} \equiv \sigma^2\left(\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2\right)k_{ii}$$
$$\mathcal{F} \equiv \sigma^2\left(\sigma^2 - \zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2\right)k_{ij}$$

where it holds that

$$\mathcal{G} = \frac{\theta(\mu - r^m)}{\alpha}\left((1-\rho)\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^m)\sigma_\epsilon^2\right) + \frac{1}{2}\zeta\sigma_\epsilon^2\left(\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2\right)\left[1 - \psi(1-\omega\delta)r^f w\right] \ ,$$
$$\mathcal{F} = \frac{\theta(\mu - r^m)}{\alpha}\left((1-\rho)\sigma^2 + \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2\right) - \frac{1}{2}\zeta\sigma_\epsilon^2\sigma^2\left[1 - \psi(1-\omega\delta)r^f w\right] \ .$$

Based on the auxiliary functions, it is straightforward to derive

$$\begin{aligned}\frac{\partial\mathcal{F}}{\partial r^f} &= -\frac{\theta}{\alpha}(1-\rho)\sigma^2 - \frac{\theta}{\alpha}\frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2 - \frac{1}{2}\zeta\psi\theta\sigma_\epsilon^2\frac{\theta(\mu - r^m)}{\alpha} + \frac{1}{2}\zeta\sigma_\epsilon^2\sigma^2\psi(1-\omega\delta)w \\ &= -\frac{\theta}{\alpha}(1-\rho)\sigma^2 - \zeta\psi\theta\sigma_\epsilon^2\frac{\theta(\mu - r^m)}{\alpha} + \frac{1}{2}\zeta\sigma_\epsilon^2\sigma^2\psi(1-\omega\delta)w \ .\end{aligned}$$

In a similar vein, we obtain

$$\begin{aligned}\frac{\partial\mathcal{G}}{\partial r^f} =& -\frac{\theta}{\alpha}(1-\rho)\sigma^2 + \zeta\psi\sigma_\epsilon^2\frac{\theta^2(\mu - r^m)}{\alpha} + \frac{1}{4}\zeta^2(\sigma_\epsilon^2)^2\psi\theta\left[1 - \psi(1-\omega\delta)r^f w\right] \\ & - \frac{1}{2}\zeta\sigma_\epsilon^2\left(\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - r^f)\sigma_\epsilon^2\right)\psi(1-\omega\delta)w \\ =& -\frac{\theta}{\alpha}(1-\rho)\sigma^2 + \zeta\psi\sigma_\epsilon^2\frac{\theta^2(\mu - r^m)}{\alpha} + \frac{1}{4}\zeta^2\psi\theta(\sigma_\epsilon^2)^2 - \frac{1}{2}\zeta\sigma_\epsilon^2\psi(1-\omega\delta)w\left(\rho\sigma^2 - \frac{1}{2}\zeta\psi\theta(\mu - 2r^f)\sigma_\epsilon^2\right) \ .\end{aligned}$$

It is straightforward to see that home bias increases in response to a monetary policy tightening if $\frac{\mathcal{G}}{\mathcal{F}}$ increases in r^f, i.e. if the following inequality holds

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \geq 0 \,.$$

Part I: Proof Statement (a)

To show statement (a) of Proposition **??**, notice that under $\omega = \delta^{-1}$, it follows that

$$\frac{\partial \mathcal{F}}{\partial r^f} < 0 \,, \quad \text{and} \quad \frac{\partial \mathcal{F}}{\partial r^f} < \frac{\partial \mathcal{G}}{\partial r^f} \,.$$

Under Lemma **??**, we also have $\mathcal{G} \geq \mathcal{F} \geq 0$. As a result, we obtain

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \geq \frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{F} = \left(\frac{\partial \mathcal{G}}{\partial r^f} - \frac{\partial \mathcal{F}}{\partial r^f}\right)\mathcal{F} \geq 0 \,,$$

which concludes the proof of the first statement.

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Part II: Proof Statement (b)

$\mathcal{A}$. *Idea of Proof.* The proof of statement (b) proceeds as follows. Whether bank home bias increases or decreases in response to a monetary policy tightening depends on the sign of the following equation

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \,. \tag{44}$$

If the sign is positive, a monetary policy tightening increases home bias as in statement (a). If the sign is however negative, a monetary policy tightening decreases home bias respectively. From the initial derivations, we know the analytical counterparts to $\frac{\partial \mathcal{G}}{\partial r^f}$ and $\frac{\partial \mathcal{F}}{\partial r^f}$. Both derivatives are linear and continuously differentiable functions in *adjusted loanable wealth* $\tilde{w} \equiv (1 - \omega\delta)w$.

In the case of $0 \leq \omega < \delta^{-1}$, one can verify that $\frac{\partial \mathcal{F}}{\partial r^f}$ is strictly increasing in $\tilde{w}$, whereas the sign of $\frac{\partial \mathcal{G}}{\partial r^f}$ in $\tilde{w}$ is *a priori* ambiguous. Imposing Lemma **??**, we also know that $\mathcal{G} \geq \mathcal{F}$ on the entire support of $\tilde{w}$. In the left limit $\tilde{w} = 0$, it thus follows by an equivalent argument as in the proof os statement (a) that $\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \geq 0$. If additionally $\frac{\partial^2 \mathcal{F}}{\partial r^f \partial \tilde{w}} > \frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}}$ holds, it is possible to show that there exists a unique $\tilde{w}^*$ such that we obtain $\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \geq 0$ for all $\tilde{w} \leq \tilde{w}^*$, respectively $\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} < 0$ for all $\tilde{w} > \tilde{w}^*$.

$\mathcal{B}$. *Characterization of parameter bounds for* (ψ, ρ).

Case 1: $\frac{\partial^2 \mathcal{F}}{\partial r^f \partial \tilde{w}} \geq \frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}}$**.** Case 1 applies if the following inequality holds

$$\rho - \frac{1}{2}\zeta\psi\theta(\mu - 2r^f)\frac{\sigma_\epsilon^2}{\sigma^2} > -1 \, . \tag{45}$$

It is straightforward to see that this condition is always satisfied if $2r^f \geq \mu$. If on the contrary $2r^f < \mu$ applies, case 1 holds if

$$\psi < \frac{2\sigma^2(1+\rho)}{\zeta\theta(\mu - 2r^f)\sigma_\epsilon^2} \equiv \overline{\psi}^{CT} \, . \tag{46}$$

A tighter sub-case of case 1 is given by imposing $\frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}} < 0$. This case indeed holds if

$$\rho \geq \frac{1}{2}\zeta\psi\theta(\mu - 2r^f)\frac{\sigma_\epsilon^2}{\sigma^2} \equiv \underline{\rho}$$

To be consistent with the upper bound $\overline{\rho}$ imposed in Lemma **??**, one needs to verify that the following inequality holds

$$-1 < \frac{1}{2}\zeta\psi\theta(\mu - 2r^f)\frac{\sigma_\epsilon^2}{\sigma^2} < 1 - \frac{1}{2}\frac{\alpha\zeta\sigma_\epsilon^2}{\theta(\mu - r^f)} \, .$$

If $\overline{\rho} > 0$, the second inequality is obviously satisfied if $\mu \leq 2r^f$. In case that $\mu > 2r^f$ applies, we obtain an additional correlation driven upper bound on ψ, i.e.

$$\psi < \frac{2\sigma^2}{\zeta\theta(\mu - 2r^f)\sigma_\epsilon^2}\overline{\rho} \equiv \overline{\psi}^{CT} \, .$$

$\mathcal{C}$. Sufficient condition for $\mathcal{G} \geq \mathcal{F} \geq 0$ on entire support of $\tilde{w}$.
To begin with, let us define the support of the auxiliary variable $\tilde{w} \in \tilde{W} = [0, \overline{\tilde{w}}]$, where the upper bound $\overline{\tilde{w}}$ of the support is specified below. Additionally, let us denote by $\overline{\psi}^{\tilde{w}}$ the infimum of ψ over the set $\tilde{W}$ from Lemma **??**, i.e.

$$\overline{\psi}^{\tilde{w}} \equiv \inf_{\tilde{w} \in [0, \overline{\tilde{w}}]} \overline{\psi}(\tilde{w}) = \inf_{\tilde{w} \in [0, \overline{\tilde{w}}]} \min\{\overline{\psi}^{GM,s}(\tilde{w}), \overline{\psi}_1^{(a),s}(\tilde{w}), \overline{\psi}^{(b),s}(\tilde{w})\} \, .$$

If $0 < \rho \leq \overline{\rho}$ and $\psi < \min\{\overline{\psi}^{CT}, \overline{\psi}^{\tilde{w}}\}$ applies, then $\frac{\partial \mathcal{F}}{\partial r^f}$ is strictly increasing in $\tilde{w}$, whereas $\frac{\partial \mathcal{G}}{\partial r^f}$ increases at most at a lower rate than $\frac{\partial \mathcal{F}}{\partial r^f}$ in $\tilde{w}$. As we have that $\frac{\partial \mathcal{F}}{\partial r^f} < \frac{\partial \mathcal{G}}{\partial r^f}$ at the left limit $\tilde{w} = 0$ and $\frac{\partial^2 \mathcal{F}}{\partial r^f \partial \tilde{w}} > \frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}}$ for all $\tilde{w} \in \tilde{W}$, we know that there exists a unique intersection point between both derivatives, which we subsequently denote by $\tilde{w}^{IS}$. Additionally, let us define the point at which $\frac{\partial \mathcal{F}}{\partial r^f}$ equals zero by $\tilde{w}^{\mathcal{F},0}$. It is given by

$$\tilde{w}^{\mathcal{F},0} = \frac{2}{\zeta\psi\sigma_\epsilon^2\sigma^2}\left(\frac{\theta}{\alpha}(1-\rho)\sigma^2 + \zeta\psi\sigma_\epsilon^2\frac{\theta^2(\mu - r^f)}{\alpha}\right).$$

If $\tilde{w} \leq \tilde{w}^{\mathcal{F},0}$ applies, then $\frac{\partial \mathcal{F}}{\partial r^f} \leq 0$ holds and vice versa. Based on the previous notation, it is possible to derive a lower bound $\underline{\tilde{w}}$ such that it holds that

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} \geq 0\,. \tag{47}$$

The lower bound depends on the fact whether the derivatives $(\frac{\partial \mathcal{G}}{\partial r^f}, \frac{\partial \mathcal{F}}{\partial r^f})$ intersect in the positive or negative orthant of $\mathbb{R}^2$. By Lemma **??** we have that $\mathcal{G} \geq \mathcal{F} \geq 0$, which implies that

(i) If $\tilde{w}^{IS} \leq \tilde{w}^{\mathcal{F},0}$ holds, equation (47) is positive if $\tilde{w} \leq \tilde{w}^{IS}$, as $\frac{\partial \mathcal{F}}{\partial r^f} \leq \frac{\partial \mathcal{G}}{\partial r^f} \leq 0$.

(ii) If $\tilde{w}^{IS} > \tilde{w}^{\mathcal{F},0}$ holds, equation (47) is positive if $\tilde{w} \leq \tilde{w}^{\mathcal{F},0}$, as $\frac{\partial \mathcal{G}}{\partial r^f} \geq 0$ and $\frac{\partial \mathcal{F}}{\partial r^f} \leq 0$.

As a result, a sufficient lower bound is given by $\underline{\tilde{w}} = \min\{\tilde{w}^{IS}, \tilde{w}^{\mathcal{F},0}\}$. By an analogous reasoning, one can characterize an upper bound $\overline{\tilde{w}}$ such that the following inequality holds

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} < 0\,. \tag{48}$$

To do so, let us consider the subsequent case distinction by using again $\mathcal{G} \geq \mathcal{F} \geq 0$ from Lemma **??**:

(i) If $\tilde{w}^{IS} \leq \tilde{w}^{\mathcal{F},0}$ holds, equation (48) is negative if $\tilde{w} \geq \tilde{w}^{\mathcal{F},0}$, as $\frac{\partial \mathcal{F}}{\partial r^f} \geq 0 \geq \frac{\partial \mathcal{G}}{\partial r^f}$.

(ii) If $\tilde{w}^{IS} > \tilde{w}^{\mathcal{F},0}$ holds, equation (48) is negative if $\tilde{w} \geq \tilde{w}^{IS}$, as $\frac{\partial \mathcal{F}}{\partial r^f} \geq \frac{\partial \mathcal{G}}{\partial r^f} \geq 0$.

As a result, we obtain $\overline{\tilde{w}} = \max\{\tilde{w}^{IS}, \tilde{w}^{\mathcal{F},0}\}$.

$\mathcal{D}$. Existence of unique intersection $\tilde{w}^*$.

It is straightforward to see that $\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G}$ is a second order polynomial in $\tilde{w}$, which is additionally continuously differentiable. By the intermediate value theorem, we hence know that there exists an odd number of intersection points at at which it holds that

$$\frac{\partial \mathcal{G}}{\partial r^f}\mathcal{F} - \frac{\partial \mathcal{F}}{\partial r^f}\mathcal{G} = 0\,.$$

As the left hand side of the previous equation is quadratic in $\tilde{\omega}$, it can has at most two intersection points. As a result, there exists a unique intersection point $\tilde{w}^* \in [\underline{\tilde{w}}, \overline{\tilde{w}}]$. Consequently, bank home bias increases in response to a monetary policy tightening if $\tilde{w} < \tilde{w}^*$ and increases on the contrary if $\tilde{w} > \tilde{w}^*$. Given the definition of $\tilde{w}$, we can define the separating frontier

$$\omega = \frac{1}{\delta}\left(1 - \frac{\tilde{w}^*}{w}\right) . \tag{49}$$

If ω is larger than the right hand side of (49), home bias increases in response to a monetary policy tightening, whereas it decreases if ω is smaller than the right hand side of (49). This completes the proof of Proposition **??**.

$\mathcal{E}$. Rule out remaining case $\frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}} \geq \frac{\partial^2 \mathcal{F}}{\partial r^f \partial \tilde{w}} > 0$.

Case 2: $\frac{\partial^2 \mathcal{G}}{\partial r^f \partial \tilde{w}} \geq \frac{\partial^2 \mathcal{F}}{\partial r^f \partial \tilde{w}} > 0$**.** In this case, the marginal effect of monetary policy on domestic lending, $\frac{\partial \mathcal{G}}{\partial r^f}$, moves faster than the marginal effect of monetary policy on foreign lending, $\frac{\partial \mathcal{F}}{\partial r^f}$, in response to a change in bankers' loanable wealth w. It is only possible if the following inequality holds

$$\rho - \frac{1}{2}\zeta\psi\theta(\mu - 2r^f)\frac{\sigma_\epsilon^2}{\sigma^2} \leq -1 \,,$$

which never holds if $\mu \leq 2r^f$. On the contrary, if $\mu > 2r^f$, the previous equation can be rearranged to

$$\psi \geq 2\frac{(1+\rho)\sigma^2}{\zeta\theta(\mu - 2r^f)\sigma_\epsilon^2} \,.$$

However, note that from Lemma **??** we assume the following restriction to ensure a global maximum of the bankers' problem,

$$\psi < \overline{\psi}^{GM,s} = 2\frac{\sigma^2}{\zeta\theta(\mu - r^f)\sigma_\epsilon^2}\left(\sqrt{2(1-\rho)} - (1-\rho)\right) .$$

Therefore, to verify that there exists a set of parameter values for ψ which satisfies the inequality and the Lemma **??** restriction, the following equation needs to hold

$$2\frac{(1+\rho)\sigma^2}{\zeta\theta(\mu - 2r^f)\sigma_\epsilon^2} \leq 2\frac{\sigma^2}{\zeta\theta(\mu - r^f)\sigma_\epsilon^2}\left(\sqrt{2(1-\rho)} - (1-\rho)\right) .$$

$$\Leftrightarrow \frac{(1+\rho)}{(\mu - 2r^f)} \leq \frac{\sqrt{2(1-\rho)} - (1-\rho)}{(\mu - r^f)} \,. \tag{50}$$

We now show that this is impossible. Given that $\rho \in [-1, 1]$, for $\rho = -1$, the above inequality holds with equality. As ρ increases, the left hand side increases at a higher rate in ρ compared to the right hand side, as the subsequent strict inequality applies

$$\frac{1}{\mu - 2r^f} > \frac{1}{\mu - r^f} - \frac{1}{(\mu - r^f)\sqrt{2(1-\rho)}} \,,$$

if $r^m \geq 0$. As a result, equation (50) never holds on the entire support of the fundamental correlation ρ. Therefore, we conclude that Case 2 is not consistent with the model assumptions, which completes the proof of Proposition **??**. $\square$

Proof Corollary 5

Proof. The proof follows in two steps. In the first part, we derive the effects of monetary policy on home bias fluctuations in case that the expected profitability channel is absent. In the second part, we analyse the effects of monetary policy on home bias fluctuations in case of a removal of cross border information frictions.

Part I: Bank home bias without profitability channel.

From equations (36) and (37) in the main body of the text, it is straightforward to see, that optimal bank lending decisions of country i bankers are characterized in the absence of a expected profitability channel ($\psi = 0$) by

$$k_{ii} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \rho\frac{\sigma_j}{\sigma_i}\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} + \frac{1}{2}\rho\frac{\sigma_j}{\sigma_i}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\right),$$

$$k_{ij} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right).$$

In a similar fashion, we obtain by an application of a symmetry argument for the lending decisions of bankers located in country j

$$k_{jj} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} + \frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right),$$

$$k_{ji} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \rho\frac{\sigma_j}{\sigma_i}\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \frac{1}{2}\zeta_j\frac{\sigma_\epsilon^2}{\sigma_i^2}\right).$$

According to equation (10) home bias of country i in the model is given by

$$\mathcal{HB}_i = 1 - \frac{1 + \frac{w_j}{w_i}}{1 + \frac{k_{jj}}{k_{ij}}}. \tag{51}$$

The home bias measure is discontinuous at $\frac{k_{jj}}{k_{ij}} = -1$. For values $\frac{k_{jj}}{k_{ij}} > -1$, it increases in reaction to a parameter change if the ratio $\frac{k_{jj}}{k_{ij}}$ increases in the respective parameter. The expression is given by

$$\frac{k_{jj}}{k_{ij}} = \frac{\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} + \frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}}{\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}}. \tag{52}$$

I. Loanable Wealth and Home Bias

It is straightforward to see that home bias (51) increases in the ratio of loanable wealth $\frac{w_j}{w_i}$.

II. Monetary Policy and Home Bias

The comparative statics of (52) with respect to the monetary policy rate are given by

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial r^f} = \frac{\left(-\frac{\theta}{\alpha\sigma_j^2}+\rho\frac{\sigma_i}{\sigma_j}\frac{\theta}{\alpha\sigma_i^2}\right)\left[\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right]-\left(-\frac{\theta}{\alpha\sigma_j^2}+\rho\frac{\sigma_i}{\sigma_j}\frac{\theta}{\alpha\sigma_i^2}\right)\left[\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}+\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right]}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}.$$

The previous equation can be simplified to

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial r^f} = \frac{-\left(-\frac{\theta}{\alpha\sigma_j^2}+\rho\frac{\sigma_i}{\sigma_j}\frac{\theta}{\alpha\sigma_i^2}\right)\left[\frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}+\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right]}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2} = \frac{1}{2}\frac{\theta\sigma_\epsilon^2}{\alpha\sigma_j^4}\frac{\left(1-\rho\frac{\sigma_j}{\sigma_i}\right)\left[\zeta_i+\rho\zeta_j\frac{\sigma_j}{\sigma_i}\right]}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}.$$

The previous derivative is positive if both terms in the numerator are either positive or negative and at least one manageability parameter is unequal to zero and positive. The first condition is satisfied if

$$-\frac{\sigma_i}{\sigma_j}\frac{\zeta_i}{\zeta_j} \le \rho \le \frac{\sigma_i}{\sigma_j}.$$

The second condition does never apply as $\rho \ge \frac{\sigma_i}{\sigma_j}$ and $\rho \le -\frac{\sigma_i}{\sigma_j}\frac{\zeta_i}{\zeta_j}$ cannot be jointly satisfied. Under the symmetry Assumption **??**, the former condition reduces to $-1 \le \rho \le 1$, which always holds as it covers the entire support of ρ.

Special Case $\rho = 0$: In the case of zero correlation, home bias can be further simplified to

$$\mathcal{HB}_i = 1 - \frac{1+\frac{w_j}{w_i}}{1+\frac{1}{1-\frac{1}{2}\frac{\alpha\zeta_i\sigma_\epsilon^2}{\theta(\mu_j-r^f)}}}.$$

III. Cross-Border Information Friction and Home Bias

The comparative statics of (51) with respect to cross border uncertainty are given by

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial \sigma_\epsilon^2} = \frac{\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j}{\sigma_i^2}\left[\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right]+\frac{1}{2}\frac{\zeta_i}{\sigma_j^2}\left[\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}+\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right]}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}.$$

The sign of the former expression is consequently determined by

$$\text{sgn}\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial \sigma_\epsilon^2} = \left[\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}\right]\left(\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j}{\sigma_i^2}+\frac{1}{2}\frac{\zeta_i}{\sigma_j^2}\right). \tag{53}$$

The overall sign is weakly positive if the following correlation bounds apply

$$-\frac{\sigma_i}{\sigma_j}\frac{\zeta_i}{\zeta_j} \leq \rho \leq \frac{\mu_j - r^f}{\mu_i - r^f}\frac{\sigma_i}{\sigma_j} \, .$$

Under Assumption **??**, the previous equality holds. If we also assume that (k_{jj}, k_{ij}) are weakly positive, the first component of the initial sign determining equation is strictly positive. The sign is thus pinned down by the second component. It is positive if the following inequality holds, which is obviously satisfied under Assumption **??**:

$$\rho \geq -\frac{\zeta_i}{\zeta_j}\frac{\sigma_i}{\sigma_j} \, .$$

IV. Risk Management Ability and Home Bias

Let us assume that both investment positions (k_{jj}, k_{ij}) are weakly positive. It is straightforward to see from equation (52) that $\frac{k_{jj}}{k_{ii}}$ increases in ζ_i, and increases in ζ_j if $\rho \geq 0$, respectively decreases if $\rho < 0$. In case of a symmetric risk management ability, i.e., $\zeta \equiv \zeta_i = \zeta_j$, we have

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial\sigma_\epsilon^2} = \frac{\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\sigma_\epsilon^2}{\sigma_i^2}\left[\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \frac{1}{2}\zeta\frac{\sigma_\epsilon^2}{\sigma_j^2}\right] + \frac{1}{2}\frac{\sigma_\epsilon^2}{\sigma_j^2}\left[\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} + \frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta\sigma_\epsilon^2}{\sigma_i^2}\right]}{\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \frac{1}{2}\zeta\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2} \, .$$

The sign of the previous derivative is determined by

$$\text{sgn}\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial\sigma_\epsilon^2} = \frac{1}{2}\frac{\sigma_\epsilon^2}{\sigma_j^2}\left[\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2}\right]\left(1 + \rho\frac{\sigma_j}{\sigma_i}\right) \, . \tag{54}$$

The sign is weakly positive in turn if the following inequality applies

$$-\frac{\sigma_i}{\sigma_j} \leq \rho \leq \frac{\mu_j - r^f}{\mu_i - r^f}\frac{\sigma_i}{\sigma_j} \, ,$$

which is obviously satisfied if Assumption **??** is imposed.

V. Fundamental Asset Correlation and Home Bias

Finally, with respect to the asset correlation we obtain the comparative statics

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial\rho} = \frac{-\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^f) - \frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2}{\alpha\sigma_i^2}\left(\frac{\theta(\mu_j - r^f)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} - \frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\right) + \frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2}\left(\frac{\theta(\mu_j - r^f)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^f)}{\alpha\sigma_i^2} + \frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right)}{\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2} \, .$$

The previous equation can be rearranged to

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial\rho} = \frac{-\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)-\frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2}{\alpha\sigma_i^2}\left(-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}-\frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\right)+\frac{1}{2}\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\frac{\theta(\mu_j-r^f)}{\alpha\sigma_j^2}+\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}\left(-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}+\frac{1}{2}\rho\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\right)}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}$$

$$= \frac{-\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)-\frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2}{\alpha\sigma_i^2}\left(-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}-\frac{1}{2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}\right)+\frac{1}{2}\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\frac{\theta(\mu_j-r^f)}{\alpha\sigma_j^2}+\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)}{\alpha\sigma_i^2}\left(-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)-\frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2}{\alpha\sigma_i^2}\right)}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}.$$

Collecting terms gives us finally

$$\frac{\partial\left(\frac{k_{jj}}{k_{ij}}\right)}{\partial\rho} = \frac{\frac{1}{2}\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^f)-\frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2}{\alpha\sigma_i^2}\frac{\zeta_i\sigma_\epsilon^2}{\sigma_j^2}+\frac{1}{2}\frac{\sigma_i}{\sigma_j}\frac{\zeta_j\sigma_\epsilon^2}{\sigma_i^2}\frac{\theta(\mu_j-r^f)}{\alpha\sigma_j^2}}{\left(\frac{\theta(\mu_j-r^m)}{\alpha\sigma_j^2}-\rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i-r^m)}{\alpha\sigma_i^2}-\frac{1}{2}\zeta_i\frac{\sigma_\epsilon^2}{\sigma_j^2}\right)^2}.$$

The sign of the former expression is positive if

$$\left(\theta(\mu_i - r^f) - \frac{1}{2}\alpha\zeta_j\sigma_\epsilon^2\right)\zeta_i + \theta(\mu_j - r^f)\zeta_j > 0\,. \tag{55}$$

This condition can be rewritten such that $\theta(\mu_i - r^f)\zeta_i + \big(\theta(\mu_j - r^f) - \frac{1}{2}\alpha\zeta_i\sigma_\epsilon^2\big)\zeta_j > 0$. A sufficient condition for the former condition to hold is that there exists an adjusted (weakly) positive risk-premium for investments abroad, i.e. $\theta(\mu_j - r^f) - \frac{1}{2}\alpha\zeta_i\sigma_\epsilon^2 > 0$. In these cases, the correlation between home and foreign risky assets amplifies bank home bias through the manageability channel: The higher the correlation between both assets is, the more banks shift their portfolio towards the domestic risky asset in order to avoid the reduction in the risk premium which arises through to the additional manageable risk component. Notice, that the correlation between both assets is irrelevant for the bank home bias if both countries have perfect manageability, i.e. $\zeta_i = \zeta_j = 0$. Under Assumption **??**, the condition on the adjusted weakly positive risk premium after risk management activities remains obviously valid. This concludes the proof of statement (a) of Corollary 5.

Part II: Bank Home Bias Without Cross-Border Information Friction

From equations (36) and (37) in the main body of the text, it is straightforward to derive, that optimal bank lending decisions of country i bankers are characterized in the absence of cross-border information frictions ($\sigma_\epsilon^2 = 0$) by

$$k_{ii} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \rho\frac{\sigma_j}{\sigma_i}\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2}\right),$$
$$k_{ij} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2}\right).$$

In a similar fashion, we obtain by an application of a symmetry argument for the lending decisions of bankers located in country j

$$k_{jj} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2} - \rho\frac{\sigma_i}{\sigma_j}\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2}\right),$$
$$k_{ji} = \frac{1}{1-\rho^2}\left(\frac{\theta(\mu_i - r^m)}{\alpha\sigma_i^2} - \rho\frac{\sigma_j}{\sigma_i}\frac{\theta(\mu_j - r^m)}{\alpha\sigma_j^2}\right),$$

As a consequence, portfolio decisions are purely driven by stochastic processes of fundamental technology shocks. In this case, home bias is in turn given by

$$\mathcal{HB}_i = 1 - \frac{1 + \frac{w_j}{w_i}}{2}.$$

As a result, home bias is solely driven by the ratio of loanable wealth, i.e., it decreases strictly in $\frac{w_j}{w_i}$. Home bias is thus independent of variations in monetary policy. Under Assumption **??**, it is evident that home bias will equal throughout zero. This completes the proof of the second statement of Corollary 5.

□