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Central Banks Casting a Global Financial Safety Net:

What Drives the Supply of Bilateral Swaps?

Jakree Koosakul and Alexei Miksjuk

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Central Banks Casting a Global Financial Safety Net: What Drives the Supply of Bilateral Swaps?

Prepared by Jakree Koosakul and Alexei Miksjuk*

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ABSTRACT: The expansion of bilateral swap arrangements (BSAs) since the Global Financial Crisis has led to a substantial reconfiguration of the Global Financial Safety Net (GFSN). This paper examines the drivers of BSA supply using a novel dataset on all publicly documented BSAs. It finds that countries with well-developed financial markets and institutions and high trade openness are more likely to backstop other economies by establishing BSAs. In addition, their choice of BSA counterparts is driven by strong investment and trade exposures to these countries, with variation in the relative importance of these factors across major BSA providers. The paper shows that geopolitical considerations often affect such decisions, as BSAs are less likely to be established between geopolitically distant countries and more likely between countries in the same regional economic bloc.

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Author’s E-Mail Addresses:	jkoosakul@imf.org, amiksjuk@imf.org

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WORKING PAPERS

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Contents

I. Introduction

Bilateral swap arrangements (BSAs) have become a key layer of the Global Financial Safety Net (GFSN). BSAs are contingent arrangements to exchange currencies between two central banks, or in some cases, between a central bank and a finance ministry. While these arrangements are often designed to alleviate foreign exchange (FX) liquidity pressures in the financial market, they might serve other purposes such as FX support to promote trade and investment. Since the Global Financial Crisis, BSAs have expanded dramatically, becoming comparable in size to the multilateral GFSN layers, namely the IMF and regional financial arrangements (RFAs).

As of end 2022, BSAs spanned over forty countries worldwide, amounting to $1.4 trillion or 1.4% of global GDP—about one third of external GFSN resources, which include BSAs, RFAs, and the IMF. Major central banks – of Canada, Euro Area, Japan, Switzerland, US, and UK - have standing BSAs with one another with no explicit line limits. There has also been a strong expansion of BSAs outside these central banks, particularly in the Asia-Pacific region, the European Union, the Americas, and the Middle East. Most notably, China has developed a global BSA network. Given its growing size and coverage, the interaction between BSAs and other GFSN layers play an important role in ensuring effective liquidity provision for countries in need and guaranteeing the stability of the International Monetary System (IMS).

Despite the growing importance of BSAs, the literature on their determinants is relatively limited. On the demand side, Perks et al. (2021) examined factors affecting BSA recipient countries' decision to seek and renew BSAs. On the supply side, existing studies are limited to a few large BSA-source countries. For instance, for the US, the probability of access to the Federal Reserve (Fed) swap lines was found to increase with larger liability exposure to US banks, stronger trade linkages, and closer military alliances (Aizenman and Pasricha, 2010; Aizenman et al., 2021). For China, access to the swap lines was found to be driven by trade, financial, geographical, and geopolitical factors (Garcia-Herrero and Xia, 2014; Liao and McDowell, 2015; Lin et al., 2016).

Using a novel dataset covering all publicly documented swaps, this paper aims to fill the gap in the literature by looking at the supply of BSAs. We argue that there are two key conditions affecting source countries' supply decision. First, a source country's decision to backstop other economies through establishing BSAs. Second, its decision to select the BSA counterparts.[1] To our knowledge, this paper is the first empirical study to examine the factors affecting the first decision. In addition, we also contribute to the literature on the second decision, by extending the coverage from the few large central banks (namely, the US and China) to 19 central banks that offer BSAs. This is important for understanding the global BSA network, which goes beyond the few largest economies, and its implications for the effectiveness of the GFSN in supporting countries during market distress.

We find that financial and trade developments play a key role in explaining the decision to become a BSA source country and the selection of BSA recipients. Countries with well-developed financial markets and institutions and high trade openness are more likely to become a BSA source country. Furthermore, BSA source countries are more likely to establish BSAs with the countries they have stronger investment and trade exposures. However, we find variation across BSA source countries. In some cases, investment considerations appear to be more important than trade exposure, while in others, trade considerations likely play a significant role in guiding the decision-making process.

[1] For China, which has an extensive BSA network, we also study the factors explaining the size of the BSA exposure. For the other countries, the limited sample size complicates the econometric modeling of the swap size.

We also find regional and global geopolitical considerations to affect the decision to provide BSAs. We confirm the role of global geopolitical factors for the US and China, and find them relevant for several other major reserve issuers. We show that these countries are less likely to establish BSAs with geopolitically distant countries – as proxied by the difference in UN General Assembly voting.[2] For other countries, whose currencies are less widely used as international reserves, we find that regional factors often matter. Specifically, we show that participation in a regional economic bloc significantly increases the probability of offering a BSA to countries in that bloc.

Our findings suggest that the evolution of the BSA network may respond to geopolitics in addition to global and regional developments in trade and finance. If countries continue to develop their financial markets and institutions and increase cross-border investment exposure, more source countries may join the BSA network, expanding coverage to more recipients. However, geopolitical fragmentation may lead to BSA network fragmentation along political lines, leaving economically interconnected but politically distant economies exposed to spillovers of shocks. Moreover, uncoordinated increase of the BSA network may pose moral hazard risk if short-term BSA financing, which usually has no policy conditionality, is used to delay macroeconomic adjustment. Given the significant and potentially growing role of the BSA network, it is important to consider its limitations and coordination between BSAs and the other GFSN layers for evaluating the effectiveness of the GFSN in supporting countries during stress and ensuring the stability of the IMS.

The remainder of this paper is organized as follows. Section II provides background information on the growing role of BSAs and discusses the relevant literature. Section III outlines the methodology of our study, including a simple motivating theoretical framework for the BSA supply, the empirical methodology, and a description of the dataset. Section IV discusses our empirical results on the determinants of BSA supply, highlighting the importance of financial and trade linkages, as well as geopolitical factors. Section V concludes with policy implications.

II. Background

A. The Growing Role of BSAs in the GFSN

The GFSN comprises a set of institutions and mechanisms that contribute to preventing or mitigating crises. It seeks to provide countries with insurance against crises, financing when shocks hit, and incentives for sound macroeconomic policies, thus helping to avoid spillovers and alleviate moral hazard concerns (IMF, 2016; Iancu et al., 2021).[3] The GFSN comprises several layers. First, international reserves, which are accumulated external assets of a country that are readily available to and controlled by the monetary authorities, are often used as the first line of defense in a crisis. Second, the IMF is a multilateral institution that pools resources from its global membership to offer financial assistance, including on a precautionary basis, to address countries' balance of payment problems. IMF financing often plays a catalytic role, signaling appropriate policies and bringing additional public or private financing. Third, RFAs are resource-pooling arrangements between groups of countries, usually in the same region, to leverage financing for any individual member in a crisis. Fourth, BSAs are contingent arrangements to exchange currencies between two central banks (in some cases, between a

[2] We use the distance between the countries' "ideal points" estimates (IPE), which represent a weighted average of voting outcomes on all topics, including human rights, colonialism, etc. (see Bailey et. al., 2017).

[3] Access to GFSN elements can boost confidence and provide insurance against crises even if the elements are not actually tapped.

central bank and a finance ministry).[4] The difference between RFAs and BSAs reflects the multilateral versus bilateral nature of the arrangements rather than their financial structures, and in some cases BSAs can morph into RFAs.[5]

Most BSAs are three-year or standing contingent arrangements between central banks to exchange their local currencies, while the terms and conditions of swap drawings may vary. Under BSAs, a central bank usually agrees to provide its own currency in exchange for the currency of the counterparty central bank, although several cases involve provision of US dollars. Some of the largest BSAs are established on a standing basis, while most other BSA lines have a 3-year duration subject to a rollover. When needed, a central bank may request to draw on the swap line subject to the other central bank's approval. While information on the terms and conditions of BSA drawings is often not publicly available and may vary across BSAs, there is evidence of their heterogeneity: in many cases, the maturity is at 3 months or below (reflecting market concentration in short-term FX swaps), but sometimes may reach 12 months and allow for a rollover (de facto, turning the swap into a multiyear arrangement); in addition, while some central banks provide swap financing close to the policy rate, others appear to price in credit risks (Perks et al., 2021; Horn et al., 2023).

BSAs can serve different objectives, from alleviating liquidity pressures during financial crises to promoting the use of local currencies in regional trade and investment. In many cases, the stated aim of BSAs is to alleviate liquidity pressures in the financial market of one country and reduce spillovers to, and financial stability risks in, the other. Not surprisingly, BSAs have often been established following a risk surge in global financial markets or during financial crises and were kept by the central banks after the shocks abated as a means of protection against future financial crises.[6] As seen in Figures 1 and 2, there is a significant correlation between the amount and size of BSAs and lagged values of the Chicago Board Options Exchange volatility index (VIX), often used as a proxy for global risk.[7] In addition, BSAs may also serve other purposes. Notably, the People's Bank of China (PBoC) created an extensive BSA network after the GFC not only as a backstop during financial crises, but also to promote the use of the renminbi and other non-dollar currencies in regional trade and investment (see, e.g., Moessner and Allen, 2010; Lin et al., 2016). Although objectives may differ, BSA financing is often provided on a short-term basis, with no policy conditionality attached, and is particularly suitable for addressing liquidity shocks and short-term FX needs. Even if not drawn, established BSAs might reduce foreign exchange liquidity pressures through confidence effects.

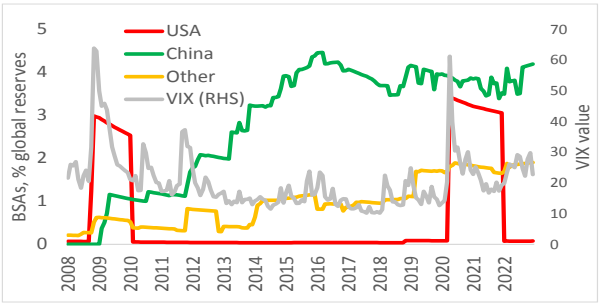
[4] Other GFSN layers, such as market-based instruments for insurance against crises, have found little use to date (IMF, 2016). In addition, some central banks started offering repo facilities to foreign central banks since the COVID-19 crisis – for instance, FIMA by the US Fed and EUREP by the ECB. While these facilities aim to alleviate liquidity pressures on the financial markets, they are not discussed in this paper, as they imply an exchange of one safe asset (government security) into another (central bank money).

[5] RFAs are multilateral arrangements that can have different funding structures, including swaps. Examples of RFAs include Arab Monetary Fund, BRICS Contingent Reserve Arrangement, Chiang Mai Initiative Multilateralization (CMIM), Eurasian Fund for Stabilization and Development, European Stability Mechanism, EU Balance of Payments Assistance Facility, and Latin American Reserve Fund. In most cases, RFAs have been originally established as multilateral arrangements, but in the case of the CMIM, a network of swaps between central banks got multilateralized with a common secretariate established to operationalize it. In other cases, swap arrangements between central banks remain bilateral rather than multilateral. For instance, the standing network of BSAs between the central banks of Canada, Euro Area, Japan, Switzerland, US, and UK allows for the provision of liquidity in each jurisdiction against any of the five currencies foreign to that jurisdiction, and is hence considered BSAs.

[6] This paper focuses on the modern BSAs. That said, central banks' cross-border lending has been used since the 19th century (Horn et al., 2020) and US swaps have been used since 1936, more systematically since 1962. Bordo et al. (2014) described the evolving role of the Fed's swap lines: since their inception in 1962 as a mechanism to support the Fed during the gold standard era; their use during the early float in 1970s to finance U.S. foreign exchange interventions; their use to supplement international reserves in Mexico; their partial elimination in the late 1990s; and more recently their re-establishment at the beginning of the GFC to finance global lender-of-last-resort operations and to prevent spillover of disorderly foreign money market conditions into the United States. Following the Asian Financial Crisis, a network of BSAs emerged in the ASEAN+3 region in 2000, but later turned into a multilateral regional financial arrangement CMIM, and hence are not considered here as part of BSAs.

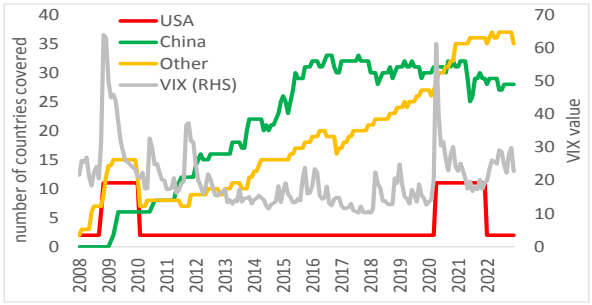
[7] E.g., the correlation between the number of BSAs and the lagged value of VIX is 0.5 for US, 0.3 for China, 0.4 for other swaps.

Figure 1. Size of BSAs, % global reserves



Source: authors' calculations

Figure 2. Number of BSAs

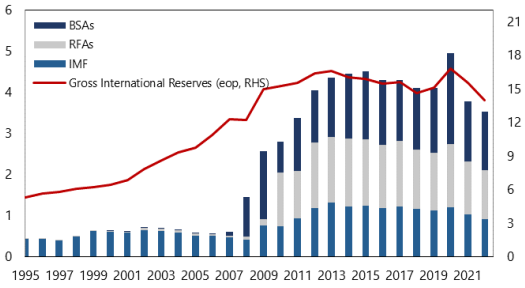


Source: authors' calculations

Note: the two panels exclude BSAs with no explicit line limits between Canada, the Euro Area, Japan, Switzerland, the US, and the UK: the potential size of such arrangements is large but hard to estimate precisely. RHS vertical axis shows the VIX values.

Since the global financial crisis (GFC), BSAs have grown in size and coverage. Globally, the total size of the BSA network has grown comparable to that of RFAs or the IMF lending capacity (Figure 3). As of end-2022, around 40 countries or currency areas[8] in the world had access to BSAs, which remained somewhat below the global coverage of RFAs (around 60 countries and currency areas) and far below the IMF's almost universal membership. While international reserves remain by far the largest layer of the GFSN, their accumulation plateaued after the Global Financial crises and their distribution remains unequal across countries.

Figure 3. GFSN evolution, % global GDP



Source: IMF (2023) and authors' calculations

For some countries, BSA access can exceed access to the other GFSN layers. For example, during the COVID-19 pandemic, resources available to New Zealand and Australia through BSAs were higher than through all the other GFSN layers combined, primarily due to the large size of US swap lines. For Mongolia and Lao, Chinese swaps accounted for about a third of total GFSN resources, and exceeded normal access to IMF resources.[9]

The significant expansion in BSAs is partly driven by US and Chinese BSAs. During the Global Financial Crisis, the US Fed established a network of standing swap arrangements with no explicit line limits with five major central banks and opened large but temporary swap lines for nine other central banks. While the latter expired at the end of the GFC, they were quickly re-opened within a month from the global risk surge during the COVID-19 crisis (see Figures 1 and 2). During 2009-2015, there has also been a rapid rise of BSAs established between China and other countries. This partly reflected China's efforts to promote the internationalization of the Renminbi, particularly its use in cross-border trade and direct investment settlement (Liao and McDowell, 2015). As a result, as of end-2022, China's BSA network covered more than 25 central banks around the world. Notably, there is no BSA between the US and China.

At the same time, other BSAs have been growing strongly. Canada, Euro Area, Japan, Switzerland, and the UK have BSAs with one another, as well as with the US and China. Australia has BSAs with China and Japan and, during the GFC and COVID-19, had access to US swaps. There has been a strong although gradual

[8] Here, the Euro Area is accounted for as one currency area rather than twenty countries.

[9] Based on IMF normal cumulative access limits. Under certain conditions outlined in the IMF Exceptional Access Policy, exceptional access to the IMF financing can be decided on a case-by-case basis.

increase in other BSAs, particularly in the Asia-Pacific region (partly driven by Japan and Korea), the European Union (ECB swaps, but also swaps between non-eurosystem central banks), and the Middle East (such as Qatar and UAE swaps with Turkey) (for more details, see Perks et al., 2021).

B. Related Literature

The literature on BSAs is relatively well established in terms of their effectiveness vis-à-vis key economic and financial outcomes. Focusing on developments during the GFC, Rose and Spiegel (2012) found that major announcements concerning the Fed swap lines with other major central banks as well as the related dollar auctions led to a significant reduction in CDS spreads, although the effects varied depending on country-specific characteristics. More recently, Aizenman et al. (2022) found that announcements of expansion of Fed liquidity facilities during the COVID-19 crisis as well as dollar auctions by major central banks had statistically significant effects on cross-currency basis and exchange rates. Focusing on ECB euro liquidity lines, Albrizio et al. (2023) found that the announcements of such liquidity lines significantly decreased the premium on euro borrowing paid by foreign agents in FX markets. A separate line of literature focusing on China has looked at the implications of BSAs for the internationalization of the Renminbi (RMB). Song and Xia (2020) and Bahaj and Reis (2020) found that the signing of Chinese BSAs has significant positive effects on the use of RMB in the settlement of cross-border trade and in payments, while Zhang et al. (2017) found similar effects for trade values with China.

The existing empirical literature also provides a comprehensive coverage of the BSA demand-side determinants. In particular, Perks et al. (2021) compiled and utilized a novel dataset covering all publicly documented BSAs to examine the factors that affect countries' decision to sign and renew BSA contracts to receive liquidity support. Their findings highlight balance of payment needs as a key factor in countries' decision to enter into BSAs to receive such support. In addition, they also found countries to be more likely to sign BSAs with China if they have strong trade linkages with China.

However, empirical studies on BSA supply determinants are currently limited to a few large country cases, namely the US and China. For the US, Aizenman et al. (2022) found that countries with larger trade exposure and stronger military alliances tended to have greater access to the Fed's swap lines, expanding an earlier finding by Aizenman and Pasricha (2010) about the role played by exposures to US banks. For China, Liao and McDowell (2015) and Garcia-Herrero and Xia (2014) found that access to the Chinese swap lines was generally driven by trade, financial, and geographical considerations. In addition to these determinants, Lin et al. (2016) found that geopolitical factors (strategic partnership and free trade agreements) also played a significant role. Notably, these studies focus on explaining the selection of BSA recipients by the US and China, and remain silent about which other countries, besides the US and China, act as BSA source countries and why.

This paper makes two contributions to the literature on BSA supply determinants by studying countries' decisions to become BSA source countries and by extending the analysis of BSA recipient selection to the full set of BSAs. First, utilizing a unique dataset on all publicly documented BSAs compiled by Perks et al. (2021), we examine the factors affecting countries' decision on whether to become BSA source country. To our knowledge, as mentioned above, this paper is the first empirical study to tackle this question. Second, for each BSA source country, we identify the factors determining the selection of counterparts. By doing so, our study extends the coverage in the existing empirical literature on BSA supply from the few large central banks to 19 central banks.

III. Methodology and Data

Our methodology of the supply-side study of the BSA network includes several key parts. To motivate the choice of explanatory variables in our empirical analysis, we start by proposing a simple theoretical framework that describes the main incentives for countries to become BSA providers and to choose their counterparts (Subsection A). Next, we discuss the identification strategy to split the BSA network between BSA source and recipient countries (Subsection B). Subsection C outlines our multi-step empirical methodology, modeling the sequence of country's decisions to become a BSA source country and to choose the BSA recipients. In section D, we describe the data used.

A. Theoretical Framework

Our paper proposes a simple two-country model where one country is exposed to a liquidity shock, with potential spillovers to the other country (see Annex 1 for details)**.** Specifically, consider a setting in which there is a home and a foreign country, with commercial banks operating in both economies. We assume that the foreign-country commercial banks are net debtors to the home-country banks. Foreign-country commercial banks face a liquidity shock in the home-country denominated currency.

Our framework extends existing models of BSAs by introducing a trade channel in addition to the financial channel to explain the potential spillovers of the liquidity shock to the home country. Under the financial channel, the liquidity shock experienced by the foreign-country banks may result in financial losses to the home-country banks if the risk of default materializes. Under the trade channel, a liquidity crisis may also result in a depreciation of the foreign country's currency, negatively impacting the home country's net exports.

To reduce the spillovers, the home-country central bank may consider providing liquidity in home-country currency (that is, to act as a BSA source country) to foreign-country banks by establishing a BSA with the foreign-country central bank. While making this decision, the home-country central bank balances the benefits of reducing the spillover risks to the home country against monitoring costs and potential losses from the foreign-country central bank defaulting on its obligations from the swap. We focus on the quantity of liquidity supplied through BSAs, while assuming that the lending terms and the exchange rate ensure the market clearance, i.e. the BSA demand meets the BSA supply.

The central bank of the home economy i will choose to provide liquidity support through a BSA if it expects the benefits of reducing the spillovers to the home economy to be larger than the costs of engaging in a swap. Solving this problem for the home-country central bank (see Annex 1 for details) leads to the following *BSA supply condition*, where the central bank chooses to provide liquidity through a BSA if:

$$\frac{k_1}{dA_p(1+\frac{C}{d_2 dA_p})} A_i^p + \frac{k_2 x}{dA_p(1+\frac{C}{d_2 dA_p})} Ex_i^p + \frac{k_2 n}{dA_p(1+\frac{C}{d_2 dA_p})} Im_i^p > \frac{d_2 k_3}{d_1 - d_2}, \quad (1)$$

where k_1, k_2, k_3 are home central bank's preference parameters with respect to financial stability risk, output losses, and own financial losses, respectively; d_1 and d_2 reflect default risk of foreign-country banks under the no BSA financing scenario and under the BSA financing scenario, respectively; d captures the probability of default on the BSA financing by the foreign-country central bank; A_p and A_i^p capture the size of the foreign-country financial market and the home-country financial system's exposure to it; Ex_i^p and Im_i^p are the levels of exports and imports of the home economy to/from the foreign economy p; x, n capture the impact of default on exports and imports of the home economy; and C captures the costs of monitoring the swap.

Two important predictions arise from our framework:

- **First, the framework provides guidance on which countries are likely to become BSA source countries: those with substantial financial market exposure to the rest of the world and/or with large international trade.** To see this, assume that the foreign economy *p* captures the rest of the world, so that A_p and A_i^p are the size of the global financial market and the home-country foreign financial assets, respectively, and Ex_i^p and Im_i^p are total exports and imports of the home economy *i*. Considering the BSA financing condition across different countries *i*, and assuming all the parameters to be fixed, it follows that the condition holds for those countries *i* that have sufficiently large nominal size of foreign financial assets A_i^p, or sufficiently large nominal values of exports and imports, Ex_i^p and Im_i^p.
- **Second, the framework provides guidance on which countries are likely to be chosen as BSA recipients: a source country will likely establish BSAs with the countries to which it has sufficiently large financial or trade exposures.** To see this, consider the BSA financing condition across different counterparts *p*. Annex 1 shows that the BSA financing condition is never met for counterparts with small financial markets ($A_p \to 0$) and small size of the economy ($Y_p \to 0$) due to the presence of fixed costs (costs of monitoring the BSA counterpart). For larger counterparts ($C/A_p \approx 0$), the BSA financing condition will hold if the financial market exposure to partner *p* is large (compared to the recipient economy's financial market size), A_i^p/A_p, or the trade exposure, Ex_i^p/A_p and Im_i^p/A_p, is high. In other words, a central bank would have an incentive to provide financing in cases where the potential financial and trade spillovers are significant (sufficiently high values of A_i^p, Ex_i^p, Im_i^p), but where it does not face overly high risks or capacity constraints (A_p not too large).

B. Identification of BSA Source and Recipient Countries

In the BSA data, we distinguish between the supply of and the demand for BSAs by identifying source and recipient countries based on several assumptions. Technically, both parties of a BSA are "source countries", as each party receives the counterpart's currency. In reality, one party may provide a hard currency (e.g., US dollar) in exchange for a soft currency (Perks et al., 2021). Across all BSAs, we consider eight main reserve issuing central banks from the IMF COFER database (Australia, Canada, China, EA, Japan, Switzerland, US, UK) to be BSA source countries and their counterparts to be BSA recipients. If both parties to a BSA are reserve issuers, both are considered to be source and recipient countries simultaneously. For the BSAs where none of the two parties is a reserve issuer, we rely on two additional assumptions. First, following Perks et al. (2021), if a central bank comes from an advanced economy, it is identified as a source country and its counterpart as a recipient. Second, if a country is known to be in a crisis, it can only be a recipient, while its counterpart is a BSA source country.

These identification assumptions allow us to split the BSA network into BSA source and recipient countries. Our list of BSA source countries as of end-2022 includes eight major reserve currency issuers (Australia, Canada, China, EA, Japan, Switzerland, US, UK) and 11 other BSA source countries: Denmark, India, Indonesia, Korea, Malaysia, Norway, Poland, Qatar, Singapore, Sweden, UAE. The list of recipients includes 39 countries. For the US, we make an additional assumption that their temporary BSAs with nine central banks, which expired at end-2021, can be re-opened during a major crisis (as it happened in the past) and, therefore, we include these BSAs into our analysis.[10] These leave us with 25 recipients for Chinese swaps, 14 recipients for US swaps, 13 recipients

[10] During the GFC, the Federal Reserve established temporary swap lines with Australia, Brazil, Denmark, Korea, Mexico, New Zealand, Norway, Singapore, and Sweden. It re-opened these lines within a month since the global risk spike during the COVID-19.

for Japan. Other major reserve issuing countries have 4-9 recipients. The other BSA source countries have up to 4 recipients (in most cases, 1-2 counterparts), which imposes additional constraints for their empirical analysis.

C. Empirical Methodology

The underlying assumption behind our estimates is that the BSA network configuration mostly reflects supply decisions by the source central banks. Since BSAs provide an additional layer of the GFSN with no costs until such swap lines are drawn, we assume that a source country's supply would normally be matched by the recipients' demand for BSAs, while the reverse is not necessarily true. In other words, we assume that it is ultimately up to the source country to decide on establishing a BSA, irrespective of who initiated the negotiations. For instance, the US Fed's temporary swap lines with nine central banks were announced on the same day during the COVID-19 crisis, reflecting the US supply decision amid high global demand for US dollars. That said, countries' demand may play a significant role for the timing of BSA establishment, which is not considered in this paper.

Based on the two predictions from the theoretical framework, our empirical analysis of BSA supply is structured around modeling the sequence of two decisions: 1) whether to become a BSA source country, and 2) for each BSA source country, the choice of BSA recipients.

First, across 137 countries[11], we study the determinants of the decision to become a BSA source country. For that, we estimate the following probit regression:

$$P(Provider_i = 1|\boldsymbol{X_i}) = \Phi(\boldsymbol{X_i\beta}) \quad (2)$$

where $Provider_i$ is a binary variable that takes the value of 1 if country i is a source country, and 0 otherwise; X_i is a vector of country i's characteristics that could potentially explain the decision to be a source country; and $\Phi(.)$ is the cumulative standard normal distribution function. Our choice of factors to include in $\boldsymbol{X_i}$ is based on the theoretical framework and includes measures of trade openness and external financial exposure (see Section D for data discussion). Since the alternative measures are likely to be collinear, we add them separately in (2) and choose the model specification with the best information criterion. In addition, we try other factors related to the capacity to provide liquidity.

Second, for each source country, we examine the factors explaining its choice of the recipients. To do that, we estimate the probit model of the form:

$$P(BSA_{ij} = 1|\boldsymbol{Y_{ij}}) = \Phi(\boldsymbol{Y_{ij}\gamma_i}) \quad (3)$$

where BSA_{ij} is a binary variable that takes the value of 1 if source country i has a BSA with country j, and zero otherwise; Y_{ij} is a vector of explanatory factors. Our choice of factors to include in $\boldsymbol{Y_{ij}}$ is based on the theoretical framework and includes measures of trade and financial linkages between countries i and j. In addition, we consider measures of geopolitical distance which could shape the choice of the counterparts.

[11] Including the Euro Area (EA) currency bloc counted as a single "country".

The estimation of (3) requires several considerations. Assuming homogeneity of the driving factors ($\gamma_i = \gamma$), we estimate (3) using a random effects panel probit model.[12,13] After that, we allow for heterogeneity of factors ($\gamma_i \neq \gamma_j$) and estimate the probit (3) separately for each source country. In both cases, we account for the multicollinearity of alternative financial and geopolitical measures by including them separately in (3) and choosing the preferred specification with the best information criterion. In addition, we explore non-linearities by including interaction terms between the variables into the preferred specification. For the source countries that are not international reserve issuers (and have few BSA counterparts), we cannot reliably estimate (3) and rather use a simple correlation analysis between BSA_{ij} and Y_{ij}.

D. Data

The data coverage spans several dimensions. We use end-2022 data on BSAs from the comprehensive dataset collected by Perks et al. (2021), containing publicly available information on all BSAs established by central banks, including the counterparts, the size, and the dates of arrangements. For the first step of modeling (decision to be a BSA source country), we try various measures of trade openness from the IMF's Balance of Payments and International Investment Position (BOP/IIP) database (exports of goods and services, imports of goods and services, and total trade in 2021). We also consider measures of countries' financial market external exposure: indicators of countries' stocks of foreign assets from the IMF's BOP/IIP (portfolio investments, other investments (debt instruments), and other investments of deposit-taking corporations) and the IMF's Financial Development index, implicitly assuming for the latter that stronger financial development leads to tighter interlinkages between countries and higher exposure. As a proxy for country's capacity to provide liquidity, we use the IMF's International Financial Statistics data on GDP and international reserves, and constructed an additional variable by augmenting the international reserves with the sovereign wealth funds data collected from the SWF Global. For the second and the third steps of modeling (choice of BSA recipients and size), we use the data on bilateral trade from the IMF's Directions of Trade Statistics and two measures of bilateral investment exposure: banks' cross-border positions (assets) from the Bank for International Settlements database and outward FDI positions (assets) from the IMF's Coordinated Direct Investment Survey. Finally, we construct two bilateral measures of geopolitical distance: difference in UN General Assembly voting behavior measured as the distance between the countries' "ideal points" estimates (IPE) (Bailey et. al., 2017) and a "regional" dummy, which is equal to one if two countries in the provider-receiver pair both belong to the same bloc, and zero otherwise.[14]

[12] Random effects model can be subject to the omitted variable bias. However, given the non-linear nature of a panel probit model, estimating a fixed effects specification is computationally challenging. As a robustness check, we also estimate a fixed effects panel linear probability model and find that the results to be relatively robust.

[13] Another potential endogeneity issue is reverse causality. While BSAs should support trade and financial flows from falling during a liquidity squeeze (which is often the BSAs' objective), given their short-term nature, we assume their effect on trends to be small. That is, BSAs should not have changed the structure of global trade and finance substantially. Similarly, we do not assume short-term swap financing to significantly affect UN voting patterns. That said, in some cases, reverse causality concerns could be relevant. For example, Chinese BSAs are often established to promote trade and settlement in the Renminbi, although their drawing often happens in situations of financial and macroeconomic distress (Horn et al., 2023). We leave the empirical relevance of this issue for future studies.

[14] The considered regional blocs include the European Single Market (ESM), the Association of Southeast Asian Nations Plus Three (ASEAN+3), the South Asian Association for Regional Cooperation (SAARC). For China, we used the Belt and Road Initiative (BRI).

IV. Empirical Results: Determinants of BSA Supply

A. Decision to Become a BSA Source Country

The level of financial development and the size of international trade are found to be significant in countries' decisions to become a BSA source country. Table 1 reports selected probit regression results for six specifications of Equation 2 (as shown in columns 1-6).[15] The level of financial development is statistically significant at 5% level or lower. The size of international trade is statistically significant in specifications 1, 3, and 4 (becomes insignificant after adding reserves and GDP in specifications 5-6, possibly due to multicollinearity). Both variables have positive signs: development of financial markets and institutions and increase of international trade raise the country's probability to establish BSAs and provide liquidity to other countries. These results are consistent with the theoretical model predictions (Section III.A), as financial development might imply stronger interaction with and exposure to the rest of the world, and together with the international trade exposure would increase the incentives for the source central bank to provide liquidity and minimize spillovers to its economy and financial market.[16]

Table 1. Probit Regression Results for the Decision to Be a BSA Source Country

	(1)	(2)	(3)	(4)	(5)	(6)
Trade Value	2.554***		1.994***	1.309*	0.956	0.376
	(4.93)		(3.23)	(1.74)	(1.23)	(0.39)
Portfolio Assets		3.519***	1.364	0.256		
		(2.90)	(1.08)	(0.23)		
Financial Development Index				0.782**	0.900***	1.005***
				(2.25)	(2.97)	(3.01)
Reserves					0.241	
					(0.62)	
GDP						1.762
						(1.24)
N	137	111	110	102	123	127
pseudo R^2	0.56	0.48	0.61	0.65	0.64	0.66
BIC	55.52	56.90	49.38	49.17	54.61	53.09

Note: Columns (1)-(4) capture various specifications of trade and financial variables (size of portfolio assets and financial development index), with specification (4) showing the lowest BIC score; Columns (5)-(6) consider adding different proxies for capacity to provide liquidity (reserves and GDP) to specification (4). For each variable, the first row reports probit coefficients, while the second row reports the corresponding t statistics, in parentheses. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively. Robust standard errors are used. A constant is included in all specifications. The reserves variable includes international reserves as well as investment in the country's sovereign wealth fund, as discussed in the Subsection III.D.

Financial development and international trade exposure variables have good explanatory power for the decision to become a BSA source country. In particular, specification 4 in Table 1 has the lowest BIC score and the highest explanatory power (pseudo R^2 of 0.65), with both variables statistically significant. Based on this specification, the derived marginal effects of the variables are also sizable (Figure A.1 in Annex II): a one-standard-

[15] As mentioned in Subsection III.D, we tried several measures of international trade (values of exports of goods and services, value of imports, and total trade), financial exposures (portfolio investments, other investments (debt instruments), and other investments of deposit-taking corporations), and reserves (excluding and including sovereign wealth funds). Table 2 reports only the results for total trade, portfolio investments, and reserves including sovereign wealth funds, which showed best statistical properties in terms of explanatory power and statistical significance.

[16] These results are robust to excluding reserve issuing countries, indicating that the drivers of the decision to be a BSA source country are common across the major reserve issuers and the other economies (see Annex II).

deviation increase in trade value (around $ 1 trillion) and financial development index (0.21) would raise the predicted probability of the country being a BSA source country by 16 and 10 percentage points, respectively. Moreover, the model performs well in terms of predictive performance (Figure A.2 in Annex II): using a threshold of 0.5 for the BSA probability, two thirds of BSA source countries are correctly predicted to be source countries (sensitivity of the prediction is 0.69) and all non-source countries are correctly predicted to be non-source countries (specificity of the prediction is 1). At a lower threshold of 0.2, these numbers become 0.88 and 0.94, respectively.

B. Choice of Recipients: Panel Regression

Our panel estimates show that trade, investment, and geopolitical linkages are all statistically significant factors explaining the choice of BSA recipients. As shown in Table 2, both trade and financial linkages are statistically significant and have the expected positive signs - that is, an increase of trade and investment linkages raises the probability of establishing a BSA between two countries, which is consistent with the theoretical model's predictions (Section III.A) and with earlier empirical findings for the US (Aizenman et al., 2022) and for China (Lin et al., 2016).[17] In addition, geopolitical considerations play a statistically significant role: larger voting distance at the UN reduces the probability of a BSA being established with that counterpart, while participation in a common "regional" economic bloc increases such probability. Interaction terms are statistically significant, pointing at some non-linearity in the mode, e.g., with larger financial exposure, trade exposure starts to have smaller impact on the probability of establishing BSAs.

Table 2. Panel Probit Regression Results for Choice of Recipients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Trade Value	0.179***	0.157**	0.152***	0.130*	0.202**	0.209**	0.143*
	(3.53)	(2.06)	(2.92)	(1.73)	(2.49)	(2.06)	(1.68)
Direct Investment	1.286***		1.462***				
	(3.26)		(3.72)				
Interbank Assets		2.916***		3.138***	3.053***	2.815***	3.273***
		(4.18)		(4.45)	(4.30)	(4.12)	(4.29)
UN Voting Distance	-0.451***	-0.355***			-0.352***	-0.342**	-0.340**
	(-3.72)	(-2.58)			(-2.58)	(-2.49)	(-2.35)
Regional Bloc			0.696***	0.944**			
			(3.10)	(2.31)			
Trade Volume * Interbank Assets					-0.186***		
					(-3.35)		
Trade Volume * UN Voting Distance						-0.052	
						(-0.93)	
Interbank Assets * UN Voting Distance							0.759**
							(2.17)
N	1882	1157	1922	1178	1157	1157	1157
pseudo R^2	0.30	0.47	0.28	0.47	0.48	0.48	0.48
BIC	527.8	299.5	543.4	301.4	305.6	305.4	303.1

Note: Columns (1)-(4) capture baseline specifications of trade, financial, and political linkages, while Columns (5)-(7) consider additional interaction terms between variables based on the baseline specification with the lowest BIC score. For each variable, the first row reports probit coefficients, while the second row reports the corresponding t statistics, in parentheses. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively. Robust standard errors are used. All variables except the regional bloc dummy are standardized. A constant is included in all specifications.

[17] As a robustness check, we estimated fixed effects panel linear probability model. Other than the geopolitical distance variable that becomes statistically significant at 10 percent level (compared to 1 percent in the baseline specifications), all other variables remain significant at 1 or 5 percent levels. This result suggests that our reported baseline specification results are robust.

Marginal effects show that, on average across BSA source countries, financial and geopolitical factors have the strongest impact on the choice of BSA recipients. Marginal effects, derived from our panel regression estimates, are reported in Figure A.3 in Annex II. The figure shows that a one standard-deviation increase in interbank assets raises the probability of establishing a BSA with the relevant country by 35 percentage points, while being in a common "regional" economic bloc increases it by 12 percentage points. On the other hand, the economic significance of trade is limited, with a one standard-deviation increase in trade value raising the probability by only 1 percentage point.

C. Choice of Recipients: Country-Specific Results

While the panel estimates in the preceding subsection provide a useful benchmark, they show "country average" numbers and can mask variations in the coefficients across individual BSA source countries. In this subsection, we estimate country-specific probit regressions and show the significant variation of the coefficients.

For the main reserve issuers, country-specific estimates show significant heterogeneity in the drivers of their choice of recipients, with trade, financial, and geopolitical factors having different relative importance across countries. Table 3 reports country-specific regression results for the preferred specification of each BSA source country based on the lowest BIC score (see Annex II for the full set of results for each source country). For Japan, the UK, and the US, financial variables (banks' foreign assets) are statistically significant in explaining their choice of BSA recipients: as the exposure to foreign assets grows, the probability of a BSA with that country increases.[18] For Australia, Canada, and Switzerland, bilateral trade turnover appears to be a significant positive driver of the choice of recipients. Finally, for China and the EA, we find a statistically significant positive impact of both financial linkages (direct investments abroad) and trade, although the latter is significant only at 10% level.

Table 3. Country Specific Regression Results for International Reserve Issuers

	Australia	Canada	China	EA	Japan	Switzerland	UK	US
Trade Value	1.468***	+	0.443*	0.444*	-0.564**	1.931***		-0.309
Interbank Assets					22.59***		+	18.20***
Direct Investment			1.783***	2.095**		2.027		
UN Voting Distance	0.471	-	0.115			-1.374***		-0.838***
Regional Bloc				0.939	1.993***			
Direct Investment * UN Voting Distance			-0.558***					
N	166	101	168	172	86	61	147	66
pseudo R^2	0.64	1.00	0.36	0.72	0.76	0.63	1.00	0.75
BIC	28.92	0.00	116.80	40.65	35.23	34.23	0.00	34.04

Note: Probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. For the regional bloc dummy variable, Eurozone is used for EA, Switzerland, and UK, ASEAN+3 is used for Japan, and Belt and Road Initiative is used for China. For countries where the model gives perfect prediction (100% success rate in predicting the binary outcome variable), + or - indicates that the variable is the variable or part of the combination of variables that result in the perfect prediction, as well as the sign of the coefficient.

[18] The coefficient for Japan is negative, which is unexpected. A closer examination of the results (Annex II.B) suggests that this is driven by the inclusion of both trade and regional bloc in the same specification, while regional bloc may already capture some of the trade exposure. More specifically, when trade is included by itself, it has an expected positive sign (although not statistically significant) (spec 1). Also, when a cross term between trade and regional bloc is included, the coefficient on trade becomes positive but significant only at 10% level (spec 4).

Geopolitical factors are statistically significant in most cases. For the US, Canada, and Switzerland, an increase in the voting distance at the UN reduces the probability of establishing a BSA with such a counterpart. For China, if there is large voting distance between countries, FDI exposure is less likely to lead to establishment of a BSA. Japan is more likely to have BSAs with its counterparts in the ASEAN+3 region. We did not find a statistically significant impact of geopolitical factors on the BSA recipient choice for Australia, the EA, and the UK, although this might also reflect data limitations due to the small number of such swap arrangements. In addition, geopolitical factors might have indirect effects on BSAs for all the countries, to the extent they impact trade and investment. The results for China, Japan, and the US are robust to excluding counterparts that are international reserve issuers (for the other countries, this could not be tested due to the small number of swaps).[19]

For the other BSA source countries' choice of recipients, regional political and trade ties are significant in most cases, although some heterogeneity is also observed. Table 4 reports correlation results of each BSA source country that is not a major international reserve issuer. Trade appears to be positively and significantly correlated with the choice of recipients for six out of eleven countries (Denmark, Norway, Sweden, Indonesia, Malaysia, Singapore), although for the Nordic countries, investment exposure (interbank assets and FDIs) is also important and it might be hard to distinguish between the two factors due to multicollinearity. For geopolitical factors, UN voting distance is significant and has the expected negative sign notably only for countries in Europe (Denmark, Norway, Sweden, and Poland).[20] By contrast, the role of regional blocs is found to be significantly correlated with counterpart choice for almost all of the countries, except Poland, Qatar, and the UAE. None of these factors was statistically significant in explaining the Qatar-Turkey and the UAE-Turkey BSAs.

Table 4. Correlation Analysis for Other Source Countries

	Trade Value	Interbank Assets	Direct Investment	UN Voting Distance	Regional Bloc
Denmark	0.25***	0.38***	0.29***	-0.20***	0.44***
Norway	0.18**		0.38***	-0.21***	0.44***
Sweden	0.20***	0.47***	0.15*	-0.21***	0.35***
Poland	0.02		0.03	-0.17**	-0.02
Indonesia	0.15*		-0.01	-0.07	0.28***
Korea	0.04	0.09	0.03	0.03	0.26***
Malaysia	0.14*		0.29	-0.06	0.28***
Singapore	0.20***			0.00	0.28***
India	-0.02		-0.01	-0.04	0.37***
Qatar	0.03			0.09	0.05
UAE	0.08			0.09	0.05

Note: ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. The different green and red shades reflect the magnitude of the correlation both in the positive and negative regions. Grey cells indicate missing data for the relevant countries for that variable. For the regional bloc dummy variable, Eurozone is used for Denmark, Norway, Sweden and Poland, ASEAN+3 is used for Indonesia, Korea, Malaysia, and Singapore, SAARC is used for India, and and Belt and Road Initiative is used for Qatar. We also conducted the same correlation analysis using Belt and Road Initiative as the regional bloc for Poland, Indonesia, Korea, Malaysia, and Singapore, but found no statistical significance.

[19] The only exception is the trade variable for the regression for China, which becomes insignificant once international reserve issuers are excluded.

[20] Since we are using simple correlation analysis for these countries, the correlation with geopolitical factors (UN voting distance, regional blocs) may reflect both the direct impact of these factors on BSAs, as well as indirect effects through trade and investment.

Our estimates yield some insights about the structure and the development of the BSA network. First, they explain the uneven coverage of BSAs, which are largely confined to the regions and countries with strong international trade or financial ties, especially with the major central banks. To the extent that financial and trade linkages between countries continue to evolve, the BSA network configuration is likely to respond to such developments. Second, our findings suggest that the BSA network can be prone to geopolitical considerations, through both direct and indirect channels. To the extent that changes in geopolitical landscapes result in a reconfiguration of trade and financial linkages, they can indirectly affect BSAs.[21] In addition, our estimates highlight the direct effects that geopolitical factors have on the BSA network: regional integration tends to stimulate BSAs in the region, while increasing geopolitical distance between countries would re-enforce BSA network fragmentation along political lines, leaving economically interconnected but politically distant economies exposed to spillovers of shocks. These implications are particularly important in the current context of rising geopolitical tensions and fragmentation documented by several studies.[22]

V. Conclusions

BSAs have become a key layer of the GFSN, particularly during liquidity crises. Since the GFC, the BSA network has significantly expanded, becoming comparable in size to the multilateral GFSN layers, including the IMF and RFAs.

In this paper, we highlighted the significant role that financial, economic, and geopolitical factors play in affecting countries' decisions to provide liquidity through BSAs. Examining the determinants of countries' decision to become a BSA source country, we found that financial development and trade openness play a key role in this decision-making process. We also found that trade, financial, and geopolitical linkages are important factors for the selection of BSA recipient countries. Our results also confirmed previous findings for the US and China within a much richer set of BSA source countries, but highlighting variations in the relative importance of trade and investment for the BSA supply decision across these countries.

Our findings suggest that the evolution of the BSA network may hinge upon ongoing and future global and regional developments in trade, finance, as well as geopolitics. For example, further expansion of financial markets, development of institutions, and increase cross-border investment exposures, might incentivize more source countries to join the BSA network, while expanding the number of recipients covered by swaps. However, shifts in the geopolitical landscape may result in a reconfiguration of the network along geopolitical lines. For instance, regional integration could foster the establishment of BSAs, while geopolitical fragmentation could make liquidity provision through swaps more fragmented, leaving economically interconnected but politically distant economies, exposed to spillovers of shocks.

Given the significant and potentially growing role of the BSA network, it is key to consider its limitations and to ensure its coordination with the other GFSN layers. Uncoordinated increase of the BSA network may pose moral hazard risk if short-term BSA financing, which usually has no policy conditionality, is used to delay macroeconomic adjustment, amplifying rather than reducing crises. Thus, cooperation between central banks, the IMF, and RFAs may become particularly important to ensure effectiveness of the GFSN in supporting countries during economic and financial distress and ensuring the stability of the IMS.

This paper also offers several avenues for further research of BSAs. First, depending on data availability, future studies could account for BSAs terms and conditions – e.g., the choice of standing versus temporary

[21] See, for example, Bolhuis et al. (2023) for a study on the impact of geoeconomic fragmentation on cross-country trade linkages.
[22] See, for example, IMF (2023) and the references therein.

instruments, their maturity, collateral requirements, and information disclosure – which could shed light on the motivation for their use and provide a broader picture of how swaps are embedded within the central banks' institutional framework. Second, it would be interesting to explore, beyond our paper's focus on BSA formation, factors affecting the cessation of some BSA links. Third, given the absence of policy conditionality attached to BSAs, a distinct and promising strand of work could center on examining the effects of BSA establishment on recipient countries' pace of macroeconomic adjustments and reforms. Finally, future research could look into the implications of geo-political fragmentation for BSA network re-configuration in more detail, analyzing risks to the GFSN effectiveness and, more generally, implications for the IMS.

Annex I. Theoretical Framework

This annex presents the details of our theoretical framework used to motivate the paper's empirical analyses. The framework extends from existing models of BSAs by introducing a trade channel in addition to the financial stability channel that is often the focus in the literature.

The annex consists of three subsections. In the first subsection, we begin by considering a setting in which financial stability considerations are the main factor driving the supply of BSAs. This financial channel is in line with the financial stability considerations explored in Aizenman and Pasricha (2010) and Bahaj and Reis (2022). In the second subsection, we extend the framework to introduce a trade channel. The final subsection then discusses the framework's implications. Note that our analysis focuses on the quantity of liquidity supplied through BSAs. While other lending terms (e.g., the interest rates) could play an important role in ensuring that the market for central bank lending clears, we abstract away from such details to focus on the dimensions of the BSAs that *are* empirically tested in this paper.[23]

BSA and financial stability risks

Consider a two-country setting consisting of countries i and p. Each country has its own central bank and a domestic banking sector (henceforth also referred to as "banks"). The balance sheets of the respective countries' banking sectors are shown in Table A1.1, where the banks in country i are assumed to lend to their counterparts in country p (for ease of reference, it may be useful to think of country i as a large economy such as the US, and country p as a smaller economy such as Thailand). Given this lending activity, we refer to country i as a source country, and country p as a recipient country, in line with the terminology in Bahaj and Reis (2022). In addition, we have the following equation: $A_i^p = L_p^i$ - that is, the assets of banks in the source country vis-à-vis banks in recipient country are equal to the liabilities of the latter vis-à-vis the former.

Table A1.1. Balance Sheets

Country *i*	
Assets	Liabilities
A_i^H	L_i
A_i^p	$Equity_i$

Country *p*	
Assets	Liabilities
A_p	L_p^H
	L_p^i
	$Equity_p$

To introduce a motivation for a BSA, we assume that banks in the recipient country can face a liquidity shock in terms of the currency of the source country. If so, there is a probability d_1 that they may not be able to pay back their liabilities to their counterparts in source country. Hence, the banks in the source country face expected losses $d_1 A_i^p$.

We further assume that the central bank of the source country may decide to provide liquidity (in the form of local currency) through a BSA to the central bank of the recipient country, who can then on-lend the FX resources to their domestic banks. Note that this resembles a standard liquidity shock setup, now brought into an international multi-currency context, where a central bank can play the role of a lender of last resort for illiquid but otherwise solvent financial institutions, with the aim of preventing a potential illiquidity-insolvency spiral.

[23] For a more elaborate model on BSAs where these features are present, see e.g., Bahaj and Reis (2022).

There are two key modifications in our setting. The first key modification is that the recipient country's central bank may not have the needed foreign currency to provide to its domestic banking system, while the source country's central bank has the resources to do so. Using our US-Thai example, this is akin to a situation where there is a dollar liquidity shortage in the Thai banking system, in which case the Bank of Thailand may need to access the Fed's swap facility to obtain the needed dollar. The second modification is the on-lending through the recipient country's central bank to their domestic banks. This reflects the fact that it may be difficult (for economic and legal reasons) for a foreign central bank to lend directly to the recipient country's banks (e.g. the Fed does not lend directly to Thai banks). These two assumptions introduce the role of a BSA, which closes the gaps in the financing arrangement. Under such a BSA, the source country's central bank lends its currency to its counterpart in the recipient country in exchange for the latter's currency.

Our assumptions imply the following risks for the relevant stakeholders. First, due to the on-lending assumption, the recipient country's central bank bears the credit risk related to their domestic banks' repayments. That is, the Bank of Thailand will take on losses in its balance sheet if the Thai banks are not able to repay the dollar loan has been on-lent to them. This risk is similar to that from any other central bank liquidity facility to its banks, and is thus not the focus of this paper. More importantly, our assumptions imply that the source country's central bank bears the credit risk related to the recipient central bank's repayment.[24] This risk is partly mitigated by the nature of the swaps contract, since the two currencies are exchanged as each other's "collateral". However, the credit risk materializes if the value of the recipient country's currency depreciates in response to the ongoing banking sector liquidity crisis, decreasing the value of the collateral.

Notationally, we assume that the source country's central bank lends its currency to the recipient country's through a BSA in the amount of A_p, which is then on-lent to the recipient country's domestic banks. With some probability $1 - d_2$, the banks in the recipient country will be able to fully repay their liabilities, and the central bank in country *i* will face no losses. However, with probability $d_2 < d_1$, the banks still default on their obligations. In addition, we assume that the BSA entails two types of cost to the source country's central bank. First, it entails financial cost in terms of monitoring cost, C (fixed costs to monitor the recipient central bank). Second, with some probability d, the central bank of the recipient country may also default on its obligation to its counterpart in the source country. Given these assumptions, the expected losses to the banks and central bank of the source country if it provides BSA liquidity are $d_2 A_i^p$ and $d_2 dA_p$, respectively.

Given this setup, the source country's central bank faces a trade-off in its decision to provide BSA liquidity. More specifically, it has to balance the potential gain in terms of reducing the expected losses for its domestic banks $(d_1 - d_2)A_i^p$, and the associated monitoring cost and the expected loss from the default on the BSA by the recipient country's central bank $(C + d_2 dA_p)$. These considerations give rise to the following condition for the central bank to find it optimal to provide BSA liquidity:

$$k_1(d_1 - d_2)A_i^p > k_3\{d_2 dA_p + C\} \quad \text{(A1.1)}$$

where k_1 and k_3 are the preference parameters of the source country's central bank with respect to financial stability and its own financial losses, respectively.

[24] This assumption is different from the treatment in Bahaj and Reis (2023), which assumes that the credit risk faced by the source country is negligible due to the high reputational damage that such a default would cause to the recipient country's central bank. However, given that BSAs are partly established precisely to deal with crisis scenarios, we treat the possibility of such a default to be non-negligible in our setting.

BSAs and trade considerations

Financial stability considerations may not be the only motivation for the source country's central bank to provide foreign currency liquidity to the recipient country. Indeed, in many cases, central banks cite trade facilitation and promotion as a purpose for BSA establishment.

To account for these cases, we extend the model to allow for a trade channel. In addition to banks' cross-border financial linkages, we assume that country i has cross-border trade with country p, as captured by exports and imports values, Ex_i^p and Im_i^p.

In addition to the financial stability considerations discussed above, an important consideration in this case is the effects of the crisis on the exchange rate and, consequently, the values of exports and imports. More specifically, the liquidity crisis in the recipient country may result in a depreciation of the country's currency relative to that of the source country (arising, for example, from the associated loss of investors' confidence, causing capital outflows from recipient country). This will have spillovers to source country's output through reduced exports to and increased imports from the recipient country, where we denote the changes in these two variables by xEx_i^p and nIm_i^p. The total expected losses for the source country (assumed to be borne by the country's central bank, for simplicity) stemming from liquidity risk in the recipient country under the no BSA and under the BSA scenarios, respectively, become:

$$L_{noBSA} = k_1 d_1 A_i^p + k_2\{d_1 xEx_i^p + d_1 nIm_i^p\}, \tag{A1.2}$$

$$L_{BSA} = k_1 d_2 A_i^p + k_2\{d_2 xEx_i^p + d_2 nIm_i^p\} + k_3\{d_2 dA_p + C\}, \tag{A1.3}$$

where k_2 is central bank's preference parameter with respect to output losses related to international trade.

Figure A1.1. Expected losses under no BSA

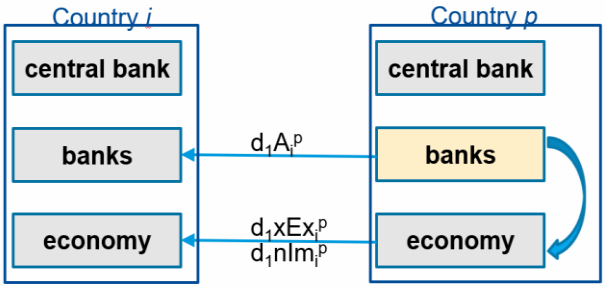
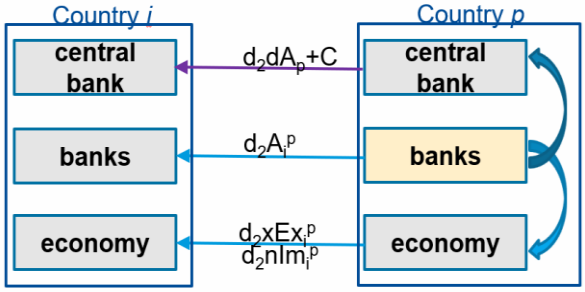


Figure A1.2. Expected losses under BSA



Assuming that the central bank aims to minimize its expected loss function value, it will establish a BSA and provide liquidity if $L_{bsa} < L_{nobsa}$, or

$$\frac{k_1}{dA_p(1+\frac{C}{d_2 dA_p})} A_i^p + \frac{k_2 x}{dA_p(1+\frac{C}{d_2 dA_p})} Ex_i^p + \frac{k_2 n}{dA_p(1+\frac{C}{d_2 dA_p})} Im_i^p > \frac{d_2 k_3}{d_1 - d_2}. \tag{A1.4}$$

Model implications

Note that due to the presence of monitoring cost C, (A1.4) does not hold for counterparts with small financial markets ($A_p \to 0$) and small size of the economy ($Y_p \to 0$). To see that, re-parametrize $A_i^p = a_i^p A_p$, $Ex_i^p = x_i^p Ex_p = x_i^p x_p Y_p = x_i^p x_p / a_p A_p$, $Im_i^p = n_i^p Im_p = n_i^p n_p Y_p = n_i^p n_p / a_p A_p$, where a_i^p is the share of country i in the financial

market of country p, x_i^p and n_i^p are the shares of exports and imports of country i in the total imports of country p, and x_p, n_p, and y_p are structural characteristics of economy p (shares of exports and imports in terms of GDP), $a_p = \frac{A_p}{Y_p}$ is the level of financial market development of country p. Under such parametrization, (A1.4) becomes

$$\frac{k_1}{d(1+\frac{C}{d_2 dA_p})} a_i^p + \frac{k_2 x}{d(1+\frac{C}{d_2 dA_p})} \frac{x_i^p x_p}{a_p} + \frac{k_2 n}{d(1+\frac{C}{d_2 dA_p})} \frac{n_i^p n_p}{a_p} > \frac{d_2 k_3}{d_1 - d_2}. \quad \text{(A1.5)}$$

As $A_p \to 0$ (small financial markets) and $Y_p \to 0$ (small size of the economy), and keeping the economic and financial structure of the country p unchanged (a_i^p, x_i^p, n_i^p, x_p, n_p, a_p are all fixed), the left-hand side of (A1.5) declines toward 0 and condition (A1.5) is never met due to the presence of monitoring cost $C > 0$.

For larger financial markets, $\frac{C}{d_2 dA_p} \approx 0$, the BSA financing condition (A1.4) simplifies to:

$$\frac{k_1}{dA_p} A_i^p + \frac{k_2 x}{dA_p} Ex_i^p + \frac{k_2 n}{dA_p} Im_i^p > \frac{d_2 k_3}{d_1 - d_2}. \quad \text{(A1.6)}$$

Thus, if the financial market of the source country and its banking sector's exposure to cross-border lending A_i^p are sufficiently large (giving rise to sufficiently large expected losses from spillbacks), the central bank of the country will have an incentive to provide BSA liquidity to the recipient country. Alternatively, if the international trade exposure (potential losses of output caused by changes in Ex_i^p and Im_i^p) of the source country to the recipient country is sufficiently large, it will also be more likely to establish a BSA to provide liquidity.

Annex II. Additional Empirical Results

This annex consists of four parts. Part A. reports results on the marginal effects and predicted probability discussed in Section IV.A and IV.B. Part B. reports results from the probit regression on the decision to be a liquidity provider excluding countries that are international reserve issuers (as discussed in Subsection IV.A). Part C reports results from all the specifications that were considered for the country-specific regressions for Subsection IV.C. Part D discusses additional analysis and results on the determinants of the *size* of Chinese swaps.

A. Marginal Effects and Predicted Probability

A.1 Decision to Become a BSA Source Country

Figure A.1: Marginal Effects for Decision to Become a BSA Source Country

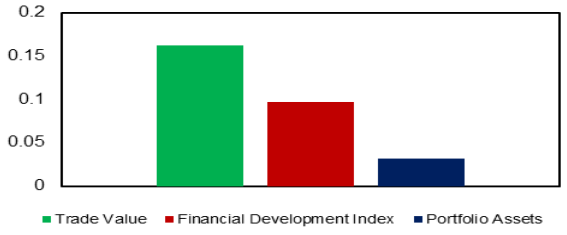
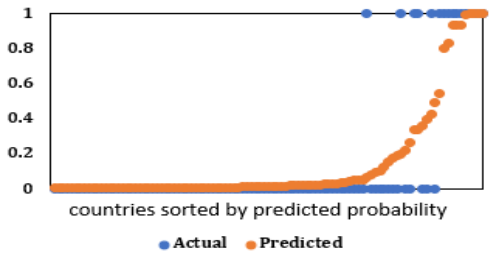


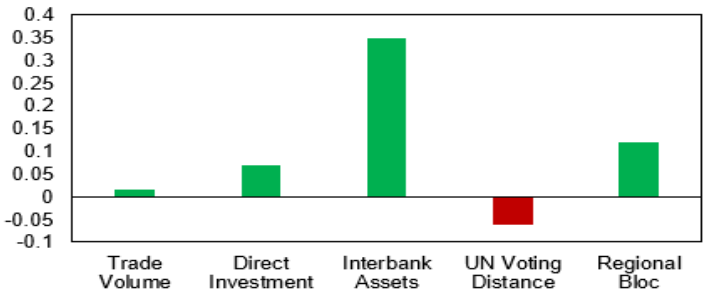
Figure A.2: Predicted Probability vs Actual Decision to Become a BSA Source Country



Source: authors' calculation.
Note: Numbers in both charts derived from specification 4 (specification with the lowest BIC score). The marginal effects in Figure A.2 are evaluated at the mean values of the independent variables.

A.2 Choice of Counterparts

Figure A.3: Marginal Effects for Choice of BSA Recipients



Source: authors' calculation.
Note: The marginal effects are derived from running an additional regression including all variables that are statistically significant in the baseline specifications (specifications 1-4 in Table 2). The effects are evaluated at the mean values of the independent variables.

B. Decision to be a Liquidity Provider Excluding International Reserves Issuers

Probit Regression Results for the Decision to Act as a Liquidity Provider
(Excluding International Reserves Issuers)

	(1)	(2)	(3)	(4)	(5)	(6)
Trade Value	2.512***		2.323***	1.586*	0.955	0.475
	(4.32)		(3.22)	(1.82)	(1.00)	(0.43)
Portfolio Assets		1.659**	0.476	0.013		
		(2.43)	(0.53)	(0.02)		
Financial Development Index				2.006*	2.312**	2.878**
				(1.82)	(2.26)	(2.52)
Reserves					0.555	
					(0.80)	
GDP						0.993
						(1.13)
N	129	103	102	94	115	119
pseudo R^2	0.363	0.218	0.415	0.457	0.456	0.477
BIC	51.34	53.28	46.70	47.87	53.31	52.45

Note: for each variable, the first row reports probit coefficients, while the second row reports the corresponding t statistics, in parentheses. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively. Robust standard errors are used. A constant is included in all specifications. The reserves variable includes international reserves as well as investment in the country's sovereign wealth fund, as discussed in the Subsection III.D.

C. Choice of Counterparts by Reserve Issuing Central Banks

Probit Regression Results on Counterpart Choice: Australia

	(1)	(2)	(3)	(4)
Trade Value	3.734***	27.79	1.468***	1.548***
Interbank Assets	-2.833**			
Direct Investment		-192.3		
UN Voting Distance	1.084*	-20.94	0.471	0.416
Trade Value * UN Voting Distance				0.0954
N	127	96	166	166
pseudo R^2	0.81	1.00	0.64	0.64
BIC	26.11	0.00	28.92	33.98

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Due to the unexpected signs of interbank assets and direct investment, we tried two additional specifications (columns 3 and 4), including just trade value and UN voting distance, and their interaction.

Probit Regression Results on Counterpart Choice: Canada

	(1)	(2)	(3)
Trade Value	313.2	1059.3	797.3
Interbank Assets	-45.30		
Direct Investment		-146.2	
UN Voting Distance	-11.76	-54.79	-43.12
N	56	101	163
pseudo R^2	1.00	1.00	1.00
BIC	0.00	0.00	0.00

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Due to the unexpected signs of interbank assets and direct investment, we tried an additional specification (column 3), including just trade value and UN voting distance, and this combination still results in perfect prediction.

Probit Regression Results on Counterpart Choice: China

	(1)	(2)	(3)	(4)	(5)	(6)
Trade Value	0.194	0.219	0.590**	0.699***	0.443*	0.434
Direct Investment	0.246	0.251	1.563***	1.220***	1.783***	1.922***
UN Voting Distance	0.026		0.0877	0.115	0.115	0.122
Regional Bloc		0.154				
Trade Value * Direct Investment			-0.279***			-0.222***
Trade Value * UN Voting Distance				-0.443***		0.42
Direct Investment * UN Voting Distance					-0.558***	-0.661
N	168	171	168	168	168	168
pseudo R^2	0.13	0.13	0.35	0.33	0.36	0.37
BIC	143.6	144.2	118	120	116.8	125

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Belt and Road Initiative is used for the regional dummy.

Probit Regression Results on Counterpart Choice: Euro Area

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade Value	0.567***	0.581***	1.091	0.444*	0.742	0.621	0.887***	13.08***
Interbank Assets	5.434***		10.75*		9.618	10.07**	50.10***	99.21***
Direct Investment		2.735***		2.095**				
UN Voting Distance	-0.553	-1.665**						
Regional Bloc			-1.871	0.939	-1.994	-2.224	20.56**	55.12***
Trade Value * Interbank Assets					1.441			1.874
Trade Value * Regional Bloc						0.00000512		-0.000137***
Interbank Assets * Regional Bloc							-0.000237**	-0.000517***
N	167	168	171	172	171	171	171	171
pseudo R^2	0.87	0.79	0.88	0.72	0.89	0.89	0.92	0.92
BIC	29.29	35.43	28.75	40.65	33.85	33.77	31.74	31.46

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Eurozone is used for the regional dummy.

Probit Regression Results on Counterpart Choice: Japan

	(1)	(2)	(3)	(4)	(5)
Trade Value	0.139	-0.564**	-0.775	1.967*	0.0968
Interbank Assets	24.74***	22.59***	24.16***	23.73**	46.86**
UN Voting Distance	0.493**				
Regional Bloc		1.993***	2.268***	2.963**	5.314**
Trade Value * Interbank Assets			1.125		
Trade Value * Regional Bloc				-0.0000747**	
Interbank Assets * Regional Bloc					-0.000225**
N	86	86	86	86	86
pseudo R^2	0.71	0.76	0.76	0.78	0.80
BIC	39.23	35.23	39.53	38.04	36.82

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. ASEAN+3 is used for the regional dummy.

Probit Regression Results on: Switzerland

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade Value	2.022***	1.931***	1.739***	1.549**	2.024***	1.443**	1.965***	-2.903
Interbank Assets	3.390*		2.627**					
Direct Investment		2.027		1.281	1.707	2.410**	1.464	-0.802
UN Voting Distance	-1.304***	-1.374***			-1.389***	-1.310***	-1.429***	-2.877***
Regional Bloc			1.046*	0.412				
Trade Value * Direct Investment					1.755			26.17***
Trade Value * UN Voting Distance						-1.433**		-17.51**
Direct Investment * UN Voting Distance							-0.777	-2.879
N	154	61	157	61	61	61	61	61
pseudo R^2	0.72	0.63	0.61	0.48	0.63	0.65	0.63	0.82
BIC	38.09	34.23	44.87	40.98	38.18	37.26	38.14	37.41

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Eurozone is used for the regional dummy.

Probit Regression Results on Counterpart Choice: UK

	(1)	(2)	(3)
Trade Value	2.052**	5.020***	
Interbank Assets			+
Direct Investment	2.852	2.480	
UN Voting Distance	-0.395*		
Regional Bloc		-15.48	
N	114	117	114
pseudo R^2	0.74	0.805	1.00
BIC	31.19	23.50	0.00

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications. Specification 3 (including interbank assets alone) results in perfect prediction.

Probit Regression Results on Counterpart Choice: US

	(1)	(2)	(3)	(4)	(5)	(6)
Trade Value	-0.309	-0.459*	2.665	-0.303	-0.115	1.690
Interbank Assets	18.20***		27.86***	17.79**	10.83***	10.30***
Direct Investment		11.79***				
UN Voting Distance	-0.838***	-0.555*	-1.071***	-0.833***	-3.628**	-7.153***
Trade Value * Interbank Assets			33.88			20.34*
Trade Value * UN Voting Distance				-0.0676		1.785
Interbank Assets * UN Voting Distance					-10.85**	-23.71**
N	66	139	66	66	66	66
pseudo R^2	0.75	0.72	0.78	0.75	0.77	0.81
BIC	34.04	45.55	35.92	38.23	36.88	42.08

Note: probit coefficients are reported. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, determined based on robust standard errors. A constant is included in all specifications.

D. Size of Chinese Swap Lines

This subsection examines the factors that explain the size of the BSA, where the analysis is limited to Chinese BSAs for which a sufficiently large BSA network exists to allow for reliable estimation. To this end, we estimate a linear regression of the form:

$$BSA\_Size_j = Y_j\delta + v_j \tag{C.1}$$

where BSA_Size_j is the size of the BSA between China and country j, Y_j is the same vector of variables as in step 2 of Section III.C.

The regression results are reported in the table below. Overall, we find that the size of Chinese BSAs is significantly determined by trade and investment linkages. More specifically, based on specification 3, which has the lowest BIC score, both trade and direct investment are statistically significant and have the expected positive sign. They are also economically significant: a one-standard-deviation increase in trade ($114 billion) results in an increase in the size of a BSA by 51 percent of its standard deviation (or around $9 billion), while a one-standard-deviation increase in investment ($13 billion) results in an increase in size by 37 percent of its standard deviation (around $7 billion). Interestingly, UN voting distance has a positive sign, although significant only at 10% level for the preferred specification. This result is potentially due to the large BSAs that China has established with Korea, Australia, UK and EU, which are distant from China in terms of their voting positions. In any case, an increase in the geopolitical distance does not reduce the size of BSAs, which is consistent with earlier findings by Lin et al. (2016).[25]

[25] Utilizing data on Chinese swap lines for an earlier sample period (ending in 2016), these authors show that once a swap line is established with a particular country (which could potentially be due to potential considerations), the *size* of Chinese swap lines is not influenced by political factors, but rather by trade and financial ties.

Regression Results for the Size of Chinese Swaps

	(1)	(2)	(3)	(4)	(5)
Trade Value	0.242	0.272	0.507***	0.542***	0.386**
	(1.50)	(1.54)	(3.24)	(2.95)	(2.61)
Direct Investment	0.163	0.173	0.364***	0.212*	0.186***
	(1.26)	(1.34)	(6.09)	(2.07)	(3.02)
UN Voting Distance	0.236		0.246*	0.410**	0.424**
	(1.58)		(1.97)	(2.14)	(2.19)
Regional Bloc		-0.486			
		(-1.43)			
Trade Volume * Direct Investment			-0.0865***		
			(-4.07)		
Trade Volume * UN Voting Distance				-0.269*	
				(-2.08)	
Direct Investment * UN Voting Distance					-0.170**
					(-2.39)
N	25	25	25	25	25
R^2	0.59	0.59	0.79	0.65	0.69
BIC	60.26	60.75	47.13	59.49	57.11

Note: Columns (1)-(2) capture our baseline specifications in terms of trade, financial, and geopolitical linkages, while Columns (3)-(5) consider additional interaction terms between variables based on the baseline specification with the lowest BIC score. ***. **, and * indicate statistical significance at 1%, 5% and 10%, respectively, based on robust standard errors. A constant is included in all specifications. For the regional bloc dummy variable, Belt and Road Initiative is used. All variables, except the regional bloc dummy, are standardized.

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