Global stores of value and the International role of the renminbi

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Abstract

We explore the conditions under which a financial asset emerges as a global store of value and can co-exist with a pre-existing (incumbent) store of value. In our model the acceptability of an asset as a global store is driven by the issuing region’s financial development, growth rate, degree of capital liberalization, and by strategic complementarities across investors vying to purchase and sell financial assets. Our model contributes to the debate on the internationalization of the renminbi, supporting the view that deep financial reforms should precede capital account liberalization to sustain the renminbi's international status over the medium term.

Keywords: Safe Assets, International Monetary System, International Currencies, Renminbi Internationalization

\textit{JEL classification codes:} F02, F30, F33, G15

\footnotesize
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\end{itemize}

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1
“... it is not nationalism which spreads the use of the dollar and the use of English; it is the ordinary search of the world for short cuts in getting things done...”

Kindleberger (1967, p.10, emphasis added)

1. Introduction

The global financial crisis of 2007-8, the euro area crisis of 2010-12, and the political disputes over the US debt ceiling in 2013, have renewed interest in the future of the international monetary system. Policymakers and academics alike have questioned the viability of the existing US dollar-based system. Some argue for wider use of the IMF’s Special Drawing Rights (SDR) as a global store of value (Zhou, 2009), while others point to the inevitability of a multipolar system in which the US dollar shares its international currency status with other currencies, notably the renminbi (Eichengreen, 2011). Dissatisfaction with the status quo has also prompted China to formally embark on a policy to internationalize the renminbi, despite its transitional stage of financial development and before fully liberalizing the capital account (McCauley, 2011; Yu, 2014).

The literature on international currency status has typically emphasized the role of strategic externalities and economies of scale (Krugman, 1980; Matsuyama et al., 1993; Rey, 2001; Flandreau and Jobst, 2009). An agent’s incentive to accept a currency depends on the extent to which future counterparties are likely to do the same. Currencies with sizable areas of circulation thus emerge as international currencies since opportunities to trade with a consenting counterparty are greatest. This, in turn, generates persistence and path dependency, since new transactions gravitate towards the largest countries. Viewed from this perspective, the international monetary system is likely to remain unipolar, with any shift away from the dollar to a new dominant international currency only taking place glacially (Frankel, 2011; Kenen, 2011).

Recent work by Eichengreen and Flandreau (2009, 2012) questions this narrative. They re-examine the thesis that the dollar dethroned sterling after World War II and conclude that international currency status was shared between the dollar and sterling as early as the inter-war years. Chițu et al. (2013) further suggest that financial development and market liquidity may have been more critical than size in propelling the international currency status of the dollar during this period. The implication is that
multipolar systems are quite plausible, and that policies aimed at sustainable financial deepening and integration could promote the international currency status of currencies other than the dollar.

In this paper, we explore the theoretical underpinnings of Eichengreen and Flandreau’s “new view” by analyzing: (a) the conditions under which a financial asset emerges as a global store of value; (b) the conditions under which it can co-exist with a pre-existing (incumbent) store of value; and (c) the role that policies geared towards financial development, capital account liberalization, and enhanced liquidity of funding markets play in that process. We then draw upon the insights of our model to evaluate the recent policy debate on the process of renminbi internationalization.

Our approach to modeling global stores of value lays emphasis on the role of information frictions. In our framework, it is difficult for investors to distinguish the underlying quality of collateral backing the financial asset (a bond). For the asset to emerge as a global store of value, it must be exchanged in “money-like” fashion without the need for costly information acquisition about collateral quality. We treat as endogenous the decision of investors to gather costly information about the asset, and show how this depends on a strategic complementarity – the payoff to an investor from choosing not to collect information is increasing in his beliefs over counterparties who behave likewise. Liquidity thus depends on acceptability, in the sense that investors regard the store of value as ‘safe’, and are prepared to trade it without monitoring.\(^1\)

We show that the emergence of an internationally acceptable store of value is linearly related to information costs and fundamentals, i.e. the growth rate of the economy and the extent of financial development. The results are intuitive. Investors readily accept a store of value issued by a financially well-developed economy with a high growth rate. But other combinations of fundamentals can also support asset acceptability. For instance, assets may be accepted as stores of value when growth rates are low, provided financial development is well advanced and vice versa. Furthermore, as differences in opinion on the bond’s underlying characteristics diminish and as information costs de-

\(^1\)As noted by Kindleberger (1967) in the epigraph, transaction costs are central to the theory of international currency. While traditional models of international currency status typically relate transactions costs to market size, we link transactions costs to an intrinsic property of the asset, i.e. collateral quality. We thus follow Jevons (1875), Menger (1892), Alchian (1977), Banerjee and Maskin (1996) and, most recently, Lester et al. (2012) in associating information and liquidity. Dang et al. (2010) and Yang (2013) also emphasize the role of “information insensitivity” as a key property underpinning the safety of debt instruments.
cline, asset acceptability is supported for a wider range of fundamentals.

We extend the basic model to a two-region setting in which one region (Blue) plays the role of incumbent, providing a global store of value with an underlying quality of collateral that is beyond doubt. The other region (Red) is characterized by faster growth, lower financial development, and capital controls. A multipolar world, in which the stores of value of both regions co-exist, now requires investors to accept both assets without monitoring. In addition to fundamentals and information costs, asset acceptability is also influenced by the degree of capital controls and measures that cushion price falls in the event of distress asset sales. We establish the combinations of these parameters that are consistent with the co-existence of stores of value in the world economy and demonstrate intuitive relationships between them.

In our model, the Blue region commands an “exorbitant privilege” (Obstfeld and Rogoff, 2005; Gourinchas and Rey, 2007; Gourinchas et al. 2010). It enjoys a negative foreign asset position and a lower cost of borrowing in return for providing liquidity to the rest of the world. This privilege erodes as the new store of value gains acceptance amongst investors. We identify the critical value of the shock to Blue fundamentals at which co-existence emerges. The effects on world interest rates are non-linear, and we show how policy actions by Red region can bring forward this transition.

Although stylized, our model setup has implications for the debate on the internationalization of the renminbi. Eichengreen (2014) identifies three pathways along which the process of renminbi internationalization might unfold. The first pathway involves building a robust and efficient domestic financial system before embarking on currency internationalization. The second pathway relies on a strategy of rapid capital liberalization to attain international currency status in the hope of eventually catalyzing domestic financial reform. And a third pathway follows an intermediate route – gradual financial reform and relaxation of capital controls, together with special offshore zones and a network of swap lines, to facilitate the international use of the renminbi.

Our results clarify some of the trade-offs involved in choosing these pathways. For instance, if capital controls are liberalized to some extent and if a rich network of swap lines is put in place, the degree of fundamental domestic financial reform necessary to facilitate international currency status is lower. Moreover, emphasizing one pathway over the others is likely to prove counterproductive. In particular, rapid capital liberalization without meaningful financial reform or the safeguard of swap lines is likely to result in
situations where international currency status is very fragile and vulnerable to small shocks. We conclude by illustrating how our model sheds light on the role that offshore financial centres play in speeding up the process of currency internationalization.

Our paper is related to, but distinct from, several recent contributions. We extend Caballero et al. (2008) to allow for endogenous asset safety by letting agents invest in costly information about underlying collateral quality. Like us, Gourinchas and Jeanne (2012) also use the Caballero et al. (2008) framework to study global safe assets. But they treat asset safety as exogenous and do not consider how the frontier between safe and unsafe assets is determined. Moreover, the large closed economy setting in their paper precludes an analysis of the coexistence of global safe assets and the role the role of macroeconomic fundamentals and information costs in promoting international currency status.

Our paper also shares common ground with Lester et al. (2012). In their extension of Lagos and Wright (2005), agents “recognize” the quality of an asset by investing in information and this, in turn, renders liquidity endogenous. While the Lester et al. (2012) treatment of recognizability is very similar to our notion of acceptability, the information acquisition process in the two models have a very different game-theoretic underpinning. Moreover, their primary focus is on monetary policy rather than on problems of co-existing global stores of value. And their search-theoretic apparatus precludes consideration of issues central to Eichengreen and Flandreau’s “new view”, such as capital liberalization and financial development.²

Finally, Zhang (2012) extends Lester et al. (2012) to a two-country setting in order to explore the issue of international currency status. As in our paper, strategic complementarities in information acquisition decisions also lead to multiple equilibria, including the possibility of co-existing international currencies. But her focus is on the role that inflation plays in disciplining countries seeking international status for their currencies. Zhang also considers the strategic interplay between monetary authorities in the two regions, a topic that is beyond the scope of our paper.

²Other papers on international currencies in the search-theoretic tradition include Zhou (1997), Trejos and Wright (2001), Head and Shi (2003), and Li and Matsui (2009).
2. The process of renminbi internationalization

In this section, we motivate our model by describing some of the progress towards renminbi internationalization. Our account is merely illustrative – the reader is referred to Cockerell and Shoory (2012), Hooley (2013), Eichengreen (2014), and Yu (2014) for detailed discussion of the reforms underpinning China’s financial integration and the international use of the renminbi.

The process of renminbi internationalization began in 2009 as a conscious policy move by the Chinese authorities (Yu, 2014). As noted by Eichengreen (2014), the policy has followed three main ‘pathways’. The first emphasizes domestic financial development, notably the strengthening of contract enforcement, reform of the banking system, and the creation of deep and liquid securities markets. The second prioritizes capital account liberalization, allowing Chinese residents to diversify their portfolios towards foreign assets and foreigners to participate more actively in renminbi-denominated business activities. Finally, a third route charts a middle way. In this multi-pronged approach, domestic financial reform and capital liberalization takes place selectively, while offshore financial centers (e.g. Hong Kong) and special onshore financial zones (e.g. Shanghai) are deployed as experimental platforms, cultivating expertise and clientele for the renminbi. These are complemented by renminbi swap lines negotiated with central banks of other countries that encourage foreign banks and firms to take positions in the renminbi.  

2.1. Domestic financial reform

The formal legal structures that underpin financial transactions in China remain weak. As Figure 1 shows, the degree to which collateral and bankruptcy laws protect borrowers and lenders in China lags well behind most advanced economies. Allen et al. (2010) are critical of China’s creditor and shareholder protection regimes, and highlight how the limited supply of qualified legal and accounting professionals has led to weak accounting standards, poor disclosure rules, and ineffective regulation of financial markets and institutions. They conclude that an alternative (and informal) system of reputation-based arrangements and institutions effectively substitutes for the many standard corporate governance mechanisms that are typically found in developed financial systems. 

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3McCaulley (2011) describes this approach as “internationalization within capital controls”.
4For example, Allen et al. (2010) document that, of the 5 million or so business enterprises in China, a mere 4% employ regular legal advisers.
The Chinese banking sector is predominantly state-owned. Table 1 presents Chinese benchmark interest rates on banks’ loans and deposits at various maturities. The imposition of a floor for lending rates and a ceiling for bank deposit rates has stifled competition in the banking sector, while ensuring stable profits for state-owned banks. In June and July 2012, the Chinese authorities relaxed these restrictions, announcing that actual rates on all bank deposits could exceed the relevant benchmark by up to 10 percent, while lending rates could be as much as 30 percent below the benchmark.
The Chinese authorities have sought to promote bond market development by issuing sovereign and other government bonds on the off-shore renminbi bond market. Since 2010, the variety of bond issuers has extended beyond state issuers to include non-financial foreign firms and mainland non-financial corporations. Reflecting this, the total issuance of “dim-sum” bonds has increased from some US$1.3 bn in 2007 to around US$18 bn in 2012 (Figure 2). But despite the sharp pickup, bond issuance remains small – the value of these off-shore assets is around a tenth the size of the United States.

2.2. Capital account liberalization

Capital flows in China remain subject to tight controls. Figure 3, which plots the Chinn and Ito (2006) financial openness measure, illustrates how far China lags behind other advanced economies. Domestic residents can only invest abroad via the Qualified Domestic Institutional Investor (QDII) scheme. By end 2012, some 106 institutions had attained QDII status and the quota for such investment was US$86 bn. Similar restrictions prevent foreigners investing in renminbi-denominated shares unless they are part of the Qualified Foreign Institutional Investors (QFII) scheme. Since 2012, the quota for such investment has been liberalized considerably (to some US$160 bn) and has been augmented by a further scheme (RFQII) that allows renminbi sourced from the offshore bond market to be invested in onshore equity and bond markets. Figure 4 illustrates the evolution of allocated quotas for foreign investment in Chinese assets.

Table 2, drawn from He et al. (2012), compares China’s international investment position as a percentage of GDP against a group of countries with very open capital accounts. As can be seen, the scale of inward and outward portfolio positions and direct investments

\[
\begin{array}{|c|c|c|}
\hline
\text{Demand} & \text{Deposit} \\
\hline
\text{Demand} & 0.4 & \text{NA} \\
\text{3-month} & 2.60 & \text{NA} \\
\text{6-month} & 2.80 & 5.60 \\
\text{1-year} & 3.00 & 6.00 \\
\text{2-year} & 3.80 & \text{NA} \\
\text{3-year} & 4.30 & 6.15 \\
\text{5-year} & 4.80 & 6.40 \\
\text{>5-year} & \text{NA} & 6.55 \\
\hline
\end{array}
\]

Table 1: Chinese benchmark interest rates as of May 5th, 2014. Source: Bloomberg
in China is considerably smaller than of the reference group. Hooley (2013) suggests, however, that if the capital account is fully liberalized then the stock of China’s external assets and liabilities could be comparable to the current position of the US by 2025.
### Table 2: International investment position as percent of GDP.

For the period 1995-2004, the Benchmark countries with open capital accounts comprised of: Belgium, France, Germany, Hong Kong SAR, Italy, Japan, Netherlands, Peru, United Kingdom and United States. While, for 2005-2009, the countries included were only: Hong Kong SAR, Italy, Netherlands, Peru and the United Kingdom. Source: He et al. (2012)

<table>
<thead>
<tr>
<th></th>
<th>Direct Assets</th>
<th>Direct Liabilities</th>
<th>Portfolio Assets</th>
<th>Portfolio Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>China in 2010</td>
<td>5.3</td>
<td>25.1</td>
<td>4.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Benchmark Countries, avg. 1995-2009</td>
<td>36.3</td>
<td>32.6</td>
<td>51.8</td>
<td>54.2</td>
</tr>
</tbody>
</table>

2.3. **Swap lines and off/onshore financial centers**

The People’s Bank of China (PBOC) has negotiated a number of bilateral agreements with central banks in other countries (see Figure 5) to swap renminbi for their national currencies. The purpose of these agreements is as a backup source of liquidity, or safety-net, to support trade denominated in local currency. In addition, China has sought to promote Hong Kong and Shanghai as special off/onshore financial centers. The rationale, according to Eichengreen (2014), is that such centers act as ‘petri dishes’, helping investors gain familiarity with the renminbi as a unit of account, store of value and as a means of payment. The centers also serve to cultivate liquidity pools and an international clientele for the renminbi.\(^5\)

An important measure of the progress of renminbi internationalization has been the evolution of renminbi deposits in Hong Kong (Figure 6). These deposits grew substantially during 2010 and 2011 and now account for some 20% of all foreign currency deposits in Hong Kong, compared with around 2% in 2007. The rapid development has been facilitated in large part by the increasing use of the renminbi in trade invoicing and settlement, with around two-thirds of all renminbi trade settlements taking place in Hong Kong.

3. **A model of acceptable stores of value**

We begin by describing a large closed economy comprising overlapping generations of agents with access to a single savings vehicle. We develop the baseline model in three steps. First, we describe the trading environment for the store of value. Second, we portray the decision by agents to gather costly information about the asset. And third,\(^5\)

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\(^5\)In addition, agents may be able to learn about institutions and financial product design and transfer this knowledge onshore via these centers during the transition to renminbi internationalization.
we show how asset acceptability arises endogenously and relates to the key parameters of the model.

3.1. The trading environment

Time evolves in discrete steps, $t = 0, 1, 2, \ldots$. The economy, which grows at a constant rate $g$, consists of $N$ islands and a long-lived central bank. A risk-neutral agent is born on every island, is economically active in each period $t$, and dies at the start of period $t+1$ to make way for the next generation.

Agents born in period $t$ receive an endowment, $(1-\delta)X_t$, at birth but can only consume
these resources at the time of death. This discrepancy between income and expenditure creates a demand for savings instruments in the economy. A bond – the sole financial asset and store of value in the economy – is backed by a capitalizable fraction \( \kappa X_t \leq \delta X_t \) of the endowment. The parameter \( \delta \) can be thought of as a measure of the degree of financial development of the economy since it captures how well property rights over earnings are defined.

Each island has a trading relationship with all other islands, enabling a young agent to purchase a bond from an old agent on another island. At \( t = 0 \), Nature draws \( \kappa = \delta \), and while those holding the bond are able to observe the realization of \( \kappa \), others cannot. Would-be buyers of the bond must therefore, decide whether to accept or reject the assurances of the seller about the collateral underlying the bond. In what follows, we allow agents to acquire costly, but coarse, information about collateral to assist them in their choice.

An agent born on island \( j \) in period \( t \) thus selects an old agent on island \( i \) at random (with probability \( 1/(N-1) \)) to trade with. The old agent, who is in possession of a bond and wishes to sell it, claims that collateral is \( \delta \), and not less. If the young agent accepts the claim then trade takes place. Agent \( j \) then observes the collateral \( \kappa = \delta \), consumes the dividend at the end of period \( t \), and attempts to sell the bond at the start of period \( t+1 \) to a young agent residing on another island, \( k \). If trade is successful, then capital gains are consumed just prior to the death of agent \( j \) at the start of period \( t+1 \).

If, on the other hand, the young agent on island \( j \) in period \( t \) rejects the seller’s claim, there is no trade. In this case, the old agent on island \( i \) must sell the bond back to the central bank. This transaction entails real costs, \( C_t \), to agent \( i \)’s consumption, however. We interpret these real costs as the outcome of a forced firesale of the asset. The central bank, in turn, reissues the bond to young agents born in period \( t+2 \) seeking stores of value. Figure 7 depicts the sequence of events in our model.

The market value of the bond is given by the discounted sum of future dividends. At time \( t \), the value of the bond is

\[
V_t = \sum_{j=0}^{\infty} \beta^j (\delta X_{t+j}) = \sum_{j=0}^{\infty} \frac{\delta X_{t+j}}{(1+r)^{j+1}} = \delta X_t \frac{\beta}{r - g},
\]

where \( \beta = 1/(1+r) \) is the discount rate, and \( r \) is the real interest rate. We assume that \( g < r < 1 \) so that the value of the bond is always positive. And, at the beginning of period
If Trade is Accepted in All Periods

<table>
<thead>
<tr>
<th>t − 1</th>
<th>t</th>
<th>t + 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Young agent j born in period t</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Old agent i sells bond to young agent j and consumes $\delta X_{t-1} + V_t - V_{t-1}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Young agent k born in period $t + 1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Old agent j sells bond to young agent k and consumes $\delta X_{t} + V_{t+1} - V_t$</td>
<td></td>
<td></td>
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</tbody>
</table>

If Trade is Rejected in Period $t + 1$

<table>
<thead>
<tr>
<th>t − 1</th>
<th>t</th>
<th>t + 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Young agent j born in period $t$</td>
<td></td>
<td></td>
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<tr>
<td>- Old agent i sells bond to young agent j and consumes $\delta X_{t-1} + V_t - V_{t-1}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Young agent k born in period $t + 1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Old agent j rejects bond from old agent j and consumes $\delta X_{t} + V_{t+1} - V_t$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Young agent l born in period $t + 2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Old agent j sells the bond to the Central Bank and consumes $\delta X_{t} + V_{t+1} - V_t - C_t$</td>
<td></td>
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</tbody>
</table>

Figure 7: The sequence of events. The upper time-line depicts the events when trade between generations takes place, while the lower time-line shows how, if trade is rejected, the old agent sells the bond to the central bank, who then reissues the bond to an agent born in $t + 2$.

$t + 1$, the agent attempts to sell the bond to younger-generation agents for

$$V_{t+1} = \frac{\delta X_{t+1}}{1 + r} + \frac{\delta X_{t+2}}{(1 + r)^2} + ... = \frac{\delta X_{t}(1 + g)}{r - g}$$  \(2\)

resulting in a capital gain of $(V_{t+1} - V_t)/V_t = g$.

Agent $j$’s objective is to maximize expected end of life consumption, $\mathbb{E} [c_{j,t+1}]$, by choosing whether to gather information about the bond, $z_{j,t} \in \{0,1\}$, at date $t$, at a cost $M_t$. Agent $j$’s payoff is $c_{j,t+1}$ whenever the level of consumption is non-zero, but is $-M_t$ if consumption is zero. Section 3.2 characterizes the binary choice problem facing agent $j$.

For the bond to serve as a secure store of value in the economy, it should be “readily acceptable” to all agents – buyers of the bond should not have any incentive to question sellers’ claims about the underlying collateral and engage in costly information gathering.
At root, the acceptability of the bond hinges on an inter-generational strategic complementarity, i.e., the willingness of agents in period $t$ to trade the bond without checking collateral depends on the willingness of agents in period $t+1$, and so on.

Let $\bar{\pi}_{t+1} \in [0,1]$ be the fraction of period $t+1$ agents who accept that the share of capitalizable output backing the bond is $\delta$. If all period $t+1$ agents are in agreement, the market is liquid ($\bar{\pi}_{t+1} = 1$) and capital gains are realized in their entirety. However, when there are doubts over collateral, period $t+1$ agents will check the underlying collateral and with probability $\gamma$ will reject the trade. The period $t$ agent, thus, sells the bond at a firesale price to the central bank. Thus,

$$r_t = \frac{V_{t+1} - V_t}{V_t} - \frac{C_t \gamma [1 - \bar{\pi}_{t+1}]}{V_t} + \frac{\delta X_t}{V_t}, \quad (3)$$

where $C_t = \phi V_t$ is the cost to the period $t$ agent from a distress bond sale. The parameter $\phi \leq 1$ measures the willingness of the central bank to cushion the fire-sale of assets.\(^6\)

In the steady state (i.e., $\bar{\pi}_{t+1} = \bar{\pi}_t$), the market value of the bond must equal the aggregate wealth, so that $V_t = W_t = X_t$. Accordingly, the equilibrium interest rate is

$$r \equiv r(\bar{\pi}) = \delta + g - \gamma (1 - \bar{\pi}) \phi, \quad (4)$$

which is increasing in agents’ agreement, $\bar{\pi}$, over the underlying collateral. Conversely, when disagreements over collateral is widespread and the central bank is reluctant to cushion price falls in the bond market, the equilibrium interest rate must decrease in order to keep the value of the bond constant.

### 3.2. Information acquisition

We now consider the period $t$ decision by agent $j$ to gather information about collateral. The decision is a discrete choice. In accepting the bond, agent $j$ must decide whether to accept the seller’s claims that collateral is $\delta$ or, instead, engage in costly monitoring. Let $z_{j,t} = 1$ be the decision by agent $j$ to accept the claim and value of the bond without monitoring, and let $z_{j,t} = 0$ be the decision to monitor. The cost of monitoring, $M_t = \mu V_t$, scales with the value of the bond, where $\mu$ represents the marginal cost of information and $V_t$ is a function of collateralizable output. Our formalization departs from the tra-

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\(^6\)In the international setting considered in this paper, the central bank may enter into bilateral swap arrangements in order to provide investors with a backstop liquidity facility.
ditional approach to modelling international currencies, where transaction costs scales with the size of a country (e.g., Matsuyama et al. 1993) and, instead, links information costs to intrinsic properties of the bond.

In addition to being costly, identifying good collateral is an inexact endeavour. Financial firms typically employ credit risk models and apply arbitrary rules of thumb when making credit decisions. With conditional probability $1 - \gamma$, the credit risk analysis correctly identifies that the bond is backed by collateral worth $\delta$. While, with probability $\gamma$, the credit risk framework incorrectly signals that collateral is less than $\delta$. If agent $j$ has a uniform prior over the conclusions of the credit risk model, then $\gamma$ and $1 - \gamma$ also serve as $j$’s posterior beliefs over the collateral.

Figure 8 illustrates the decision tree facing agent $j$. If the agent decides to monitor, then $z_{j,t} = 0$. With probability $\gamma$, agent $j$ believes that the fraction of collateral is less than $\delta$ and is uniformly distributed over $[0, \delta)$. Agent $j$ is thus better off rejecting the trade instead of purchasing the bond for $V_t$, expecting to consume $\delta X_t/2$ and subsequently selling the bond for $V_{t+1}/2$. Thus, agent $j$ receives a payoff

$$-M_t = -\mu V_t.$$  

With probability $1 - \gamma$, the agent believes that the fraction of capitalizable output to be $\delta$ and buys the bond to earn both dividend and capital gains, for a payoff

$$V_{t+1} - V_t + \delta X_t - M_t = V_t [r - \mu].$$  

In deriving this payoff we assume that agent $j$’s consumption is strictly positive, which implies that the marginal monitoring cost must be less than the interest rate.\(^7\)

Should the agent decide, instead, not to gather costly information, then $z_{j,t} = 1$. The payoff to agent $j$ now depends on whether, upon resale, younger-generation trading partners also accept the bond at face value or opt to monitor. Defining $\bar{\pi}_{j,t+1}$ to be agent $j$’s expectation over the fraction of younger-generation trading partners who accept the claim that collateral is $\delta$,

$$\bar{\pi}_{j,t+1} = \frac{1}{N - 1} \sum_{l \neq j}^{N-1} \mathbb{E}[z_{l,t+1}],$$  

\(^7\)In assuming that this holds even when the market is illiquid, we obtain that $\mu < \delta + g - \phi \gamma$.  

15
Agent $j$ accepts the seller’s claim ($z_{j,t} = 1$)

Agent $j$ decides to verify the seller’s claim ($z_{j,t} = 0$)

Randomly selected agent in period $t+1$ refutes $j$’s claim and rejects trade with probability $\gamma (1 - \tilde{\pi}_{j,t+1})$

Signal confirms the seller’s claims with probability $1 - \gamma$

Signal refutes the seller’s claims with probability $\gamma$

$V_{t+1} - V_t + \delta X_t - M_t$

$V_{t+1} - V_t - C_t + \delta X_t$

Figure 8: Agent $j$’s decision to monitor.

the probability that a randomly selected younger-generation investor checks the bond and decides to reject is $\gamma (1 - \tilde{\pi}_{j,t+1})$. In this case, agent $j$ must sell the bond to the central bank, incurring a cost $C_t = \phi V_t$. The payoff to agent $j$ is

$$V_{t+1} - V_t + \delta X_t - \phi V_t = V_t [r - \phi].$$

(8)

This payoff assumes that agent $j$’s consumption is strictly positive, which implies that $\phi < r$.\(^8\)

With probability $\tilde{\pi}_{j,t+1}$ the young agent accepts the claim without monitoring, while with probability $(1 - \gamma)(1 - \tilde{\pi}_{j,t+1})$, the young agent who monitors agrees that collateral is $\delta$. Summing the two, we obtain that trade occurs with probability $1 - \gamma (1 - \tilde{\pi}_{j,t+1})$, and the payoff to $j$ is

$$V_{t+1} - V_t + \delta X_t = V_t r.$$  

(9)

The expected payoff in period $t$ to agent $j$ from accepting the bond without monitoring

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\(^8\)A sufficient condition for this is to take $\phi < (\delta + g)/(1 + \gamma)$. Taken together with the condition for the payoff in equation (6), we obtain a tighter bound $\mu < \gamma (\delta + g)/(1 + \gamma)$ for the cost of information.
is thus
\[ V_t \left[ r - \gamma (1 - \bar{\pi}_{j,t+1}) \phi \right], \quad (10) \]

while the expected payoff from monitoring is
\[ V_t \left[ (1 - \gamma) r - \mu \right]. \quad (11) \]

Note that the payoff to agent \( j \) from choosing \( z_{j,t} = 1 \) is increasing in \( \bar{\pi}_{j,t+1} \). Furthermore, by recursively writing out the payoffs for \( j \)'s future generation trading partners, their payoffs from choosing not to monitor will also be increasing in their beliefs over future generation agents who do not monitor. Strategic complementarity across counter parties is, therefore, inter-generational.

3.3. Asset acceptability

Comparing the payoffs between monitoring (equation 10) and not monitoring (equation 11), agent \( j \) selects \( z_{j,t} = 1 \) whenever
\[ r - \gamma (1 - \bar{\pi}_{j,t+1}) \phi > (1 - \gamma) r - \mu, \quad (12) \]

which, upon rearranging, yields the optimal choice
\[ z_{j,t}^* = \begin{cases} 1, & \text{if } \gamma \left[ \phi \left( \frac{1}{N-1} \sum_{\ell=0}^{N-1} z_{\ell,t+1}^* - 1 \right) + r \right] + \mu \geq 0 \\ 0, & \text{otherwise} \end{cases}. \quad (13) \]

In deriving equation (13), we make use of the fact that the belief of agent \( j \) over the actions of the next generation must be consistent with the best responses of the next generation of agents. Equation (13) makes clear that the best response of agent \( j \) at time \( t \) depends on the best responses of the trading partners at time \( t + 1 \). These, in turn, will depend on the best responses of other agents in the future.

**Proposition 1.** The Nash equilibria in pure strategies are given by the stationary values of \( \bar{\pi} \) that solve the fixed-point equation
\[ \bar{\pi} = \sum_{\ell=0}^{N-1} \left( \frac{N - 1}{\ell} \right) \bar{\pi}^\ell (1 - \bar{\pi})^{N-1-\ell} \left\{ \gamma \left[ \delta + g - \gamma (1 - \bar{\pi}) \phi - \left( 1 - \frac{\ell}{N-1} \right) \phi \right] + \mu \right\}, \quad (14) \]

where \( 1\{\ldots\} \) is the indicator function.
**Proof.** See the appendix.

Figure 9 illustrates Proposition 1 by plot the solutions to equation (14) for different values of $\gamma$. For small $\gamma$, where there is a high degree of agreement between the assessment of agents that the collateral is $\delta$, there is a unique solution with $\bar{\pi} = 1$. All agents accept the bond without monitoring. As $\gamma$ increases, two more solutions emerge – a stable one at $\bar{\pi} = 0$ where all agents monitor and active trading of the bond is curtailed, and an unstable solution with $\bar{\pi} < 1$. The basin of attraction for the $\bar{\pi} = 0$ solution grows with $\gamma$, while that for the $\bar{\pi} = 1$ solution depletes.

**Definition** The bond is “readily acceptable” whenever equation (14) has a unique Nash equilibrium, $\bar{\pi} = 1,$ and all agents accept the bond without checking.

**Proposition 2.** In the limit that the number of islands is large, $N \gg 1$, there is a unique Nash equilibrium in pure strategies where all agents readily accept the bond without monitoring whenever

$$\delta > -g - \frac{\mu}{\gamma} + (1 + \gamma) \phi.$$  \hspace{1cm} (15)

On the other hand, for lower values of $\gamma$ there are two Nash equilibria in pure strategies – (1) all agents accept the bond without monitoring and (2) all agents decide to monitor and active trading is curtailed.

**Proof.** See the appendix.
Equation (15) provides a condition on the size of $\delta$, relative to the other model parameters, that is consistent with there being an unique Nash equilibrium in pure strategies where all agents accept the bond without monitoring. For values of $\delta$ on and below the locus, $-g - \frac{\mu}{\gamma} + (1 + \gamma) \phi$, there are multiple equilibria. We thus interpret the bond as being readily acceptable whenever there is an unique Nash equilibrium where all agents accept the bond without monitoring. Clearly, this equilibrium is stable to small perturbations. While, in the case of multiple equilibria, the path along which agents accept the bond without monitoring is no longer stable to perturbations.

Figure 10 illustrates the locus described in Proposition 2. It shows the degree of financial development, $\delta$, required to support a readily acceptable bond for any given growth rate, $g$. Intuitively, a store of value will be readily accepted in the case of a high-growth economy that is financially well developed (the upper right-hand quadrant). But other combinations are also feasible. Asset acceptability is also possible in low-growth – high-financial development cases, as well as situations where growth rates are high and financial development is low.

The comparative statics for the locus are also clear from equation (15). The ratio $\mu/\gamma$ captures the opportunity cost of an additional unit of information relative to its noise when other agents are not checking. As Figure 10 shows, a rise in $\mu$ (correspondingly, a decrease in $\gamma$) makes the bond more acceptable, i.e., the locus shifts downwards.

A decrease in $\phi$, which reflects a greater willingness of the central bank to cushion the price fall in the event that agent $j$ is stuck with the bond and is forced into a distress
sale, also has the effect of shifting the locus downward. This result is also intuitive – the more willing are the authorities to provide an emergency liquidity backstop, the more acceptable a store of value is likely to be.

4. Acceptable stores of value in a two-region world

We now partition the island economy into two distinct regions, Blue and Red, each with its own long-lived central bank. Let $x^B = X^B_t/(X^B_t + X^R_t)$ be the share of the Blue region’s output in the world economy and, correspondingly, let $x^R = 1 - x^B$ be the share of Red output. We set initial conditions so that the Blue region is more financially developed, i.e., $\delta^B > \delta^R$, while the Red region grows more quickly, i.e., $g^R > g^B$. Moreover, we take $g^R - g^B > \delta^B - \delta^R$. Finally, without loss of generality, we assume the two regions are of equal size ($x^R = x^B = 1/2$) in what follows.

4.1. Trading environment

Each region issues its own bond. At $t = 0$, agents born on islands in the Red region are endowed with Red bonds, while those born in the Blue region receive Blue bonds. Thus, initially there are $N/2$ Red and $N/2$ Blue bonds in circulation. At the same time, Nature draws the collateral backing the Blue and Red bonds as $\kappa^B = \delta^B$ and $\kappa^R = \delta^R$, respectively. Critically, we suppose it is common knowledge that the Blue bond is always readily acceptable: all agents – those holding bonds and those seeking to buy – agree that the collateral backing the Blue bond is $\delta^B$. In contrast, only agents holding Red bonds know that $\kappa^R = \delta^R$. Thus, buyers of Red bonds must decide whether to accept the sellers’ claims or gather costly information about the collateral underpinning the Red bond.\(^9\)

As in Section 3, each island has a trading relationship with all other islands, so that a young agent can purchase a bond from an old agent on another island. We suppose, however, that a fraction $\chi \in (0, x^R)$ of agents endowed with Red bonds are unable to trade with other islands. These agents must instead trade with young agents born on the same island. The parameter $\chi$ thus reflects the extent of capital controls in the Red region. Agents residing on all other islands have recourse to their own as well as the other region’s central bank. Since Blue bonds are readily acceptable, agents holding Blue

\(^9\)Our model thus corresponds to the current international economic situation, where the United States (Blue) is highly financial developed and occupies a role as provider of a global safe asset, while China (Red) is financial underdeveloped, growing rapidly and seeking a greater international role for the Renminbi. See Eichengreen (2011) for a detailed discussion.
bonds do not suffer any fire-sale losses. But the possibility that the market for Red bonds can turn illiquid means that Red bond-holders could face real costs $C_t^R = \phi V_t^R$ if they are forced to sell their bonds to a central bank.

4.2. Interest rates and co-existing stores of value

The interest rates for Red and Blue bonds must equal the respective dividend price ratio plus the capital gains and minus, in the case of the Red bond, costs in the event of a forced sale. Thus

$$r_t^B = \frac{\delta_t^B X_t^B}{V_t^B} + \frac{V_{t+1}^B - V_t^B}{V_t^B},$$

and

$$r_t^R = \frac{\delta_t^R X_t^R}{V_t^R} + \frac{V_{t+1}^R - V_t^R}{V_t^R} - \frac{\phi V_t^R \gamma (1 - \bar{\pi}_{t+1})}{V_t^R}. \tag{17}$$

Market clearing is given by the condition where aggregate wealth of all agents, $W_t$, is equal to aggregate output, which implies $X_t = V_t$. Consequently, the ratio $X_t^B/V_t^B$ may be expressed as $x_t^B X_t/(v_t^B V_t)$, where $v_t^B = V_t^B/V_t$ is the relative value of the Blue bond. If all potential buyers of Red bonds decide to check the collateral then, in the long-term limit, all Red bonds will be rejected and only Blue bonds will be demanded. Accordingly, $v_t^B = x_t^B + (1 - \bar{\pi}) (x_t^R - \chi)$, where $(1 - \bar{\pi})$ is the fraction of agents who decide to check the collateral underlying the Red bond. We thus obtain in the stationery state that

$$r_t^B = \delta_t^B \left( \frac{1}{1 + (1 - \bar{\pi})(1 - 2 \chi)} \right) + g_t^B, \tag{18}$$

and

$$r_t^R = \delta_t^R \left( \frac{1}{1 - (1 - \bar{\pi})(1 - 2 \chi)} \right) + g_t^R - \gamma (1 - \bar{\pi}) \phi \tag{19}$$

Equations (18) and (19) can be readily compared to equation (4), the closed economy expression for the equilibrium real interest rate. If $\bar{\pi} = 1$, and all agents readily accept the Red bond, then $r_t^B = \delta_t^B + g_t^B$. But, if $\bar{\pi} = 0$, then the demand for the Blue bond in the world economy increases, implying a lower interest rate for the Blue region, namely $r_t^B = \delta_t^B/2 (1 - \chi) + g_t^B$. Likewise for the Red region, when $\bar{\pi} = 1$, there are no potential fire-sale losses and $r_t^R = \delta_t^R + g_t^R$. But when $\bar{\pi} = 0$, there are two effects on the Red interest rate: On the one hand, fire-sale losses lower the interest rate. At the same time, the relative demand for Red bonds drops to $1/2 \chi$, where $\chi$ is the fraction of Red bond holders barred from trading with others, placing an upward pressure on the interest rate. When
\[ \delta^R \left( \frac{1}{2} \chi - 1 \right) > \gamma \phi \] the demand-side effect dominates, implying an increase in the Red region’s interest rate.

Figure 11 characterizes the information acquisition problem confronting agents in the two-region economy. At time \( t \), the agent born on island \( j \) and randomly selects an old agent on island \( i \) to trade with. If the old agent is selling a Blue bond, then agent \( j \) will readily accept it without monitoring, since \( j \) knows that all agents in the future will also readily accept the Blue bond without monitoring. But if the old agents is selling a Red bond then, as before, agent \( j \) must decide whether to accept the bond without monitoring or collect costly information about collateral in the Red region.

If agent \( j \) decides to gather costly information \((z_{j,t} = 0)\) then with probability \( 1 - \gamma \), the agent correctly learns that \( \kappa^R = \delta^R \) and will purchase the bond. The payoff to \( j \) is

\[
V_{t+1}^R - V_t^R + \delta^R X_t^R - M_t = V_t^R \left( r^R - \frac{\mu}{v^R} \right), \tag{20}
\]

where the cost of monitoring is \( M_t = \mu V_t = \mu V_t^R / v^R \). But, with probability \( \gamma \), agent \( j \) will incorrectly believe that the \( \kappa^R < \delta^R \) and is uniformly distributed over \([0, \delta^R)\). In this case, \( j \) is better off rejecting the trade and purchasing a Blue bond from the Blue central bank.
The payoff to agent $j$ is\(^{10}\):

$$V_{t+1}^R - V_t^R + \delta^R X_t^R - M_t = V_t^R \left[ \frac{v^R}{v^R} r^R - \frac{\mu}{v^R} \right]. \tag{21}$$

If agent $j$ opts not to gather information and, instead, accept the seller’s claim that $\kappa^R = \delta^R$, the final payoff depends on whether a buyer in period $t+1$ is willing to accept the Red bond. If $\bar{\pi}_{j,t+1}$ is the probability that a randomly selected young agent in period $t+1$ is willing to accept the Red bond from $j$, then the conditional probability that a young agent in period $t+1$ rejects the trade is $\gamma \left( 1 - \bar{\pi}_{j,t+1} \right)$. In this event, agent $j$ is forced into a distress sale of the Red bond and incurs a loss $\phi V_t^R$ to his consumption. The payoff to $j$ is

$$V_{t+1}^R - V_t^R - \phi V_t^R + \delta^R X_t^R = V_t^R \left[ r^R - \phi \right].$$

While, with probability $1 - \gamma \left( 1 - \bar{\pi}_{j,t+1} \right)$, agent $j$ is successful in selling the Red bond to a young agent in period $t+1$ for a payoff:

$$V_{t+1}^R - V_t^R + \delta^R X_t^R = V_t^R r^R.$$

We now characterize the conditions under which the two stores of value co-exist in the world economy, i.e., when all agents are willing to accept both Blue and Red bonds without monitoring.

**Proposition 3.** The minimum $\delta^R$ consistent with the unique Nash equilibrium in pure strategies, where all agents readily accept both Blue and Red bonds without monitoring is given by the solution to the implicit function

$$H \left( \delta^R, \chi, \phi, \mu \right) \equiv \gamma \left[ - (1 + \gamma) \phi + g^R - g^B (1 - \chi) + \frac{\delta^R - \delta^B}{2 \chi} \right] + \frac{\mu}{\chi}. \tag{22}$$

**Proof.** See the appendix. \(\square\)

In our model, the Red region’s policy-maker has three potential instruments with which to promote the acceptability of the Red bond. He can (a) influence the pace of financial reform by varying $\delta^R$; (b) control the extent to which the Red central bank is able to cushion distress sales of the Red bond by varying $\phi$; and (c) liberalize capital

\(^{10}\)The payoffs in equations (20) and (21) must be consistent with $j$ having a strictly positive levels of consumption. This is satisfied whenever $\mu < \chi r^R(\chi)$. 

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controls by lowering $\chi$. Figure 12 depicts the combinations of the instruments required to support the co-existence of both stores of value in the global economy. Below the plane only Blue bonds are readily acceptable. While, for combinations of $\phi$, $\chi$ and $\delta^R$ on and above the plane, both Blue and Red bonds are readily acceptable and co-exist in the world economy. When capital controls are strict, $\chi$ is large, and fire-sale losses are adverse, $\phi$ is large, then a high level of financial development is needed for the Red bond to be readily acceptable. However, as capital accounts are liberalized, and fire-sale losses are mitigated by decreasing $\phi$, a lower level of financial development is needed for the Red bond to be readily acceptable. Corollary 1 formalizes these insights.

Figure 12: Combinations of $\chi$, $\phi$ and $\delta^R$ necessary to support co-existing stores of value. Lighter colors indicate larger values of $\delta^R$, while darker colors imply smaller values of $\delta^R$. The parameter $\chi$ is decreasing in the direction towards the bottom of the figure, while $\phi$ is decreasing as one approaches the left-hand corner of the figure.

**Corollary 1.** A marginal decrease in $\phi$ lowers the minimum $\delta^R$ necessary for both bonds to be readily acceptable. If the cost of information is high, $\mu/\gamma > g^B + (\delta^B - \delta^R)/2$, then a marginal decrease in $\chi$ also lowers the minimum $\delta^R$ required for both bonds to be readily acceptable. Finally, a marginal increase in $\mu$ decreases the minimum $\delta^R$ necessary for both bonds to co-exist as acceptable stores of value.

**Proof.** See the appendix.

4.3. Multipolar world and strategic complementarities

A multipolar world in which stores of value co-exist implies that small changes in fundamentals, or in the perception of these fundamentals, can have important implications for capital flows (see Gourinchas et al. 2011; Eichengreen, 2011). For example, a
negative shock to the capacity of the Blue region to stand behind the Blue bond could trigger capital flight as some investors switch to the Red bond if it is perceived as readily acceptable.

Our model is able to shed light on how large the shock to fundamentals would need to be in order to propel the Red bond to a position of being readily acceptable to investors. If initial conditions are such that only Blue bonds are readily acceptable to investors, then the total demand for Blue bonds will be the sum of demands in both regions, excluding Red islands that are prohibited from asset trades, namely,

\[ X_t \left[ \frac{1}{2} + \left( \frac{1}{2} - \chi \right) \left( 1 - \delta^R \right) \right] , \quad (23) \]

where \( X_t = X_t^B + X_t^R \). This value, however, is greater than the Blue region’s wealth, \( X_t/2 \). So the net foreign asset position of the Blue region – the difference between the wealth of islands in the Blue region and the total value of its assets – is strictly negative, i.e.,

\[ \frac{X_t}{2} - X_t \left[ \frac{1}{2} + \left( \frac{1}{2} - \chi \right) \left( 1 - \delta^R \right) \right] < 0 . \quad (24) \]

Moreover, when only Blue bonds are acceptable, \( \bar{\pi} = 0 \), the world interest rate\(^{11} \) at which the Blue region can borrow is low,

\[ r = \frac{1}{2} \left[ g^B + \delta^B \right] + \frac{1}{2} \left[ g^R + \delta^R \right] - \left[ \left( \frac{1}{2} - \chi \right) \left( g^R - g^B \right) + \chi \gamma \phi \right] . \quad (25) \]

Equations (24) and (25) make clear the advantage to the Blue region arising from its role as sole provider of international liquidity to the world economy. The relaxed external constraint implied by these equations is consistent with the ‘exorbitant’ privilege of the global safe asset issuing country highlighted by Obstfeld and Rogoff (2005), Gourinchas and Rey (2007) among others.

Now consider a permanent shock \( \Delta \) to the Blue region that adversely affects the Blue region’s capacity to back stop the Blue bond i.e., \( \kappa^B = \delta^B - \Delta \), while the wealth of the Blue region remains proportional to \( 1 - \delta^B \). To the extent that only the Blue bond is readily acceptable to all investors, the effect of the shock is two-fold. First, the shock lowers the value of Blue bonds. On the demand side, however, there is no change in in the demand

\(^{11}\)See the Appendix for the derivation of the world interest rate.
for Blue bonds, both within the Blue region and from the Red region. This implies that the net foreign asset position of the Blue region remains negative at the value given by equation (24).

These dynamics persist as long as the $\Delta$-shock is small. However, once the Blue region’s capacity to back its bond reaches $\kappa_B = \delta_B - \Delta^*$, Red bonds become readily acceptable, where

$$\Delta^* = -\frac{2\mu}{\gamma} + 2\chi \left( (1 + \gamma) \phi - g^R \right) + 2 \left( 1 - \chi \right) g^B + \delta^B - \delta^R$$

(26)

The critical $\Delta^*$ is influenced by all three of our policy variables – $\delta^R$, $\chi$ and $\phi$. As the Red region becomes more financially developed, a smaller shock to the Blue region is needed for the Red bond to become readily acceptable, $\partial \Delta^*/\partial \delta^R < 0$. Likewise, marginal decreases in the fire-sale losses, $\phi$, and capital controls, $\chi$, imply that smaller $\Delta^*$ are required for the Red bond to become readily acceptable.

In this multipolar world, where both Blue and Red bonds are readily acceptable, the world interest rate increases to

$$r = x^B \left[ g^B + \delta^B \right] + x^R \left[ g^R + \delta^R \right].$$

(27)

Since investors are indifferent between purchasing Blue and Red bonds, fraction of Blue bonds demanded falls from $1 - \chi$ to $1/2$, while the fraction of Red bonds demanded increases from $\chi$ to $1/2$. In this new equilibrium, the demands for the Blue and Red bonds are exactly matched by the supplies of the two regions, implying that both regions have balanced accounts, with their net foreign asset positions’ being exactly zero.

5. Discussion

Our model speaks to the three pathways to renminbi internationalization outlined in Section 2. The three policy parameters of our model, $\delta^R$, $\chi$, and $\phi$, correspond to domestic financial reform, capital account liberalization, and the panoply of policies that promote pools of liquidity through swap lines and special financial centres. Figure 12 thus illustrates combinations of these policies that are compatible with an international currency – in the sense that the renminbi co-exists with the US dollar as a global store of value.

It is important to note that the plane depicted in Figure 12 illustrates combinations of $\delta^R$, $\chi$ and $\phi$ that are just compatible with currency internationalization. For ren-
minbi internationalization to be robust to small shocks, the policy combinations must be sufficient to place the economy well above the plane. Thus, for example, rapid capital liberalization and extensive swap lines, absent domestic reform, are not sufficient to sustain an international currency – the economy would be located at the (relatively fragile) bottom-left-hand corner of the plane. Similarly, domestic reform, without complementary relaxation of capital restrictions and promotion of offshore markets, would be insufficient on its own to cement the status of an international currency.

These implications of our model, thus, temper the arguments of some commentators (e.g. Sheng, 2012) who favor renminbi internationalization through rapid capital liberalization in the hope that it will catalyze the (inevitably slow) process of domestic financial sector reform. Our model is more supportive of views of those such as Ju and Wei (2010) and Yu (2014) who counter that domestic financial reform is a critical pre-requisite if currency internationalization is to be sustained into the medium-term. But emphasizing the first ‘pathway’ of domestic financial reform at the expense of other pathways would mean that renminbi internationalization could take a very long time. It is therefore unsurprising that Chinese policymakers appear to be taking a holistic approach towards currency internationalization, simultaneously pursuing elements of all three pathways in an attempt to hasten progress.

While a rapid rise of the renminbi to international currency status is not impossible, Eichengreen (2014) suggests that it would require a confluence of circumstances, notably a shock that undermines confidence in the US dollar and rapid policy reform in China. In addition to this, our model suggests that take up of the renminbi will depend critically on the willingness of investors to experiment with a new store of value. If investors are too cautious about the actions of their counterparties and do not believe that others will readily accept the renminbi, internationalization will take a very long time. Conversely, if agents do not harbor such concerns, then take-up will likely be rapid. The ‘petri dish’ approach of creating special financial zones in which agents develop expertise with renminbi-based transactions can be viewed, in large part, as an attempt to exceler-

\footnote{Ju and Wei (2010) extend the model of Holmström and Tirole (1997) by allowing the returns on capital to be endogenously determined by a country’s characteristics. In doing so, they provide a micro-foundation for the trade-off between capital account liberalization and domestic financial reforms. Their results suggest that, although rapid capital account liberalization has an ambiguous welfare effect on emerging economies, these countries are better served by prioritizing financial sector reform and improved corporate governance.}
ate such learning dynamics.

Figure 13 illustrates. The solid line depicts the analysis of Section 4, in which the Red bond becomes readily acceptable following an adverse shock to the capacity of the Blue region to backstop the Blue bond. The outcome is non-linear and, following the critical realization of the shock, the Red bonds tips from being not accepted to being readily accepted.

![Figure 13: Demand for Red bonds as a function of the shock $\Delta$ to the Blue Region. The solid line depicts the pure Nash equilibrium solution, while the dashed shows how when one permits ambiguity, as in Anand and Gai (2012), the tipping-point result is smoothened out.](image)

Critically, in our model, when overlapping generations of agents interact, the agent on island $j$ is certain about the play of generations that are yet unborn – he uses the expected utility criterion to rank payoffs. In producing the dashed line in Figure 13 we relax this strong assumption and generalize our model to permit ambiguity about the future play of unborn agents.\textsuperscript{13} Under these circumstances, it can take significantly longer for the Red bond to become readily accepted. Ambiguity about the actions of investors’ counterparties and the counterparties of those counterparties prompts a ‘flight to safety’ – and the Blue bond remains the safe asset of choice for much longer than might be warranted by its fundamentals.

6. Concluding remarks

Traditional models of international currencies emphasize economies of scale as a key driver in determining which currencies agents use. Transaction costs scale with a coun-

\textsuperscript{13}The reader is referred to Anand and Gai (2012).
try's size, suggesting that the future of the international monetary system will remain unipolar, with the US dollar reigning as the de-facto currency within international markets.

In re-examining the ascent of the dollar during the interwar years, Eichengreen and Flandreau (2009, 2012), and Chițu et al. (2013) question the traditional view. These authors argue that financial development and market liquidity may have been more important than size in propelling the dollar's use. This “new view” suggests that a multipolar international monetary system is plausible. Moreover, policies aimed at sustainable financial deepening and integration could promote the international currency status of currencies other than the dollar.

In this paper we formalize some of the intuition behind this “new view”. In doing so we explore how a financial asset – bond – can emerge as a global store of value. This, in turn, depends on the issuing region’s growth rate and financial development. A fast-growing region needs a relatively low level of financial development for its asset to emerge as the global store of value. Conversely, a slow-growing country requires a high level of financial development to achieve the same.

We extend this basic model to a two-region (Red and Blue) setting, where both regions issue bonds. Assuming that Blue bonds have already achieved an international status, we examine the prerequisites for both Red and Blue bonds to co-exist as global stores of value. Our findings inform the current debate on ways of enhancing the international role of the renminbi. They suggest that deep financial reforms should precede capital account liberalization if the internationalization of the renminbi is to be sustained over the medium-term.

A key assumption in our extended model is that the Blue bond is perfectly acceptable to all agents (there are no frictions between buyers and sellers). Consequently, we only focus on measures that would promote the Red bond’s acceptability. An area for future work is to have the acceptability of both Blue and Red bonds being determined endogenously. This opens important questions on the role of cooperation and coordination of monetary and fiscal policies of the regions issuing bonds. Equilibria where each region unilaterally decides on its policies are likely to be sub-optimal with overly tight policies. Instead, if one allows for cooperation, better outcomes may be achievable.

Finally, our analytical results point to a testable hypothesis highlighting the role of financial development and macroeconomic growth as important determinants of the in-
ternational acceptability of stores of value. Empirical analysis of the model along these lines would complement existing studies (e.g., Cecchetti et al. 2010), and is left for future research.
7. Appendix

Proof of Proposition 1.
In the stationary state, where $\bar{\pi} = \bar{\pi}_{j,t} = \bar{\pi}_{i,t+1}$, by the law of large numbers, $\bar{\pi}$ is the probability that a randomly selected agent will trade without monitoring. We now solve for $\bar{\pi}$ by the following fixed-point argument. Let $\ell$ be the number of trading partners who accept the bond without monitor. Consequently, agent $j$ will also accept the claim and not monitor whenever

$$\ell > \frac{N-1}{\phi} \left( \phi - r_{RB} \right).$$  \hspace{1cm} (A1)

What matters for agent $j$ is the absolute number of trading partners who agree, rather than their individual identities. With $N-1$ potential trading partners, the number of different combinations of $\ell$ agents who agree is $\binom{N-1}{\ell}$. The probability that these $\ell$ agents agree to trade without monitoring is $\bar{\pi}^\ell (1 - \bar{\pi})^{N-1-\ell}$. Summing over $\ell$ and combining this with equation (A1), where $r \equiv r(\bar{\pi}) = \delta + g - (1 - \bar{\pi})\phi$, we obtain the result in equation (14).

Proof of Proposition 2.
For $N \gg 1$, we can apply the de Moivre-Laplace Central Limit Theorem (Papoulis and Pillai, 2002) and approximate the Binomial distribution in equation (14) by a Normal distribution that is sharply peaked around its mean, i.e.,

$$\lim_{N \to \infty} \binom{N-1}{\ell} \bar{\pi}^\ell (1 - \bar{\pi})^{N-1-\ell} = \frac{1}{2\pi N \bar{\pi} (1 - \bar{\pi})} e^{-\frac{(\ell - \mu)^2}{2N\bar{\pi}(1 - \bar{\pi})}} = D(\ell - N \bar{\pi}),$$

where $D(x)$ is the Dirac-delta function – a degenerate Normal distribution function that has value 1 for $x = 0$, and is zero everywhere else. Denoting $s = \ell/N$, the fixed-point equation simplifies to

$$\bar{\pi} = \int_0^\infty D(s - \bar{\pi}) \left\{ \gamma \left( \delta + g - (1 - \bar{\pi})\phi - (1 - s)\phi \right) + \mu \right\} ds = 1 \left\{ \gamma \left( \delta + g - 2\phi (1 - \bar{\pi})\phi + \mu \right) \right\}.$$  \hspace{1cm} (A2)

Clearly, equation (A2) has only two possible fixed-points, i.e., $\bar{\pi} = 1$ and $\bar{\pi} = 0$. Let us first investigate the conditions for $\bar{\pi} = 1$ to be a fixed-point. The argument of the indicator function simplifies to $\gamma(\delta + g) + \mu$, which is always positive. Hence, $\bar{\pi} = 1$ is always a fixed-point.

On the other hand, for $\bar{\pi} = 0$ to be a solution, we must have that $\gamma(\delta + g - 2\phi) + \mu < 0$. Solving this inequality for $\delta$, we obtain the condition in equation (15).

Proof of Proposition 3.
Comparing payoffs, we obtain that the expected payoffs to agent $j$ from monitoring and not monitoring are

$$V^R_t \left[ r^R - \gamma \left( r^R - r^B \frac{v^B}{v^R} \right) - \frac{\mu}{v^R} \right],$$ \hspace{1cm} (A3)

and

$$V^R_t \left[ r^R - \gamma (1 - \bar{\pi}_{j,t+1}) \phi \right].$$ \hspace{1cm} (A4)
respectively. The best response for agent $j$ is thus

$$z_{j,t}^* = \begin{cases} 1, & \text{if } \gamma \left[ \phi \left( \frac{1}{N-1} \sum_{l} z_{l,t+1}^* - 1 \right) + r^B \frac{v^B}{v^R} \right] + \frac{\mu}{v^R} \geq 0, \\ 0, & \text{otherwise} \end{cases}, \quad (A5)$$

where $z_{l,t+1}^*$ are the best responses of agents born in period $t+1$.

Defining the number of future trading partners who accept by $\ell$, we have that it is a best response for $j$ to accept the Red bond without monitoring whenever

$$\ell > \frac{N-1}{\phi} \left( \phi - \frac{\mu}{v^R} + r^B \frac{v^B}{v^R} - r^R \right). \quad (A6)$$

Since it is only the absolute number of trading partners who accept that matters for agent $j$, following an identical line of reasoning to that used in Proposition 1, we obtain that the Nash equilibrium in pure strategies for the fraction of agents who accept the Red bond without monitoring, $\bar{\pi}$, is given by the fixed-point solution to

$$\bar{\pi} = \sum_{\ell=0}^{N-1} \left( \frac{N-1}{\ell} \right) \bar{\pi}^\ell (1-\bar{\pi})^{N-1-\ell} \left[ \gamma \left[ r^R \left( \frac{1}{N-1} \right) - r^B \frac{v^B}{v^R} - \phi \left( 1 - \frac{\ell}{N-1} \right) \right] + \mu \right]. \quad (A7)$$

Finally, in the limit $N \gg 1$, we can apply the de Moivre-Laplace Central Limit Theorem and approximate the Binomial distribution in equation (A7) by a Normal distribution that is sharply peaked around its mean, yielding a new fixed-point equation

$$\bar{\pi} = 1 \left\{ \gamma \left[ r^R (\bar{\pi}) - r^B (\bar{\pi}) \frac{v^B (\bar{\pi})}{v^R (\bar{\pi})} - \phi (1 - \bar{\pi}) \right] + \frac{\mu}{v^R (\bar{\pi})} \right\}. \quad (A8)$$

When $\bar{\pi} = 1$, the argument of the indicator function is

$$\frac{\gamma}{2} \left[ g^R - g^B - (\delta^B - \delta^R) \right] + \mu > 0,$$

implying that $\bar{\pi} = 1$ is always an equilibrium. For $\bar{\pi} = 0$ to be a fixed point, we must have that the argument of the indicator function is negative, i.e.,

$$\gamma \left[ (1+\gamma) \phi + g^R + \frac{\delta^R}{2\chi} - \left( g^B + \frac{\delta^B}{2(1-\chi)} \right) \left( \frac{1}{1-\chi} \right) \right] + \frac{\mu}{\chi} < 0. \quad (A9)$$

Therefore, the unique $\bar{\pi} = 1$ solution is obtained whenever the inequality in equation (A9) is violated, which gives us the implicit function of equation (22).
Proof of Corollary 1.

The partial derivative of the implicit function $H(\delta^R, \chi, \phi, \mu)$ are as follows:

\[
\frac{\partial H}{\partial \delta^R} = \frac{\gamma}{2\chi} > 0, \quad (A10)
\]
\[
\frac{\partial H}{\partial \chi} = \frac{1}{\chi^2} \left[ \gamma (g^B - \frac{\delta^R - \delta^B}{2} - \mu) \right] < 0, \quad (A11)
\]
\[
\frac{\partial H}{\partial \phi} = -\gamma (1 + \gamma) < 0, \quad (A12)
\]
\[
\frac{\partial H}{\partial \mu} = \frac{1}{\chi} > 0. \quad (A13)
\]

The sign of the derivative with respect of $\chi$ follows from the assumption that $\mu/\gamma > g^B + (\delta^B - \delta^R)/2$. Finally, by the implicit function theorem we get:

\[
\frac{\partial \delta^R}{\partial \chi} = -\frac{\partial H/\partial \chi}{\partial H/\partial \delta^R} > 0, \quad (A14)
\]
\[
\frac{\partial \delta^R}{\partial \phi} = -\frac{\partial H/\partial \phi}{\partial H/\partial \delta^R} > 0, \quad (A15)
\]
\[
\frac{\partial \delta^R}{\partial \mu} = -\frac{\partial H/\partial \mu}{\partial H/\partial \delta^R} < 0. \quad (A16)
\]

Derivation of the world interest rate.

The values for the bonds issued by the Red and Blue regions are

\[
r V_t^i = V_{t+1}^i - V_t^i - \left(1 - \bar{\pi}_{t+1}^i\right) C_t^i + \delta^i X_t^i, \quad (A17)
\]

where $i \in \{R, B\}$. Summing up across the two regions and using that the Blue bond is always readily acceptable, $\bar{\pi}^B = 1$, while for the Red bond $\bar{\pi}^R = \bar{\pi}$ and $C^R = \phi V^R_t$, we obtain

\[
r V_t = \left[g^B + \nu^R \left(g^R - (1 - \bar{\pi}_{t+1}) \phi - g^B\right)\right] V_t + \left[\delta^B + \frac{1}{2} (\delta^R - \delta^B)\right] X_t,
\]

where

\[
V_t = V_t^R + V_t^B, \quad X_t = X_t^R + X_t^B, \quad (A18)
\]

and

\[
\nu^R = \frac{V_t^R}{V_t}, \quad \chi^R = \frac{X_t^R}{X_t}. \quad (A19)
\]

In equilibrium, the outputs from the two regions must be equal to the wealth of all agents, which must be the same as the value of all bonds, i.e., $X_t = W_t = V_t$, which yields

\[
r = \frac{1}{2} (g^B + \delta^B) + \frac{1}{2} \left(g^R + \delta^R\right) - (1 - \bar{\pi}) \left[\frac{1}{2} \chi \left(g^R - g^B\right) + \chi \gamma \phi\right]. \quad (A20)
\]
References


Eichengreen, B., Flandreau, M., 2009. The rise and fall of the dollar (or when did the dollar replace sterling as the leading reserve currency?). European Review of Economic History 13 (3), 377–411.


