Trade Networks and a Dominant Settlement Currency*

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Abstract

We develop a network model of currency competition in which issuers choose commitment levels to improve the international usability of their currencies, while users allocate trade settlement across currencies depending on their positions in a trade network. Our model identifies a feedback mechanism between users' currency choices and issuers' commitments, showing that network integration reinforces incumbent currencies, while central users concentrate currency use more strongly and increase the issuer's incentive to support the currency they prefer. Using import-invoicing data for USD, EUR, and RMB, we provide evidence consistent with the incumbent-reinforcement mechanism: growth in network centrality reinforces USD and EUR invoicing where these currencies are already entrenched, but not RMB invoicing.

Keywords: global currency; trade network; subgame perfect equilibrium; network game

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1 Introduction

Since the end of World War II, the United States dollar (USD) has been the dominant currency for international payments, invoicing, and foreign reserves. The USD shapes the cost of trade, the access to international capital, and the vulnerability to US monetary policies, granting the US political power to influence global financial transactions. Today, the US appears to be in the final stage of a cycle in which global powers rise—first by expanding international trade, then by developing dominant financial centers, and finally by issuing the world's leading reserve currency (Dalio, 2021). On the other hand, China appears to be in the initial phase of this cycle. The replacement of the USD by another currency as the dominant global currency will have far-reaching economic and political consequences for the US and the rest of the world.

Under what conditions can we expect the rise and fall of global currencies? To answer this question, we propose a new model by integrating the network game à la Ballester et al. (2006) into a framework of strategic competition where currency choice exhibits strategic complementarity—users prefer currencies widely accepted by their trade partners. Even if a key trade partner prefers a particular currency, it may not be optimal for a country to adopt it unless it can also be used for settling trade with other partners. The network game enables us to understand such network-wide incentives rather than bilateral ones. Furthermore, we model the currency choice for trade settlement, since currency internationalization has often started by encouraging the usage in trade invoicing and settlement (see Eichengreen, 2011). On the supply side, we assume that issuers can attract users by choosing commitment levels to improve the international usability of their currencies. Issuers move sequentially, i.e., there is a first mover, a second mover, and so on. This setup is natural, for example, when we would like to analyze how the USD dominance is challenged by another currency such as the renminbi (RMB).

We contribute to the literature by applying network-game tools to a macroeconomic problem of international currency use. Specifically, we integrate the strategic competition of currency issuers with the allocation problem of users in a trade network with externalities. Externalities among

users are often captured without an explicit network structure in aggregate user-based models (e.g., Vaubel, 1984; Dowd and Greenaway, 1993) and search models (e.g., Matsuyama et al., 1993; Lagos and Wright, 2005; Liu and Shi, 2010), while studies emphasizing the store-of-value function of currencies typically abstract from such user complementarities (e.g., Caballero et al., 2008; Maggiori, 2017; Gopinath and Stein, 2018, 2021; Clayton et al., 2024). Moreover, we endogenize commitments by issuers, which capture policies and infrastructures that improve the international usability of a currency, whereas theoretical work on settlement currencies often ignores or treats such institutional factors as exogenous (e.g., Rey, 2001; Chahrour and Valchev, 2022; Liu et al., 2019). We highlight the feedback mechanism between commitment of issuers and settlement-currency choice of users depending on their positions in a trade network—a channel that remains unexplored in the settlement currency literature. Integrating this mechanism into broader monetary or search models would be a natural extension that builds on our analysis.

We focus on the network-spillover channel, while abstracting from other determinants of currency dominance such as financial depth, legal institutions, and geopolitical alignment. First, we show that the more integrated a trade network is, the fewer currencies are used internationally. This is because issuers respond by strengthening their commitments for currency internationalization, thereby deterring the entry of new currencies. Second, we show that central users—those who are well-connected to other users in a trade network—play the key role in reinforcing global currency dominance: the more central a country is in a trade network, the more concentrated its currency allocation becomes. We generalize this result to a market with finitely many currencies and formalize currency-use concentration using a distributional inequality measure such as the Gini coefficient.

It follows that the issuer of a currency preferred by central users has stronger incentives to improve the currency's usability and achieves greater adoption. This feedback mechanism between network spillovers and the commitment for currency internationalization provides a novel explanation for why an incumbent settlement currency may be difficult to displace, and more importantly, how a challenger may level up the game and cause a sudden shift in dominant currencies when

the trade network changes. Using import-invoicing data for USD, EUR, and RMB, we provide evidence consistent with the incumbent-reinforcement mechanism: growth in Katz-Bonacich centrality reinforces USD and EUR invoicing where these currencies are already entrenched, while the corresponding effect for RMB is insignificant.

Our model also relates to multi-action network games developed by Chen et al. (2018) and Chen et al. (2022), in which agents engage in multiple activities that may be substitutes or complements. Agents in these models do not solve a resource allocation problem, which is the key feature of our model. In this respect, the closest to our setup is Belhaj and Deroïan (2014), who characterize equilibrium in a network game where each agent allocates fixed resources between two activities. However, Belhaj and Deroïan (2014) does not study a currency usage problem nor do they model an interaction between users and issuers. From a methodological perspective, our setup is more general as we solve a resource allocation problem and characterize the equilibrium with finitely many currencies.

Empirical studies have captured the idea that countries are more likely to adopt a currency that is already widely used (e.g., Flandreau and Jobst, 2009; Frankel, 2012; Lee, 2014). Building on this insight, our model provides a theoretical mechanism linking a country's structural position in the global trade network to its choice of settlement currencies. In particular, the model predicts that countries with higher network centrality—a measure of how well-connected a country is to others—use more of their preferred currency and exhibit more concentrated currency allocations. Consistent with this prediction, Pham (2026) finds that countries use more of their home currency for imports as their structural network positions improve. This paper complements that evidence by showing that growth in network centrality reinforces the use of incumbent invoicing currencies, especially the USD and EUR, where they are already entrenched. We also show theoretically that a country's commitment for currency internationalization—through financial development, capital account liberalization, and payment infrastructure—is shaped by the network structure, alongside political partisanship (e.g., Quinn and Inclan, 1997), trade openness (e.g., Rajan and Zingales,

2003), or legal origin (e.g., Porta et al., 1998; Beck et al., 2003).

The remainder of the paper is organized as follows. Section 2 introduces our model with two currencies. Section 3 explains the solution concepts. Section 4 presents the theoretical results. Section 5 extends the baseline framework to a finite T-currency setting. Section 6 discusses our model's implications on the USD–RMB competition and provides empirical evidence on incumbent-currency reinforcement. Section 7 concludes. The proofs and robustness checks are relegated to Appendix.

2 A two-currency problem

There are two currency issuers $\{a, b\}$. They issue currency a and currency b, respectively. Each issuer $p \in \{a, b\}$ sequentially decides whether to internationalize its currency and, if so, chooses commitment level $e_p \in [0, 1]$ for currency internationalization. This commitment summarizes policies and institutional arrangements that make the currency easier to use internationally, such as maintaining an open capital account, swap lines, payment infrastructure, clearing and settlement systems, and financial markets that support currency conversion and hedging. In this model, a is the first mover, and b is the second mover, followed by currency choices of users. In this sense, e_p is a commitment: once chosen, it is observed by subsequent players and can not be reversed during the later stages.

There is a finite set of users $N = \{1, 2, 3, \ldots, n\}$ $(n \geq 2)$. Each user i must settle m_i units of international transactions with the available currencies. We interpret m_i as the real value of user i's international transactions to be settled, measured in a common numeraire. Accordingly, each user's choice is the real value of transactions settled in each currency, rather than nominal currency balances. We abstract from endogenous exchange-rate determination and money-market clearing, and instead treat currency-risk exposure, hedging costs, and other non-network currency attributes as reduced-form components of settlement costs. This partial-equilibrium formulation allows us

to isolate the role of network position and commitment of issuers in shaping settlement-currency choice. Throughout this paper, we assume that each country has a representative user who decides on the currencies to settle its imports. This formulation is natural because importers make payments to foreign suppliers, while exporters often face pricing and invoicing conventions associated with dominant currencies. Section 3.1 discusses why the network mechanism is unchanged if the allocation is instead modeled from the exporter side or from both sides of trade.

We assume that settling imports with an international currency incurs costs that fluctuate with exchange rates. These costs are mitigated by two factors: the usability maintained by the commitment of issuers for currency internationalization and the network externalities of using the same currency as trade partners. The objective of users is to minimize the cost of import settlement with the two international currencies.

We assume that trade relationships are given exogenously. Countries (importers) are naturally more influenced by the currency choices made by their major trade partners (exporters). To capture this, we represent the network as a weighted directed graph, where links represent the flows of payments, and therefore originate from importers to exporters. Each link ij from i to j with $(i, j) \in N^2$ has a weight $w_{ij} \geq 0$, indicating how much i values j's decision, or the dependency of i on j. The weights w_{ij} can be interpreted broadly and need not be based only on aggregate bilateral trade. In empirical applications, they may be constructed from sectoral, end-use, or commodity-specific trade flows, allowing the framework to incorporate differences in trade composition while focusing on the role of network position. Related dimensions of currency dominance, such as sovereign borrowing, banking flows, and reserve-asset demand, are outside the scope of the present trade-settlement model. When $w_{ij} > 0$, j's usage and i's usage of the same currency are strategic complements from i's perspective. For simplicity, we assume that $w_{ii} = 0$ for all $i \in N$. The adjacency matrix for the network is $W = [w_{ij}]$, which is a zero-diagonal non-negative square matrix.

The game unfolds in three stages:

(i) The incumbent a chooses whether to internationalize its currency and, if so, a commitment level $e_a \in [0, 1]$ for currency internationalization.

(ii) Given a's choice, the challenger b chooses whether to internationalize its currency and, if so, a commitment level $e_b \in [0, 1]$ for currency internationalization.

(iii) Given the choices of the two issuers, each user i decides the usage of each currency, x_{ia} and x_{ib}, to settle its imports such that $x_{ia} + x_{ib} = m_i$ for all $i \in N$.

The cost for user i to settle x_{ip} of its import with currency p is given by

$$C_{ip}(\boldsymbol{x_p}, e_p) = x_{ip}\Bigg[\underbrace{\epsilon}_{\text{settlement risk}} \underbrace{- \sum_{j \neq i} w_{ij} x_{jp}}_{\text{network externality}} \underbrace{- f_{ip}(e_p)}_{\text{usability}}\Bigg],$$

where $\boldsymbol{x_p}$ denotes the vector of usage of currency p by all users and the unit cost term, $[\epsilon_p - \sum_{j \neq i} w_{ij} x_{jp} - f_{ip}(e_p)]$, captures risks and fees arising from using currency p. The term ϵ is a random variable with zero mean and variance σ^2, capturing uncertainty in the non-network cost of settling transactions in an international currency, including currency conversion, hedging, and other settlement-related costs. For simplicity and to isolate the role of network spillovers and commitment for currency internationalization, we assume that this uncertainty is symmetric across currencies and do not model endogenous exchange-rate determination.

The network externality term, $\sum_{j \neq i} w_{ij} x_{jp}$, reduces the unit cost when user i's trade partners also use p. We model network externalities in reduced form as a reduced-form measure of bilateral settlement-cost savings, consistent with the widely documented idea that the usefulness of an international currency increases with its use by relevant trade partners. Importer i's unit cost of settling import in currency p reduces when its trading partner j settles more of its trade in the same currency as it makes it more likely for j to accept i's payment in the same currency, thereby reducing the cost that arises from transacting in multiple currencies. The arising saving in unit cost is naturally weighted by i's import value from j, w_{ij}. This formulation delivers a tractable link

between currency allocation and network position, which is the main mechanism studied below.

Finally, $f_{ip}(e_p)$ captures the user-specific usability generated by issuer p's commitment for currency internationalization. We assume that $f_{ip}(e_p) : [0,1] \to [0,\infty)$ is differentiable, concave, and strictly increasing in the commitment level e_p. A higher e_p lowers the non-network cost of settling transactions in currency p by improving access to the currency, reducing conversion and hedging frictions, and increasing its acceptability in international transactions. We model this channel in reduced form because the paper focuses on how commitment of issuers interacts with trade-network spillovers, rather than on the institutional microfoundations of currency usability.

We assume that users have *mean - variance preferences*, that is, they dislike the risk measured by the variance of the cost. Hence, the user i's perceived cost of settling x_{ip} transactions with currency p becomes

$$\mathscr{C}_{ip}(\boldsymbol{x_p}, e_p) := \frac{\eta}{2}\mathbb{V}[C_{ip}] + \mathbb{E}[C_{ip}] = \frac{\beta}{2}x_{ip}^2 - \sum_{j\neq i} w_{ij}x_{ip}x_{jp} - f_{ip}(e_p)x_{ip},$$

where $\eta > 0$ represents the risk aversion, which is assumed to be the same for all users, and $\beta := \eta\sigma^2$ captures the exchange rate risk perceived by users. As will be shown in Section 3.1, β is assumed to be sufficiently large to ensure a unique and non-negative solution for the currency choice problem. The convex cost associated with the exchange rate risk gives users an incentive to diversify their currency use.[1]

Each user i decides its usage of the two international currencies issued by a and b by solving

$$\min_{0\leq x_{ia},x_{ib}\leq m_i} v_i(\boldsymbol{x_a}, \boldsymbol{x_b}, e_a, e_b) = \mathscr{C}_{ia} + \mathscr{C}_{ib} \quad \text{s.t. } x_{ia} + x_{ib} = m_i. \tag{1}$$

[1]Although this functional form is restrictive, such quadratic functions can be seen as the second-order Taylor approximations of general convex functions that represent risk aversion, providing a balance between theoretical clarity and analytical tractability. This approach aligns with foundational work in financial economics (e.g., Markowitz, 1952) and systemic risks (e.g., Acemoglu et al., 2015), while enabling closed-form solutions that connect equilibrium outcomes to network structure.

Each issuer $p \in \{a, b\}$ solves the utility maximization problem given by

$$\max_{e_p} u_p(e_p, e_{-p}) = \begin{cases} X_p(e_p, e_{-p}) - kc(e_p) & \text{if } 0 \leq e_p \leq 1 \\ 0 & \text{if } e_p = \emptyset, \end{cases} \tag{2}$$

where $X_p := \sum_{i \in N} x_{ip}$ is the total usage of currency p, the cost of commitment for currency internationalization $c(e_p) : [0, 1] \to (0, \infty)$ is differentiable, convex, and strictly increasing in e_p, and $k \geq 0$ captures the weight of the commitment cost. For simplicity, we assume that issuers face the same cost function. Note that $c(0) > 0$ because we assume that it is costlier to internationalize a currency with the minimum level of commitment than not to internationalize it at all, since even the minimum level of internationalization requires the establishment and maintenance of supporting financial and payment institutions.

3 The equilibrium

We begin this section with the currency choice of users given the commitments for currency internationalization by issuers. Then, by backward induction, we solve for the commitment levels of issuers and find the subgame perfect Nash equilibrium (SPE).

3.1 The users

Each user minimizes its cost given the commitments for currency internationalization chosen by issuers and the currency choices made by other users. We assume that when there is only one issuer internationalizing its currency, users settle all their transactions in the only available international currency; and if both issuers give up on internationalizing their currencies, users cannot settle their imports using any international currency.[2] We first derive the currency choices by users given e_a

[2] If neither issuer internationalizes their currency, trade must be settled in local currencies, a scenario not modeled in this paper as we focus on cases where at least one international currency is available.

and e_b in the range [0,1], that is, when both issuers internationalize their currencies.

Since $x_{ib} = m_i - x_{ia}$ for all $i \in N$, the FOC for (1) with respect to x_{ia} yields

$$x_{ia}(\boldsymbol{x_a}, \boldsymbol{x_b}, e_a, e_b) = \frac{1}{2\beta}\left[\sum_{j\neq i} w_{ij}(x_{ja} - x_{jb}) + f_{ia}(e_a) - f_{ib}(e_b) + \beta m_i\right]. \tag{3}$$

Equation (3) shows that a) given any pair (e_a, e_b), the currency choice of a user depends on that of other users, and b) the usage of currency a is increasing in its usability generated by issuer a's commitment, $f_{ia}(e_a)$, and decreasing in the usability of currency b generated by issuer b's commitment, $f_{ib}(e_b)$. Similarly, the FOC with respect to x_{ib} yields

$$x_{ib}(\boldsymbol{x_a}, \boldsymbol{x_b}, e_a, e_b) = \frac{1}{2\beta}\left[\sum_{j\neq i} w_{ij}(x_{jb} - x_{ja}) + f_{ib}(e_b) - f_{ia}(e_a) + \beta m_i\right]. \tag{4}$$

Let $d_i := x_{ia} - x_{ib}$ be the *usage difference* chosen by user i in the equilibrium given a and b's commitment levels. From (3) and (4), for all $i \in N$

$$d_i = \frac{1}{\beta}\left[\sum_{j\neq i} w_{ij}(x_{ja} - x_{jb}) + f_{ia}(e_a) - f_{ib}(e_b)\right] = \frac{1}{\beta}\sum_{j\neq i} w_{ij}d_j + \gamma_i, \tag{5}$$

where $\gamma_i(e_a, e_b) := \frac{f_{ia}(e_a) - f_{ib}(e_b)}{\beta}$. Note that the numerator of this term is equal to the difference in marginal costs that user i faces when choosing between the two currencies. The denominator normalizes this difference by the user's sensitivity to the exchange rate risks. Thus, γ_i quantifies the *non-network-driven preference* for currency a over currency b. Given the vector $\boldsymbol{\gamma}$ with entries γ_i, the vector $\boldsymbol{d}$ with $d_i = x_{ia} - x_{ib}$ that satisfies (5) can be written as $\boldsymbol{d} = \frac{1}{\beta}W\boldsymbol{d} + \boldsymbol{\gamma}$. Solving it for $\boldsymbol{d}$ yields

$$\boldsymbol{d} = (\mathbb{I} - \frac{1}{\beta}W)^{-1}\boldsymbol{\gamma} = \sum_{\ell=0}^{\infty}\frac{1}{\beta^\ell}W^\ell\boldsymbol{\gamma}, \tag{6}$$

where $\mathbb{I}$ is the identity matrix. Let $r(W)$ be the spectral radius of W, i.e., the absolute value of the largest eigenvalue of W. In order for vector $\boldsymbol{d}$ to be unique and finite, we need $\beta > r(W)$. For any $i \in N$, we have $x_{ia} + x_{ib} = m_i$ and $x_{ia} - x_{ib} = d_i$. Therefore, the optimal usage level of each currency by user i is

$$x_{ia} = \frac{m_i + d_i}{2} \quad \text{and} \quad x_{ib} = \frac{m_i - d_i}{2}. \tag{7}$$

Define $-p \coloneqq b$ if $p = a$, and $-p \coloneqq a$ if $p = b$. From (5), $-m_i \leq d_i \leq m_i$ for all i and for any pair (e_a, e_b) when $\beta \geq \max_{i \in N, p \in \{a,b\}} \frac{\sum_{j \neq i} w_{ij} m_j + f_{ip}(1) - f_{i,-p}(0)}{m_i}$. Hence, when β is sufficiently large, the resulting usage levels of the two currencies are non-negative. Let $\underline{\beta}$ be the minimum values of β that ensure a unique and nonnegative solution for the currency choice problem. Throughout this paper, we assume that $\beta \geq \underline{\beta}$. So far, given any pair (e_a, e_b), we have derived the unique solution for the currency choice problem.

Note that (6) implies that a user's usage level of each currency is closely related to its Katz-Bonacich centrality in the network (Katz, 1953; Bonacich, 1987). Given a parameter λ that satisfies $0 < \lambda < \frac{1}{r(W)}$, the vector of Katz-Bonacich centralities of the nodes in network W is finite and uniquely defined by

$$\boldsymbol{\kappa} \coloneqq (\mathbb{I} - \lambda W)^{-1} \mathbf{1} = \sum_{\ell=0}^{\infty} \lambda^{\ell} W^{\ell} \mathbf{1}, \tag{8}$$

where $\mathbf{1}$ is an $n \times 1$ vector of ones. Here, each entry z_{ij} of the square matrix $Z \coloneqq (\mathbb{I} - \lambda W)^{-1} = \sum_{\ell=0}^{\infty} \lambda^{\ell} W^{\ell}$ counts all the paths in W that start at i and end at j, with paths of length ℓ being weighted by λ^{ℓ}. Therefore, the Katz-Bonacich centrality of user i, κ_i, measures the total number of paths originating from i, with each path weighted by a decay factor that diminishes as the path length increases. A user has a high Katz-Bonacich centrality if a) many links leave the user, b) these links have large weights, and c) these links point to users with high centralities.

The matrix $(\mathbb{I} - \lambda W)^{-1}$ also has an interpretation analogous to the Leontief inverse in production-network models. In input-output models, the Leontief inverse maps a sector's direct exposure

to shocks into its total exposure, including indirect effects transmitted through suppliers' suppliers and longer production chains (e.g., Rubbo, 2023). Similarly, in our setting, $(\mathbb{I}-\lambda W)^{-1}$ maps users' non-network preference across currencies into total currency-usage differences after accounting for direct and indirect settlement-currency spillovers through the trade network. Thus, a user's Katz-Bonacich centrality can be viewed as its network-adjusted exposure to currency preferences, propagated through chains of trade relationships.

From (6) and (8), we have the following result.

Lemma 1. *Define the Katz-Bonacich centrality* $\boldsymbol{\kappa} \coloneqq (\mathbb{I} - \frac{1}{\beta}W)^{-1}\mathbf{1}$. *When* $\gamma_i(e_a, e_b) = \gamma$ *for all* $i \in N$, *we have* $\boldsymbol{d}(e_a, e_b) = \gamma\boldsymbol{\kappa}$. *When* $\gamma_i(e_a, e_b)$ *differs across users, by defining an adjusted Katz-Bonacich centrality* $\tilde{\boldsymbol{\kappa}} \coloneqq (\mathbb{I} - \frac{1}{\beta}W)^{-1}\boldsymbol{\gamma}$, *we have* $\boldsymbol{d}(e_a, e_b) = \tilde{\boldsymbol{\kappa}}$.

Lemma 1 states that the difference in the usage of the two currencies by each user is proportional to its (adjusted) Katz-Bonacich centrality. When $\gamma_i(e_a, e_b) > 0\ \forall i$, a user with a higher centrality uses more of currency a and less of currency b. In contrast, when $\gamma_i(e_a, e_b) < 0\ \forall i$, vice versa. Intuitively, when a user becomes more central in a network, its currency usage becomes more uneven. This is because a more central user benefits more from matching the currency with its trade partners. Moreover, a central user's currency choice influences others (directly and indirectly), which in turn raises the central user's benefit of using the currency. Thus, a user with a higher centrality has incentives to use more the currency that it prefers. Consistent with this prediction, Pham (2026) finds that countries use more of home currency for imports as their structural network positions improve.

Since the Katz-Bonacich centrality is calculated based on paths originating from each node, the direction of links, that is, how users take others' behavior into account, is important in determining the currency choice. We believe that in a currency choice problem, the directed links should represent the flows of payments and therefore, originate from importers to exporters. This is because an importer prefers to pay an exporter in a currency commonly used by both of them to minimize

transaction costs. Similarly, an exporter prefers to receive payments in a currency it can use to pay its imports, reducing future transaction needs. In both cases, users make currency decisions based on their payment destinations. Thus, the direction of the links reflects how much weight users place on each other's currency choices, with the flows of payments naturally representing these interdependent decisions. Therefore, no matter whether we let importers or exporters decide the transaction settlement, their decisions are still proportional to the (adjusted) Katz-Bonacich centrality in terms of the payment flows. Hence, it matters little whether users choose currencies to settle their imports, exports or both in our model. For simplicity, we assume that users choose currencies to settle their imports and thus m_i is user i's total import.[3]

3.2 The issuers

Given the responses of users, the payoffs to the two issuers for their commitment levels (e_a, e_b) are well-defined. We make the following two assumptions on the choices of issuers.

Assumption 1.

(a) If $u_p(e_p) \leq 0$, then p prefers not to internationalize its currency rather than to internationalize its currency with commitment level e_p.

(b) Consider two distinct choices e_p and e'_p. If $u_p(e_p) = u_p(e'_p)$, then p chooses $\max\{e_p, e'_p\}$.

Assumption 1(a) states that an issuer does not internationalize its currency unless it is beneficial for itself. This assumption is essential for the existence of the Nash equilibria. Assumption 1(b) states that if multiple commitment levels yield the same payoff, the issuer chooses the higher one. This assumption allows us to investigate the best that issuers would do to internationalize their currencies. Although the players have infinitely many actions to consider, we can show that the

[3]If the decision is modeled as export settlement, m_i should be interpreted as user i's total exports rather than imports. If both import and export settlement are modeled jointly, the state variable becomes the settlement value for total trade. The network-spillover mechanism is unchanged, although additional complementarities between import and export settlement may affect the exact allocation.

best responses exist at every subgame, and thus the SPE exists.

Lemma 2. *Suppose that Assumption 1(a) holds. Then, the game has at least one subgame-perfect Nash equilibrium.*

Therefore, by backward induction, we obtain the SPE. By Assumption 1(b), ties are broken and we can choose a unique SPE where issuers do their best to internationalize their currencies.

Let $M \coloneqq \sum_{i \in N} m_i$ be the total demand for international currencies. It is worth noting that when $k > \frac{M}{c(0)}$, the cost of the lowest commitment level is higher than the benefit from obtaining the whole market, thus no issuer has an incentive to internationalize its currency. Therefore, we focus on the range of k such that $0 \leq k \leq \frac{M}{c(0)}$ to analyze the SPE. In general, under any game setting, there is a threshold $\underline{k}$ that is crucial for determining the distribution of currency usage in the SPE outcome. Denote e_p^* as the choice of issuer p in the SPE outcome. We have the following result.

Lemma 3. *Given any W, $\boldsymbol{m}$ and β, there exists $\underline{k} \geq 0$ such that*

(a) If $0 \leq k < \underline{k}$, then both issuers internationalize their currencies, i.e., $e_a^* \geq 0$ and $e_b^* \geq 0$.

(b) If $\underline{k} \leq k \leq \frac{M}{c(0)}$, then one issuer attains its monopoly, i.e., $\exists p \in \{a, b\}$ such that $e_p^* \geq 0$ and $e_{-p}^* = \emptyset$.

Lemma 3 states that given any game setting, when k is sufficiently low, both issuers choose to internationalize their currencies; while when k is sufficiently high, there is only one international currency issuer in the market.

4 Theoretical results

4.1 The incumbent advantage

To highlight the incumbent advantage, we assume that the players are "symmetric" in this section and study the equilibrium outcome.

Definition 1. *Users are symmetric if the two currencies yield the same usability, i.e.,* $f_{ia}(e) = f_{ib}(e) = f(e)\ \forall i \in N$.

Let e_p^* be the choice of issuer p and X_p^* be the total usage of currency p in the SPE outcome. We obtain the following result.

Proposition 1. *Suppose that users are symmetric. Given any* W *and* $\boldsymbol{m}$*, there exist* $\underline{k}$ *and* $\bar{k}$ *such that* $0 < \underline{k} < \bar{k} < \frac{M}{c(0)}$ *and*

(a) If $\bar{k} \leq k \leq \frac{M}{c(0)}$*, then* a *attains its monopoly with zero commitment level, i.e.,* $e_a^* = 0, e_b^* = \emptyset, X_a^* = M$ *and* $X_b^* = 0$.

(b) If $\underline{k} \leq k < \bar{k}$*, then* a *attains its monopoly with a positive commitment level, i.e.,* $0 < e_a^* \leq 1, e_b^* = \emptyset, X_a^* = M$ *and* $X_b^* = 0$.

(c) If $0 \leq k < \underline{k}$*, then* a *and* b *choose the same commitment level and share the market equally, i.e.,* $0 \leq e_a^* = e_b^* \leq 1$ *and* $X_a^* = X_b^* = \frac{M}{2}$.

Moreover, $\underline{k}$ *is increasing in* β *and* M.

Given that users are symmetric, when issuers choose the same commitment level, each user's position in the network does not make them favor any currency. Since the two currencies are identical to all users, no matter how important a user is in the network, it chooses to use both currencies equally. That is, $d_i = \gamma_i \kappa_i = 0$ for any user i in this case (see Lemma 1). Therefore, users' centralities do not affect their currency choices as long as issuers choose the same commitment level. In other words, the network structure is neutral to the results under this setting.

Figure 1 depicts an example of the equilibrium commitment levels as a function of k, where the user network is generated randomly.[4] Intuitively, when the cost of commitment for currency internationalization is very high relative to the benefit from global adoption, the incumbent can deter the challenger with a low commitment level. This is because the incumbent issuer anticipates that

[4] $n = 12, m_i = 1\ \forall i \in N, \beta = 2.2, f(e) = e^{0.5}$, $k = 1$, and $c(e) = \exp(e)$.

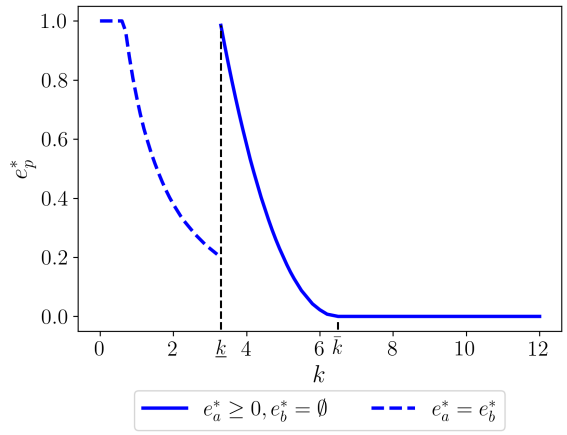


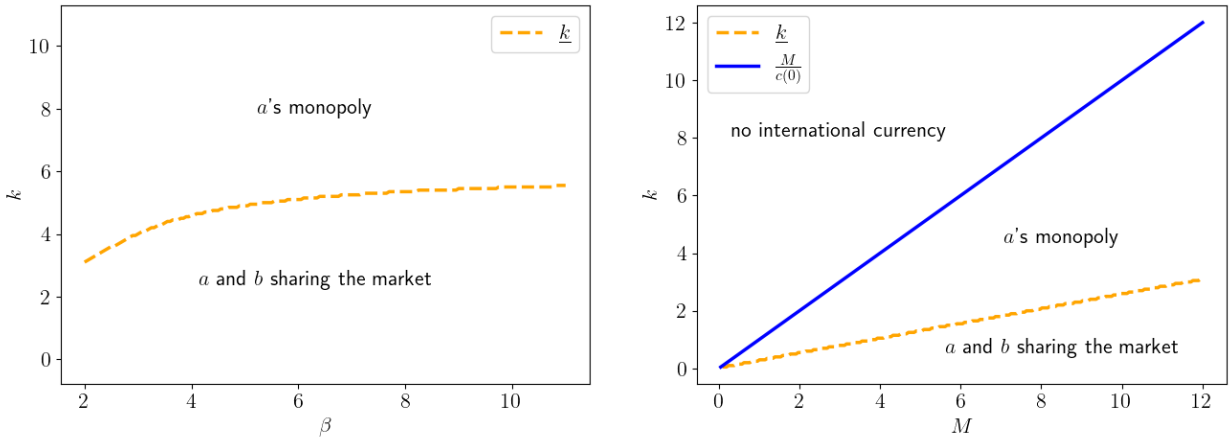
Figure 1: Commitment levels of issuers

even without a strong commitment, the challenger would incur a loss if it decided to enter the market due to the high costs involved. As the cost of internationalizing a currency decreases, the incumbent must raise its commitment level to deter the challenger. The reduced cost lowers the barrier for the challenger to enter the market, thereby increasing its incentive to internationalize its currency. Consequently, the incumbent needs to commit more substantially to maintain its dominant position. When the cost is sufficiently low, both issuers have the capacity to internationalize their currencies with high commitment levels. In this scenario, the benefit of global currency adoption outweighs the cost for both issuers, leading to a more competitive environment where multiple currencies can coexist internationally.

This proposition suggests that a multipolar payment system may emerge if the cost for internationalization becomes sufficiently low relative to potential benefits. Historically, internationalizing a currency has been costly—requiring opening capital accounts, establishing an international payment system, and building supporting institutions. The US made great efforts to promote the usage of the USD worldwide as a first mover, including the establishment of the Bretton Woods Institutions, the World Trade Organization, the petrodollar system, etc. However, the cost for internationalizing is arguably decreasing as advancements in payment technologies can reduce monitoring

costs for issuers while enhancing security and transparency. As access to these technologies improves, the costs for internationalization decrease, making the benefits of enhanced international status more pronounced for issuing countries.

Proposition 1 also states that the threshold $\underline{k}$ that determines the adoption of the two currencies is increasing in β. This is because when both currencies are risky, it is harder for the incumbent to maintain its monopoly as users prefer to diversify. Moreover, when the demand for international currencies M grows, the commitment cost becomes relatively lower than the benefit that issuers can gain from international adoption of their currencies. Therefore, it becomes harder for the incumbent to deter the challenger and thus the threshold $\underline{k}$ increases. The changing market share of the two issuers as β and M change is depicted in Figure 2(a) and 2(b).



(a) Market share as β changes

(b) Market share as M changes

Figure 2: Distribution of the market share

4.2 Home bias and centrality

It is reasonable to assume that some users are not neutral regarding the choice of international currencies for trade settlement. For example, the US users would prefer the USD to any other currencies since they can settle both domestic and international transactions in the USD, thereby

reducing the cost associated with the exchange rate risks. We capture these asymmetries with the following definition.

Definition 2. *User i prefers currency p over $-p$ if $f_{ip}(e) = \mu_i f_{i,-p}(e)$ with $\mu_i > 1$.*

While the centrality considering paths originating from each user plays a crucial role in currency choice (see Lemma 1), the complementarity in currency choices suggests that a user with many paths pointing toward itself has greater influence over others' choices. To simplify the analysis, we assume that network links are two-way and symmetric, meaning that $w_{ij} = w_{ji}$ for any pair (i, j). Under this assumption, the network W is undirected, ensuring that the effects of outgoing and incoming connections on currency choices are balanced. To show how issuers compete depending on network positions of home users, we focus on the range of k where the incumbent does not have an advantage (that is, $k < \underline{k}$). Let $\boldsymbol{\kappa} \coloneqq (\mathbb{I} - \frac{1}{\beta}W)^{-1}\mathbf{1}$ be users' Katz-Bonacich centrality vector. We have the following result.

Proposition 2. *Suppose that there are two distinct users i and j with opposite preferences, i.e., $f_{ip}(e) = \mu f_{i,-p}(e) = f_{j,-p}(e) = \mu f_{jp}(e)$ where $\mu > 1$. Let all other factors be symmetric: W is undirected, $m_h = m\ \forall h \in N$, and $f_{ha}(e) = f_{hb}(e) = f(e)$ for all users $h \in N\backslash\{i, j\}$. If $\kappa_i > \kappa_j$ and $k < \underline{k}$, then $e_p^* \geq e_{-p}^*$ and $X_p^* > X_{-p}^*$.*

Under the conditions that a) the interdependency between users is two-way and symmetric, b) there are two users with opposite preferences, and c) the cost is sufficiently low so that both issuers decide to internationalize their currencies, Proposition 2 states that the issuer of the currency preferred by the user with a higher centrality commits more strongly and captures a larger market share. The intuition is as follows. First, since $\kappa_i > \kappa_j$, we have $x_{ip} > x_{j,-p}$ given the same commitment by the two issuers. Since the bilateral weight is symmetric, the total cross-effect that user i's decision has on other users must be larger than that of j, giving the issuer of the currency favored by i (i.e., issuer p) a higher incentive to raise its commitment, thereby making everyone prefer its currency. Due to this feedback mechanism, in the SPE outcome, p chooses a higher com-

mitment than $-p$ and obtains a larger market share. Therefore, the network centrality of the users with a stronger preference for a particular currency plays an important role in shaping the currency competition.

4.3 Network integration

In this section, we investigate how network integration influences the outcomes of the game. For any two networks W and W', we say W' is strictly more integrated than W and write $W' \gneq W$ if $w'_{ij} \geq w_{ij}$ for all $(i,j) \in N^2$ with at least one strict inequality. Let $\underline{\beta}(W)$ denote the minimum values of β that ensure a unique, finite, and non-negative usage allocation by the users given network W and any pair (e_a, e_b). Throughout this section, we assume that $\beta \geq \max\{\underline{\beta}(W), \underline{\beta}(W')\}$. We have the following result.

Lemma 4. *Suppose that $W' \gneq W$. Given any $\boldsymbol{m}$ and β,*

(a) Commitments are more effective under W', i.e., $\frac{\partial X_p(W')}{\partial e_p} > \frac{\partial X_p(W)}{\partial e_p}$ for any $p \in \{a, b\}$.

(b) Suppose that all users prefer currency p. Then, the increase in commitment effectiveness due to network integration is larger for p, i.e., $\frac{\partial X_p(W')}{\partial e_p} - \frac{\partial X_p(W)}{\partial e_p} > \frac{\partial X_{-p}(W')}{\partial e_{-p}} - \frac{\partial X_{-p}(W)}{\partial e_{-p}}$.

Lemma 4 states that network integration increases users' response to issuers' commitment. Specifically, an increase in an issuer's commitment results in a larger increase in the usage of its currency when the network is more integrated. This network integration effect is amplified for a currency that is preferred by users.

In the following, we study the influence of network integration when players are symmetric as in Section 4.1.

Proposition 3. *Suppose that users are symmetric. Given any $\boldsymbol{m}$, if $W' \gneq W$, then $\underline{k}(W') < \underline{k}(W)$. Moreover, a can deter b with a lower commitment level under W', that is, there exists k' such that $e_a^*(W', k) < e_a^*(W, k)$ for $k \in [\underline{k}(W), k')$.*

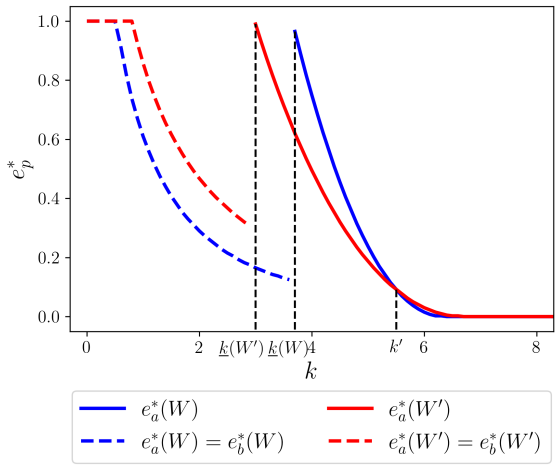


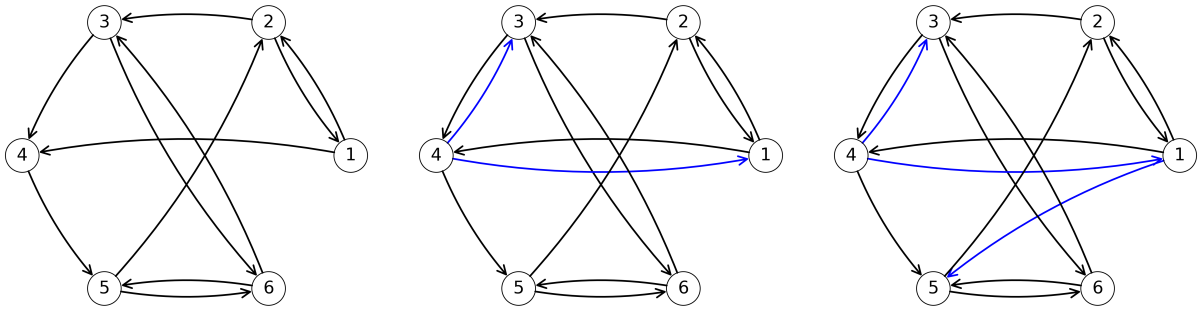
Figure 3: The effect of network integration on commitment levels: $W' \gneq W$

Proposition 3 implies that network integration amplifies the incumbent advantage. Suppose k is sufficiently low such that two issuers initially internationalize their currencies. As users become more interconnected, the incumbent has an incentive to raise its commitment to deter the challenger and attain its monopoly. When k is sufficiently high for a to attain its monopoly initially, network integration strengthens users' incentives to coordinate their currency choices, allowing the incumbent to sustain its monopoly with a lower commitment level. The effect of network integration when all users are symmetric is illustrated in Figure 3.[5]

Lemma 4 and Proposition 3 imply that there are two effects that network integration has on the behavior of issuers and the currency adoption in the equilibrium. First, since users respond more to commitment of issuers, network integration gives issuers, especially the issuer of the currency preferred by users, stronger incentives to increase their commitments for currency internationalization. Second, it amplifies the advantage held by the incumbent. When users have a preference for the emerging currency over the incumbent, which of these two effects dominates depends on the extent of the network integration as demonstrated in the following example.[6]

[5] $n = 12, m_i = 1\ \forall i \in N, \beta = 2.2, f(e) = e^{0.5}$, $k = 1$, and $c(e) = \exp(e)$.

[6] We can have a more integrated network by adding new links and (or) increasing the weight of existing links. For simplicity, we only add new links in this example.



(a) W (b) W' (c) W''

Figure 4: An example of network integration

Example: We introduce asymmetry favoring b by setting $f(e_a) = e_a^{0.6}$ and $f(e_b) = 1.1e_b^{0.6}$ and keeping other factors symmetric: $m_i = 1\ \forall i, \beta = 2, k = 1.5$, and $c(e) = \exp(e)$. Consider first the case where we initially have network W with each link having weight 0.25 (Figure 4(a)). Then, in the SPE outcome, $(e_a^*(W), e_b^*(W)) = (0.27, 0.31)$, $X_a^*(W) = 2.83$ and $X_b^*(W) = 3.17$. Now, suppose that additional links of the same weight from user 4 are added to form W' (Figure 4(b)). Then, the stronger network effects increase the incentive for issuers to strengthen their commitments for currency internationalization, especially for b who issues the currency preferred by users. As a result, b raises its commitment more than a and gains a higher global adoption than when the network is less integrated. Specifically, in the new SPE outcome, $(e_a^*(W'), e_b^*(W')) = (0.29, 0.34)$, $X_a^*(W') = 2.79$ and $X_b^*(W') = 3.21$.

Now, we add another link into W' from user 1 to user 5, which creates an even more integrated network W'' (Figure 4(c)). The larger network externalities mean that if a tries to deter b, users would respond more to its commitment than before, giving it a higher utility than sharing the market with b. This change in the users' reaction gives a a higher incentive to internationalize its currency for a monopoly status. As a result, a deters b by choosing $e_a^*(W'') = 1$ and obtains the whole market.

5 A T-currency problem

Our focus on the two-currency framework is motivated by the rivalry between the US and China. While this dyadic competition provides a benchmark to analyze network effects and issuers' strategies, this section extends the model to a setting with finitely many currencies. We provide a solution concept for the currency allocation problem of users, given the commitment levels of issuers. With a well-defined solution for the currency choice problem, we can find the SPE of the game by backward induction. The main insights from the two-currency case continue to hold in the extended model.

5.1 A dynamic programming approach

The multi-currency allocation problem is static and can be solved directly using the Lagrangian method. We nevertheless present a dynamic programming formulation because it provides a systematic way to characterize the solution in the finite-currency case. As shown below, the recursive formulation expresses optimal allocation through a sequence of marginal-cost equalization conditions across currencies, yielding a simple law of motion for currency usage and a direct characterization of usage differences in terms of adjusted Katz-Bonacich centrality.

The objective of users is to minimize their overall cost by allocating their transactions to T currencies issued by T issuers. Let the set of issuers be $E = \{1, 2, ..., T\}$. First, we assume that each user has an order of currencies that they consider for their transaction settlement and think of the currency allocation as choices in a recursive problem. We show below that under our assumptions, the optimal currency allocation for users is unique and order-independent. Let user i consider currencies in order $1, 2, ..., T$. The state variable is the user's remaining transactions to be settled in each stage t, denoted as m_{it}, and the choice variable is the user's usage of each currency t, denoted as x_{it}. Given state $m_{i,t-1}$, user i chooses its usage of currency t, thus decides $m_{it} = m_{i,t-1} - x_{it}$. Since user i needs to settle a total of m_i transactions, we set $m_{i0} = m_i$. The perceived cost of using

x_{it} of currency t for user i is $\mathscr{C}_{it}(\boldsymbol{x_t}) = \frac{\beta}{2}x_{it}^2 - w_{ij}x_{it}x_{jt} - f_{it}x_{it}$, where $x_{it} = m_{i,t-1} - m_{it}$. We denote the vector of usage of currency t as $\boldsymbol{x_t}$. The cost minimization problem of each user i is

$$\min_{x_{i1},...,x_{iT}} \mathcal{V}_i(\boldsymbol{x_1}, ..., \boldsymbol{x_T}) = \sum_{t=1}^{T} \mathscr{C}_i(\boldsymbol{x_t}) \quad \text{s.t.} \sum_{t=1}^{T} x_{it} = m_i.$$

We can then rewrite the problem in terms of the Bellman equation for each user i as follows.

$$V_{i,t-1}(m_{i,t-1}) = \min_{0 \leq m_{it} \leq m_{i,t-1}} \{\mathscr{C}_{it}(m_{i,t-1} - m_{it}) + V_{it}(m_{it})\}$$

The FOC and the Envelope theorem yield the Euler equation

$$\mathscr{C}'_{it}(x_{it}) = \mathscr{C}'_{i,t+1}(x_{i,t+1}), \tag{9}$$

which is equivalent to $\beta x_{it} - \sum_{j \neq i} w_{ij}x_{jt} - f_{it} = \beta x_{i,t+1} - \sum_{j \neq i} w_{ij}x_{j,t+1} - f_{i,t+1}$. If $m_{it} \leq \sup\{m \in (0, m_{i0}] : \mathscr{C}'_{it}(m) \leq \mathscr{C}'_{i,t+1}(0)\}$, then the marginal cost of settling all the remaining transaction with currency t is lower than the marginal cost of starting settling them with $t+1$. Thus, user i would choose to settle all the remaining transactions with currency t without considering other currencies. Hence, when β is sufficiently high such that $m_{i,t} \geq \sup\{m \in (0, m_{i0}] : \mathscr{C}'_{i,t}(m) \leq \mathscr{C}'_{i,t+1}(0)\}$ for all i and for all t, the Euler equation (9) holds for all i and for all t, which implies the solution is interior and the order of consideration of the currencies does not matter for the resulting usage of each currency by users.[7] Therefore, we can identify the minimum value of each β, denoted $\underline{\beta}$, that ensures a unique, nonnegative, and order-independent solution for the users' currency choice problem.[8] Suppose that $\beta \geq \underline{\beta}$. Then, we can rewrite the Euler equations

[7] When β is sufficiently low, then some users may choose to settle all their transactions before considering T, thus the order of consideration of the currencies matters for the users' currency choice.

[8] It can be checked that the condition is satisfied when $\beta \geq \max_{i \in N, (t,\tau) \in E^2} \frac{\sum_{j \neq i} w_{ij}m_j + f_{it} - f_{i\tau}}{m_i}$.

in terms of matrices:

$$\beta \boldsymbol{x_{t+1}} - W\boldsymbol{x_{t+1}} - \boldsymbol{f_{t+1}} - \beta \boldsymbol{x_t} + W\boldsymbol{x_t} + \boldsymbol{f_t} = \mathbf{0}. \tag{10}$$

Hence, the "law of motion" for currency usage is

$$\boldsymbol{x_{t+1}} = \boldsymbol{x_t} + (\beta \mathbb{I} - W)^{-1}(\boldsymbol{f_{t+1}} - \boldsymbol{f_t}). \tag{11}$$

For the currency usage to be well-defined, we need $\beta > r(W)$, where $r(W)$ is the spectral radius of the weight matrix W. From (11), each usage vector $\boldsymbol{x_t}$ can be written as a function of $\boldsymbol{x_1}$. Using the constraint $\sum_{t=1}^{T} \boldsymbol{x_t} = \boldsymbol{m}$ and some linear algebra, we can derive the unique solution for the usage of each currency by all users given the commitment levels of issuers.

So far, we have shown how the optimal currency allocation can be derived given the commitment levels of issuers. We can then find the SPE of game among T issuers by backward induction. The following corollary shows that the main insights from the two-currency case continue to hold in this extended model.

Corollary 1.

(a) Suppose that users are symmetric. As k increases, there are less international currencies.

(b) Suppose that there are T users and each user i prefers a distinct currency p_i, i.e., $f_{i,p_i}(e) = \mu f_{i,-p_i}(e) = \mu f(e)$ where $\mu > 1$. Let W be undirected, $m_i = m \; \forall i \in N$ and $k < \underline{k}$ so that all issuers internationalize their currencies. For any pair (i, j), if $\kappa_i > \kappa_j$, then $e^*_{p_i} \geq e^*_{p_j}$ and $X^*_{p_i} > X^*_{p_j}$.

(c) Suppose that users are symmetric. When the network is more integrated, there are less international currencies.

The mechanisms behind these results are analogous to those discussed in Section 4. It is important

to note that although many currencies might have the potential to be used internationally, the equilibrium is likely to feature only a few dominant ones. This outcome arises from the strategic advantage of early entrants, especially in an increasingly integrated global trade network.

5.2 Usage difference and the Gini coefficient

In this section, we analyze the relationship between the currency choice of each user and its position in the network. Define $\boldsymbol{\gamma}_t \coloneqq \frac{1}{\beta}[\boldsymbol{f_t} - \boldsymbol{f_{t+1}}]$, which captures the non-network-driven preference between t and $t+1$, excluding the network effects. From equation (11), the extent to which users choose currency t over currency $t+1$ is captured by the usage difference

$$\boldsymbol{d_t} \coloneqq \boldsymbol{x_t} - \boldsymbol{x_{t+1}} = \left(\mathbb{I} - \frac{1}{\beta}W\right)^{-1} \boldsymbol{\gamma}_t, \tag{12}$$

which corresponds to an adjusted Katz-Bonacich centrality. In fact, since the solution is order-independent, we can write the usage difference between any two currencies in an analogous way. That is, the difference in usage of any two currencies is an adjusted Katz-Bonacich centrality, where the connection from a user to a trade partner is weighted by the partner's preference between currencies. This gives us an insight into the measure of diversity in each user's currency choice. Let the Gini coefficient, originally introduced in Gini (1912), measure the extent to which the allocation of usage among currencies deviates from a perfectly equal allocation. The coefficient is given by

$$G_i = \frac{\sum_{t=1}^{T}\sum_{u=1}^{T}|x_{it} - x_{iu}|}{2T\sum_{t=1}^{T} x_{it}} = \frac{\sum_{t=1}^{T}\sum_{u=1}^{T}|x_{it} - x_{iu}|}{2Tm_i}. \tag{13}$$

Proposition 4. *Let $\tilde{\kappa}_{it} \coloneqq \frac{t(T-t)|d_{it}|}{Tm_i}$ be user i's Katz-Bonacich centrality adjusted by the non-network-driven preferences for t over $t+1$ of users. Then, $G_i = \sum_{t=1}^{T-1} \tilde{\kappa}_{it}$.*

Proposition 4 states that the Gini coefficient of each user's currency allocation is a sum of Katz-Bonacich centralities adjusted by the non-network-driven preferences. In other words, ceteris

paribus, a country's currency allocation for trade settlement is more concentrated when it has a higher network centrality. This result highlights that users with more or stronger trade ties in the global trade network tend to concentrate its usage more heavily on a few currencies. The intuition is similar to Lemma 1 for the two-currency case: Given the same import value to be settled, a user's central position makes the gains from using a common medium of exchange more valuable, thereby reducing the incentives to diversify across currencies.

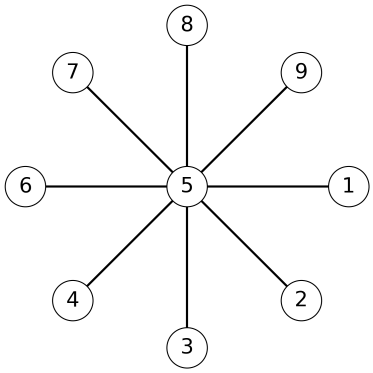


Figure 5: A star network

Example: Consider the undirected network as depicted in Figure 5, where each link has a weight of 0.125. User 5 is the most central node, while all other users have identical (lower) centrality. Suppose that there are five issuers (1 through 5) competing to attract global currency usage, and the commitments by issuers that enter later generate lower usability for users due to additional transaction and management costs for adopting new currencies into the payment system. Specifically, let the usability function for currency 1 be $f_1(e) = e^{0.4}$ and $f_t(e) = 0.7^{t-1} f_{t-1}(e)$ for $t \in \{2, 3, 4, 5\}$. Let $\beta = 2.1$, $k = 0.3$, and $c(e) = \exp(1.5e)$. In the SPE outcome of this game, issuers that enter later choose lower commitment, and the last issuer chooses not to internationalize its currency. Specifically, the SPE outcome commitments are given by $(e_1^*, e_2^*, e_3^*, e_4^*, e_5^*) = (0.86, 0.7, 0.54, 0.42, \emptyset)$. While facing identical preference, users' currency allocations differ depending on their network centralities. As shown in Figure 6, the most central user (user 5) concentrates its usage on currency 1, while others allocate their usage more evenly across multiple

currencies. Indeed, the Gini coefficient of user 5's currency allocation is 0.42, whereas that of the other users is 0.3.

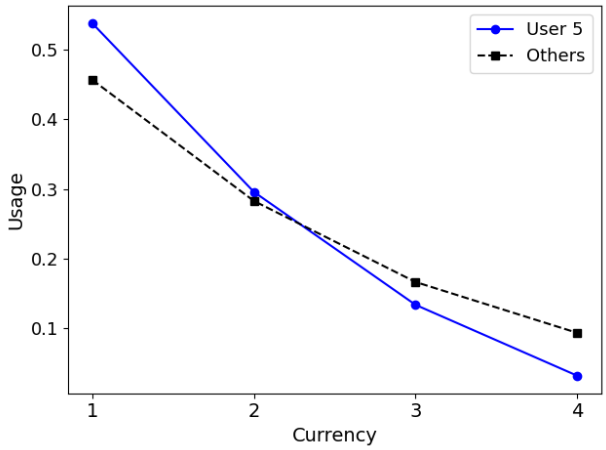


Figure 6: Currency usage: User 5 vs others

The above result has important implications. It suggests that central countries contribute disproportionately to reinforcing global currency dominance by concentrating their usage and affecting their trade partners' currency choices. In turn, this can deepen the entrenchment of incumbent currencies and raise the bar for challengers, particularly if central countries are biased toward the incumbent or resistant to adopting emerging currencies. This prediction is empirically relevant: it implies a systematic relationship between trade-network centrality and the concentration of currency use across countries. Consistent with this implication, Pham (2026) emphasizes the bargaining power of economies that serve as key destination markets in global trade, showing that more central network positions are associated with greater home-currency use in imports. More broadly, the framework can guide empirical work on how global trade-network structure shapes international currency use over time.

6 Model implications and empirical evidence

This section connects the model to the competition between the USD and the RMB. Section 6.1 interprets USD persistence and limited RMB adoption through the model's feedback mechanism between network spillovers and currency internationalization. Section 6.2 then provides empirical evidence consistent with the incumbent-reinforcement mechanism, using import-invoicing data for USD, EUR, and RMB.

6.1 The USD and the RMB

Our model helps interpret the historical emergence of the USD as a dominant international currency. The USD's rise occurred at a time when the global trade network was fragmented following the world wars. This fragmentation limited coordination among users, allowing a new issuer to challenge the incumbent by making a strong commitment to international currency usability. The US subsequently built institutions and markets that supported the global use of the dollar, including the Bretton Woods institutions, the postwar international payment system, and dollar-based commodity settlement arrangements, establishing the USD usability before the network became more integrated. Once established, such dominance tends to persist even when new competitors emerge, since trade integration reinforces it by increasing users' incentives to coordinate on the currency already widely used in settlement.

China's experience illustrates why trade size alone is insufficient for currency dominance. Although China has surpassed the US in global trade share, RMB use in international payments remains limited relative to the USD. In the model, this gap can arise because adoption depends not only on trade value, but also on the network position of users and the usability of the currency. China has taken important steps to promote RMB use through the Belt and Road Initiative, the Asian Infrastructure Investment Bank, bilateral swap agreements, and RMB settlement infrastructure. However, these efforts remain more regional and bilateral than the global institutional

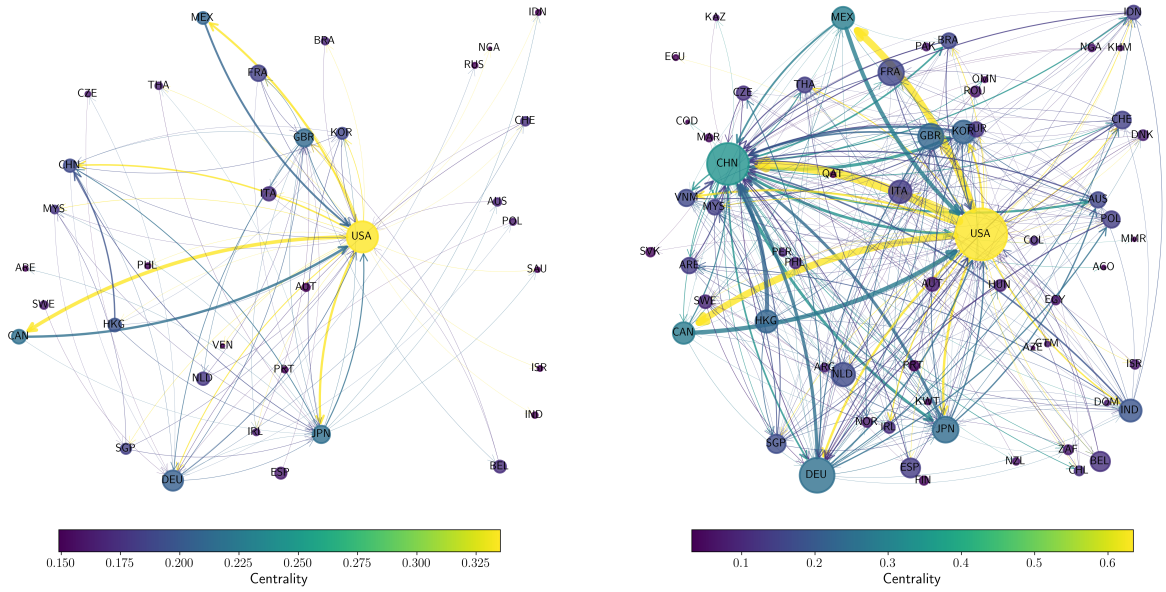
framework supporting the USD, and China's capital account remains relatively restricted. In the language of the model, China's commitment improves RMB usability but may not yet be strong or global enough to overcome the incumbent advantage of the USD.

Figure 7 shows that, despite rapid growth in China's trade, the US remains much more central in the global trade-payment network. China's imports increased elevenfold, compared with 2.8-fold for the US, yet both countries' Katz-Bonacich centrality rose about twofold, leaving China's centrality roughly half that of the US. The US, as a major importer of final goods, imports heavily from key importers who also trade intensively with other key economies. Its users' currency choices therefore generate larger direct and indirect spillovers. By contrast, China's major import partners are less central, limiting the propagation of RMB use through the network.[9]

The model therefore suggests that a domestic preference for the RMB translates into global adoption only if it is propagated through sufficiently central trade links and supported by high international usability. Because the home currency is used in domestic transactions, domestic users naturally have incentives to settle international transactions in their own currency, reducing currency-risk exposure, conversion costs, and hedging needs. However, such preferences generate global spillovers only when domestic users occupy central positions in the trade network. China's lower centrality reduces the responsiveness of global users to RMB internationalization commitment, making a regional strategy more natural than a fully global challenge to the USD.

Our analysis also suggests why adoption of the RMB by less central economies may not be sufficient to generate global dominance. Given similar trade values and non-network-driven preferences, economies with weaker network connectivity have stronger incentives to diversify settlement currencies. Their adoption of an emerging currency, however, is less likely to spread widely because their currency choices generate weaker spillovers. For example, BRICS countries may be more willing to adopt the RMB, but as they are not highly connected to other major economies,

[9]China's top importing partners include Australia, Brazil, Indonesia, Malaysia, Thailand, and Vietnam, whose import values are relatively low, and they do not import significantly from other key economies in the network.



(a) Trade payment network in 2000

(b) Trade payment network in 2022

Note: Data source: UN Comtrade. Trade among euro-area countries is excluded. Only bilateral trade with a value above USD 10 billion is plotted. Node size proportional to total import value. Directed links indicate payment flows, where a link from country i to country j represents payments made by i (the importer) to j (the exporter) for trade transactions. The thickness of links corresponds to payment value (i.e., import value). The trade value is in trillion USD and Katz-Bonacich centrality is computed with $\lambda = 1$ for both years. The formula is introduced in Section 3.1.

Figure 7: Global trade-payment networks and centrality

the RMB use within this group is unlikely by itself to generate strong spillover effects.

The framework therefore suggests that RMB internationalization requires more than China's large trade share. RMB use is more likely to spread internationally if users, especially its domestic users, develop stronger preferences for the RMB. When such users have more central positions in the global trade network—possibly achieved through deeper ties among BRI countries, their preference can spread internationally, which would increase China's incentive to raise its commitment for currency internationalization and further expands the RMB's adoption through the feedback mechanism we identified in this paper. Absent these conditions, trade integration is more likely to reinforce incumbent-currency use than to generate a rapid transition toward the RMB.

6.2 Empirical evidence

The theoretical results generate two related empirical implications. The first concerns countries' network positions and the use of a preferred currency, which is examined in Pham (2026). In this section, we focus on the second implication: trade integration should reinforce the use of currencies that are already entrenched in a country's invoicing system. This implication is directly related to the model's feedback mechanism between network spillovers and currency adoption.

Since comprehensive cross-country data on settlement-currency shares are not available, we use import-invoicing currency shares as the closest observable counterpart to trade-currency use. We use the dataset compiled by Boz et al. (2025), which reports USD, EUR, and RMB import-invoicing shares for 132 countries over 2000–2023. For each year, we construct a directed global trade-payment network from bilateral trade data in UN Comtrade, with links running from importers to exporters, and compute each country's Katz-Bonacich centrality.[10] In the baseline network, we exclude intra-euro-area trade because these transactions are overwhelmingly denominated in EUR by institutional design and therefore do not reflect currency competition. The results are robust to including intra-euro-area trade in the centrality calculations, as shown in Appendix Table B1. Missing bilateral trade flows are set to zero in the baseline. Appendix Table B2 shows that the results are robust to regularizing the network by adding a small constant to all bilateral flows.

The empirical specification is guided by the model's network-reinforcement mechanism. Lemma 4 shows that network integration raises the responsiveness of currency use to the commitment of issuers, thus currencies with an existing advantage are more strongly reinforced in a more integrated network. In the model, this advantage is generated by the commitment of issuers, currency usability, and non-network-driven preferences of users. Since these components are not directly observed in the data, we use the lagged invoicing share as a reduced-form measure of the extent to

[10] With bilateral trade values expressed in USD billions, the spectral radius of each weighted adjacency matrix remains below one throughout the sample. We follow standard treatments of Katz–Bonacich centrality (Sargent and Stachurski, 2024) and set $\lambda = 1$, which satisfies the convergence condition in all cases.

which currency is already entrenched in each country's invoicing system and interact it with growth in Katz-Bonacich centrality. The interaction coefficient measures whether growth in a country's network centrality amplifies the use of a currency that is already entrenched in its invoicing system. A positive coefficient is consistent with the model's prediction that trade-network integration reinforces incumbent-currency advantages.

To test for incumbent-currency reinforcement, we estimate whether growth in network centrality has a larger effect on currencies with higher pre-existing invoicing shares. Following Goldberg and Tille (2008), Ito and Chinn (2014), Boz et al. (2025) and Pham (2026), for each currency $c \in \{\text{USD}, \text{EUR}, \text{RMB}\}$, we estimate

$$s^c_{i,t} = \beta^c_0 + \beta^c_1 \Delta\kappa_{i,t} \times s^c_{i,t-1} + \beta^c_2 \Delta\kappa_{i,t} + \beta^c_3 s^c_{i,t-1} + \boldsymbol{\theta^{c\prime} x^c_{i,t}} + \alpha^c_i + \tau^c_t + \epsilon^c_{i,t}$$

where $s^c_{i,t}$ is the share of importer i's imports invoiced in currency c; $\Delta\kappa_{i,t} \equiv \ln \kappa_{i,t} - \ln \kappa_{i,t-1}$ is growth in Katz-Bonacich centrality, capturing changes in a country's network connectedness and reflecting how its direct and indirect trade links evolve; α^c_i and τ^c_t are country and year fixed effects; and $x^c_{i,t}$ is a vector of controls. The coefficient of interest is β^c_1. A positive estimate implies that trade integration reinforces the use of currencies that are already widely used in a country's invoicing system, consistent with the network feedback mechanism in the model.

The controls account for alternative channels emphasized in the invoicing-currency literature. We include total imports as a share of world trade because larger importing economies may rely more heavily on dominant invoicing currencies independently of growth in network centrality. We also control for import shares from major currency issuers—the US, the euro area, and China—and from broader currency blocs. The USD and EUR blocs are defined using the de facto exchange-rate regime classification of Ilzetzki et al. (2019), while the RMB bloc is proxied by ASEAN trade following Boz et al. (2025). In addition, we control for commodity-import shares, bilateral exchange rates against each currency, financial market depth, and capital account openness. These

controls help ensure that the estimated network effect is not simply capturing trade composition, valuation effects, financial infrastructure, or cross-border financial access. Summary statistics are shown in Table 1.

	count	mean	sd	min	max
Katz-Bonacich centrality growth	529	-0.04	0.13	-0.47	0.16
USD share in import invoicing	529	59.11	26.30	0.67	99.52
EUR share in import invoicing	529	21.55	24.52	0.00	90.18
RMB share in import invoicing	529	0.51	1.82	0.00	18.20
Total import growth	529	0.04	0.18	-0.68	0.81
Total import as a share of world trade	529	0.44	0.70	0.00	3.89
Commodity imports share	529	19.10	7.34	3.16	45.31
Share of imports from US	529	9.32	13.73	0.57	89.31
Share of imports from Euro area	529	19.88	16.27	0.35	60.72
Share of imports from China	529	13.39	8.06	0.18	38.11
Share of imports from USD bloc	529	16.41	14.77	0.00	72.77
Share of imports from EUR bloc	529	6.36	8.44	0.00	37.76
Share of imports from ASEAN	529	5.72	7.74	0.03	43.35
Bilateral exchange rate against USD (log)	529	3.46	2.61	-0.98	9.99
Bilateral exchange rate against EUR (log)	529	3.63	2.61	-0.85	10.11
Bilateral exchange rate against RMB (log)	529	1.55	2.61	-2.91	8.08

Note: The table reports summary statistics of the variables used in all regressions in this paper. Statistics are based on the common estimation sample of 67 countries with non-missing USD, EUR, and RMB import-invoicing shares and controls.

Table 1: Summary statistics

We focus on non-dominant-currency economies as users, excluding the US and euro-area countries because their home currencies are already internationally accepted and their invoicing choices reflect issuer-specific regimes rather than ordinary currency-choice decisions; China is absent because its invoicing data are not available. To ensure comparability across currencies, the main specifications use a common estimation sample for which USD, EUR, and RMB import-invoicing shares and all control variables are observed. This leaves 67 countries and prevents cross-currency differences in estimates from reflecting reporting coverage. Appendix Table B3 shows similar results using the maximum available sample for each currency.

	(1) USD	(2) EUR	(3) RMB
Centrality growth × Lagged invoicing currency share	0.135**	0.096***	-0.038
	(0.059)	(0.026)	(0.142)
Centrality growth	-11.173***	0.057	0.193
	(4.195)	(0.882)	(0.269)
Lagged invoicing currency share	0.655***	0.598***	0.657***
	(0.103)	(0.150)	(0.237)
Controls	✓	✓	✓
Year and country FEs	✓	✓	✓
Within R^2	0.609	0.643	0.638
Observations	526	526	526
Countries	67	67	67

*Note: S*tandard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All panels exclude the US and euro-area countries. Standard errors are clustered at the country level.

Table 2: Growth in connectedness in explaining currency choice

Table 2 reports the baseline results. The interaction between centrality growth and the lagged invoicing share is positive and statistically significant for the USD and the EUR, but not for the RMB. This indicates that growth in network centrality does not affect all currencies uniformly. Rather, it reinforces currencies that are already entrenched in a country's invoicing system. For the USD, the estimated marginal effect of centrality growth becomes positive only when the lagged USD share exceeds about 83 percent.[11] Thus, centrality growth does not necessarily favor the USD for all countries. When the USD is not the locally entrenched currency, a country may be more closely tied to the EUR, the RMB, a regional currency bloc, or home-currency invoicing; stronger network centrality may then reinforce these alternative invoicing arrangements instead. Our result shows that centrality growth reinforces USD invoicing primarily where the USD is already highly dominant.

This finding is consistent with the model's incumbent-reinforcement mechanism. As a country becomes more connected through direct and indirect trade linkages, firms have stronger incentives

[11] The threshold is calculated as $-\hat{\beta}_2^c/\hat{\beta}_1^c$.

to coordinate on currencies already embedded in contracts, payment systems, and hedging relationships. The positive interaction for the EUR suggests a similar persistence mechanism among non-euro-area countries, although one that is likely more regional than the USD. By contrast, the insignificant interaction for the RMB suggests that growth in network centrality does not reinforce RMB invoicing in the same way. This is consistent with the model's implication that trade integration tends to amplify incumbent advantages unless the emerging currency has already reached a sufficiently strong position in users' invoicing systems.

A natural concern is that centrality growth may simply capture changes in total import value. Appendix Table B4 addresses this concern by replacing centrality growth with import growth. The interaction between import growth and lagged invoicing shares does not show the same reinforcement pattern for the USD or the EUR. This suggests that the baseline results are not driven by simple expansion in import scale. Instead, they reflect changes in a country's position in the global trade-payment network, including indirect linkages. In this sense, the empirical evidence supports the model's prediction that network integration reinforces incumbent-currency advantages.

7 Conclusion

We explain the rise and fall of dominant international currencies by developing a network model where issuers and users interact in the presence of externalities. The objective of issuers is to maximize the international usage of their currencies by committing to currency internationalization, while users allocate a fixed real value of trade settlement across available currencies. We assume that settlement costs can be reduced by choosing a currency that trade partners also use and by the usability generated by the issuer's commitment. The framework abstracts from endogenous exchange-rate determination and broader reserve-currency mechanisms in order to isolate how network position affects settlement-currency choice.

Our analysis elucidates why being dominant in bilateral trade is insufficient to achieve dominant

currency status. We find that the incumbent issuer has an advantage as it can deter the emerging currency by choosing a sufficiently strong commitment to currency internationalization. This advantage is amplified when the trade network is more integrated. Here, central users play a critical role as it is their preferences that matter most for choices of both users and issuers. We find that central users concentrate their usage of currencies, while peripheral users diversify theirs. The issuer of a currency preferred by central users has stronger incentives to improve the currency's usability, which in turn leads to greater adoption of the currency. This feedback mechanism leads to our central insight on the interplay between commitment of issuers and currency choice of users that shapes settlement-currency dominance.

We also provide empirical evidence consistent with this mechanism. Using import-invoicing data for USD, EUR, and RMB, we show that centrality growth reinforces USD and EUR invoicing where these currencies are already entrenched, while the corresponding effect for RMB is insignificant. These patterns suggest that trade integration does not mechanically promote the adoption of an emerging currency; rather, it tends to amplify incumbent-currency advantages.

Our model helps explain 1) the US's incumbent strategy to maintain the USD dominance and the prohibitive costs for China to establish itself as an issuer of a new international currency, 2) the increasing reliance on the USD for invoicing and settlement as international trade becomes more integrated, 3) how the US's high centrality and its domestic preference of users towards their home currency incentivize the US to maintain the institutions and markets that support the global USD usability. The mechanisms also elucidate China's limited commitment and the RMB's low global adoption despite its trade dominance. More broadly, our framework highlights how changes in global trade networks can shape the persistence or displacement of dominant settlement currencies.

A Appendix: Proofs

Proof of Lemma 1. The proof follows directly from (6) and (8). □

Proof of Lemma 2. To show the existence of the SPE, we show that the best responses exist at every subgame. First, consider b's best response given any e_a chosen by a. Define $Z \coloneqq (\mathbb{I} - \frac{1}{\beta}W)^{-1}$. From (7), the total usage of currency b is $X_b(e_b) = \frac{M - \sum_{i\in N}\sum_{j\in N} z_{ij}\gamma_j(e_a,e_b)}{2}$. Thus, b's utility is $u_b(e_b) = \frac{M - \sum_{i\in N}\sum_{j\in N} z_{ij}\gamma_j(e_a,e_b)}{2} - kc(e_b)$, which is concave as $-\sum_{i\in N}\sum_{j\in N} z_{ij}\gamma_j(e_b)$ is a sum of concave functions and $c(e_b)$ is convex. We find b's best response to a's commitment level $e_a \in [0,1]$ by taking the FOC w.r.t e_b

$$\frac{\partial u_b(e_a,e_b)}{\partial e_b} = \frac{1}{2\beta}\sum_{j\in N}\sum_{i\in N} z_{ij} f'_{jb}(e_b) - kc'(e_b) = 0. \tag{14}$$

Let e'_b be the unique solution for (14). Then, b's best response when a internationalizes its currency is $\tilde{e}_b = \min\{1, e'_b\}$ if $u_b(e_a,\tilde{e}_b) > 0$ and $\emptyset$ otherwise. When a chooses not to internationalize its currency, b's best response is $e_b = 0$.

Next, consider when a chooses an e_a between [0,1] anticipating b's best response, which is either $\tilde{e}_b$ or $\emptyset$. Since $u_b(e_a,\tilde{e}_b)$ is decreasing in e_a, there exists a value $\hat{e}_a \in \mathbb{R}$ such that $u_b(\hat{e}_a,\tilde{e}_b) = 0$, thus b's best response is $\tilde{e}_b$ if $e_a < \hat{e}_a$ and $\emptyset$ if $e_a \geq \hat{e}_a$. Hence, a's utility function is $u_a(e_a) = \frac{M + \sum_{i\in N}\sum_{j\in N} z_{ij}\gamma_j(e_a,\tilde{e}_b)}{2} - kc(e_a)$ for $e_a < \hat{e}_a$, and $u_a(e_a) = M - kc(e_a)$ for $e_a \geq \hat{e}_a$. Since $\lim_{e_a\to\hat{e}_a^-} = \frac{M + \sum_{i\in N}\sum_{j\in N} z_{ij}\gamma_j(\hat{e}_a,\tilde{e}_b)}{2} - kc(\hat{e}_a) \leq M - kc(\hat{e}_a)$, $u_a(e_a)$ is upper-semicontinuous. By the Weierstrass maximum theorem, a's choice set obtains its maximum values. Therefore, the best responses exist at every subgame and thus, the game has at least one SPE. □

Proof of Lemma 3. To analyze the SPE, we derive the best response of each issuer given the choice of the other. Given b's best response as derived in the Proof of Lemma 2, we can analogously find a's optimal commitment level $\tilde{e}_a$ when they share the market. However, it may be more beneficial for a to choose a commitment level that makes b give up. The commitment level for a to deter b

is $\underline{e}_a = \hat{e}_a$ if $\hat{e}_a \geq 0$ and $\underline{e}_a = 0$ otherwise, which is not feasible if $\hat{e}_a > 1$. a's best response is $\underline{e}_a$ if $u_a(\tilde{e}_a, \tilde{e}_b) \leq u_a(\underline{e}_a, \emptyset)$ (deterring is more beneficial) and $\hat{e}_a \leq 1$ (deterring is feasible). When it is not beneficial or not feasible for a to deter b, its best response is $\tilde{e}_a$ if $u_a(\tilde{e}_a, \tilde{e}_b) > 0$, and $\emptyset$ otherwise. Since both issuers play their best responses in the SPE, possible SPE outcomes are

$$(e_a^*, e_b^*) = \begin{cases} (\underline{e}_a, \emptyset) & \text{if} \quad u_a(\tilde{e}_a, \tilde{e}_b) \leq u_a(\underline{e}_a, \emptyset) \text{ and } \hat{e}_a \leq 1 \\ (\emptyset, 0) & \text{if} \quad u_a(\tilde{e}_a, \tilde{e}_b) \leq 0 \text{ and either } u_a(\tilde{e}_a, \tilde{e}_b) > u_a(\underline{e}_a, \emptyset) \text{ or } \hat{e}_a > 1 \\ (\tilde{e}_a, \tilde{e}_b) & \text{otherwise.} \end{cases}$$

Now we are ready to find the values of k for each case above.

We first find the values of k so that $(e_a^*, e_b^*) = (\underline{e}_a, \emptyset)$. We can check that when $k \to 0$, $(e_a^*, e_b^*) = (\tilde{e}_a(k), \tilde{e}_b(k)) = (1, 1)$ and both gain a non-negative total usage, thus $\hat{e}_a(k) > 1$. Moreover, when $k = \frac{M}{c(0)}$, $u_b(0, \tilde{e}_b) < 0$, thus $\hat{e}_a < 0$ and $(e_a^*, e_b^*) = (0, \emptyset)$. By the chain rule, $u_b(\tilde{e}_b; k)$ is decreasing in k, thus $\hat{e}_a$ is decreasing in k. Therefore, $\exists \hat{k} \in [0, \frac{M}{c(0)}]$ such that $\hat{e}_a(\hat{k}) = 1$ and $\hat{e}_a(k) < 1$ for any $k \in (\hat{k}, \frac{M}{c(0)}]$. Similarly, $\exists \check{k} \in [0, \frac{M}{c(0)}]$ such that $\hat{e}_a(\check{k}) = \tilde{e}_a(\check{k})$ and $\hat{e}_a(k) < \tilde{e}_a(k)$ for any $k \in (\check{k}, \frac{M}{c(0)}]$. Next, we find the values of k such that $u_a(\tilde{e}_a, \tilde{e}_b; k) \leq u_a(\underline{e}_a, \emptyset; k)$. We only need to consider the range of k such that $\tilde{e}_a(k) = e'_a(k) \leq 1$ and $\hat{e}_a(k) \geq 0$. By applying the chain rule, $\frac{\partial[u_a(\underline{e}_a, \emptyset; k) - u_a(\tilde{e}_a, \tilde{e}_b; k)]}{\partial k} = -k \left[\frac{\partial c(\underline{e}_a)}{\partial \underline{e}_a} \frac{\partial \underline{e}_a}{\partial k} - \frac{\partial c(\tilde{e}_b)}{\partial \tilde{e}_b} \frac{\partial \tilde{e}_b}{\partial k} \right] - [c(\underline{e}_a) - c(\tilde{e}_a)]$, which is negative when $\underline{e}_a(k) > \tilde{e}_a(k)$ and is positive when $\underline{e}_a(k) < \tilde{e}_a(k)$, that is, when $k > \check{k}$. Note that when $k \to 0$, $u_a(\underline{e}_a, \emptyset) \to M > u_a(\tilde{e}_a, \tilde{e}_b)$; when $\hat{e}_a(k) = 0$, $u_a(\underline{e}_a, \emptyset) > u_a(\tilde{e}_a, \tilde{e}_b)$. Hence, $u_a(\tilde{e}_a, \tilde{e}_b)$ and $u_a(\underline{e}_a, \emptyset)$ may intersect at at most two points, and $u_a(\tilde{e}_a, \tilde{e}_b) \leq u_a(\underline{e}_a, \emptyset)$ for any k larger than the highest intersection point. (If they do not intersect, this inequality is always satisfied.) Note that in the case the two functions intersect at two points, $\hat{k}$ has to be higher than the lower intersection point. This is because $\hat{e}_a(\hat{k}) = 1 > \tilde{e}_b(\hat{k})$, which implies $\left. \frac{\partial[u_a(\underline{e}_a, \emptyset; k) - u_a(\tilde{e}_a, \tilde{e}_b; k)]}{\partial k} \right|_{k=\hat{k}} > 0$. Let $\dot{k} \geq \hat{k}$ be the minimum k such that both inequalities hold for any $k \geq \dot{k}$. If $k \in [\dot{k}, \frac{M}{c(0)}]$, then $(e_a^*, e_b^*) = (\underline{e}_a, \emptyset)$.

Next, we find the values of k such that $(e_a^*, e_b^*) = (\emptyset, 0)$, which occurs when a gets a negative

utility by playing $\tilde{e}_a$ and not being able to deter b. By the chain rule, $u_a(\tilde{e}_a, \tilde{e}_b; k)$ is decreasing in k. Consider k' such that $u_a(\tilde{e}_a, \tilde{e}_b; k') = 0$. Such k' is in $[0, \frac{M}{c(0)})$ since $u_a(\tilde{e}_a, \tilde{e}_b; k) < 0$ when $k = \frac{M}{c(0)}$. Then, $u_a(\tilde{e}_a, \tilde{e}_b; k) \leq 0$ given any $k \in [k', \frac{M}{c(0)}]$. When $k' \geq \dot{k}$, $\nexists k$ such that $(e_a^*, e_b^*) = (\emptyset, 0)$. When $k' < \dot{k}$, if $k \in [k', \dot{k})$, then $(e_a^*, e_b^*) = (\emptyset, 0)$. Let $\underline{k} = \min\{k', \dot{k}\}$. If $k \in [\underline{k}, \frac{M}{c(0)}]$, then either $e_a^* = \emptyset$ or $e_b^* = \emptyset$. If $k \in [0, \underline{k})$, then $(e_a^*, e_b^*) = (\tilde{e}_a, \tilde{e}_b)$. □

Proof of Proposition 1. First, we show that when players are symmetric, $\nexists k$ such that $(e_a^*, e_b^*) = (\emptyset, 0)$. When players are symmetric, $\tilde{e}_a(k) = \tilde{e}_b(k) = \tilde{e}(k)$ for any k. Consider k' such that $u_a(\tilde{e}, \tilde{e}; k') = u_b(\tilde{e}, \tilde{e}; k') = 0$ as defined in the proof of Lemma 3. From (6), $d_i(\tilde{e}(k'), \tilde{e}(k')) = 0$ for all i, thus $X_a(\tilde{e}(k'), \tilde{e}(k')) = \frac{M}{2}$. Hence, a chooses $\underline{e}_a = \tilde{e}(k')$ and deters b. Therefore, $k' \geq \dot{k}$. This implies that $\nexists k$ such that $(e_a^*, e_b^*) = (\emptyset, 0)$.

Next, we derive the case when a deters b with zero commitment level. Let $\bar{k}$ be k such that $\hat{e}_a(\bar{k}) = 0$. Since $\hat{e}_a$ is decreasing in k, if $\bar{k} \leq k \leq \frac{M}{c(0)}$, then $\{e_a^*, e_b^*\} = \{0, \emptyset\}$ and $\{X_a^*, X_b^*\} = \{M, 0\}$. By Lemma 3, if $k \in [\underline{k}, \bar{k})$, then $0 < e_a^* \leq 1, e_b^* = \emptyset, X_a^* = M$ and $X_b^* = 0$. If $k \in [0, \underline{k})$, then $e_a^* = e_b^* = \tilde{e}(k) \in [0, 1]$.

Next, we show that $\underline{k}$ is increasing in β by proving both $u_a(\tilde{e}, \tilde{e}) - u_a(\underline{e}_a, \emptyset) = \frac{-M}{2} + k[c(\underline{e}_a(k, \beta)) - c(\tilde{e}(k, \beta))]$ and β, $u_b(1, \tilde{e})$ are increasing in β. Since $\underline{k} \leq k'$, $u_a(\tilde{e}, \tilde{e}; \underline{k}) = u_b(\tilde{e}, \tilde{e}; \underline{k}) \geq 0$, which implies $\underline{e}_a(\underline{k}, \beta) = \hat{e}(\underline{k}, \beta) \geq \tilde{e}(\underline{k}, \beta)$. From (14), $\tilde{e}$ is increasing in β. Consider any $k \in [\underline{k}, k')$. As β increases, $\hat{e}_a(k, \beta)$ (and thus $\underline{e}_a(k, \beta)$) increases more than $\tilde{e}(k, \beta)$ so that $u_b(\hat{e}_a, \tilde{e}) = 0$, implying $k[c(\underline{e}_a(k, \beta)) - c(\tilde{e}(k, \beta))]$ is increasing in β. Since $d_i(1, e_b) \geq 0$ is decreasing in β $\forall i$, by the envelope theorem, $u_b(1, \tilde{e})$ is increasing in β. Therefore, $\underline{k}$ is increasing in β.

Finally, we show that $\underline{k}$ is increasing in M. From (6) and (14), an increase in M does not change $\boldsymbol{d}(e_a, e_b)$ and $\tilde{e}$, which means $u_b(e_a, \tilde{e})$ and thus $\underline{e}_a$ and $u_b(1, \tilde{e})$ are increasing in M. Hence, both $k(c(\underline{e}_a(k)) - c(\tilde{e}(k))]$ and $u_b(1, \tilde{e})$ are increasing in M, implying $\underline{k}$ is increasing in M. □

Proof of Lemma 4. Suppose that $W' \gneq W$. Define $Z := (\mathbb{I} - \frac{1}{\beta}W)^{-1}$ and $Z' := (\mathbb{I} - \frac{1}{\beta}W')^{-1}$.

Since $z'_{ij} \geq z_{ij}$ for all $(i,j) \in N^2$ with at least one inequality, from (6) and (7), for any $p \in \{a,b\}$,

$$\frac{\partial X_p(W')}{\partial e_p} - \frac{\partial X_p(W)}{\partial e_p} = \frac{1}{2\beta} \sum_{i \in N} \sum_{j \in N} (z'_{ij} - z_{ij}) \frac{\partial f_{jp}(e_p)}{\partial e_p} > 0. \tag{15}$$

Suppose that $f_{ip}(e) = \mu_i f_{i,-p}(e)\ \forall i \in N$. From (15), for any $e \in [0,1]$,

$$\frac{\partial X_p(W')}{\partial e_p} - \frac{\partial X_p(W)}{\partial e_p} > \frac{\partial X_{-p}(W')}{\partial e_{-p}} - \frac{\partial X_{-p}(W)}{\partial e_{-p}}. \qquad \square$$

Proof of Proposition 2. Suppose that $k < \underline{k}$. Then, we have $e_p^* = \tilde{e}_p(W)$ for any $p \in \{a,b\}$. Without lost of generality, suppose that $f_{ia}(e) = f_{jb}(e) = \mu f_{ib}(e) = \mu f_{ja}(e)$ with $\mu > 1$. We have

$$\gamma_h(e_a,e_b) = \frac{f(e_a) - f(e_b)}{2\beta} := \bar{\gamma}; \quad \gamma_i(e_a,e_b) = \bar{\gamma} + \Delta_i(e_a,e_b); \text{ and } \gamma_j(e_a,e_b) = \bar{\gamma} + \Delta_j(e_a,e_b)$$

where $\Delta_i(e_a,e_b) := \frac{f_{ia}(e_a) - f(e_a) - f_{ib}(e_b) + f(e_b)}{2\beta}$ and $\Delta_j(e_a,e_b) := \frac{f_{ja}(e_a) - f(e_a) - f_{jb}(e_b) + f(e_b)}{2\beta}$ measure the extent to which i prefers a and j prefers b compared to other users. Then, (6) becomes $\boldsymbol{d} = [\kappa_g \bar{\gamma} + z_{gi}\Delta_i + z_{gj}\Delta_j]_{g=1}^n$. Since $\sum_{g=1}^n z_{gi} = \sum_{g=1}^n z_{ig} = \kappa_i$, the sum of all entries of $\boldsymbol{d}$ gives

$$X_a(e_a,e_b) - X_b(e_a,e_b) = \sum_{g=1}^{n} \kappa_g \bar{\gamma} + \kappa_i \Delta_i(e_a,e_b) + \kappa_j \Delta_j(e_a,e_b). \tag{16}$$

Suppose that $\kappa_i > \kappa_j$. From (16), $X_a > X_b$ when $e_a = e_b$. Moreover, from (7) and (16), $\frac{\partial X_a}{\partial e_a}\big|_{e_a=e} - \frac{\partial X_b}{\partial e_b}\big|_{e_b=e} = \frac{1}{4\beta}[(\kappa_i - \kappa_j)[(\mu-1)f'_{ib}(e)]] > 0$ for any e. Hence, $\tilde{e}_a \geq \tilde{e}_b$. Therefore, $e_a^* \geq e_b^*$ (equality holds only if $e_a^* = e_b^* = 1$ when k is sufficiently close to 0) and $X_a^* > X_b^*$. $\square$

Proof of Proposition 3. Consider the game with $k \in [0, k'(W))$ where $k'(W)$ is defined in the proof of Lemma 3. Consider any $e_a \in (\tilde{e}(k), 1]$. Since users are symmetric, $\gamma_i(e_a,\tilde{e}) = \gamma(e_a,\tilde{e}) = \frac{f(e_a) - f(\tilde{e}(k))}{\beta} > 0$ and thus $d_i(e_a,\tilde{e}) = \gamma(e_a,\tilde{e})\kappa_i > 0$ for any i. From (2) and (7), $u_b(e_a,\tilde{e}) =$

$\frac{M-\gamma(e_a,\tilde{e})\sum_{i\in N}\kappa_i}{2} - kc(\tilde{e}(k))$. Since $\tilde{e}(k)$ is b's best response to e_a, by the envelope theorem

$$\frac{\partial u_b(e_a,\tilde{e})}{\partial w_{gh}} = -\frac{\gamma(e_a,\tilde{e})}{2}\sum_{i\in N}\frac{\partial \kappa_i}{\partial w_{gh}} < 0$$

for any pair (g,h). Since $\frac{\partial u_b(e_a,\tilde{e})}{\partial w_{gh}} < 0$ holds for any $e_a \in (\tilde{e}(k),1]$, $\underline{e}_a(W',k) < \underline{e}_a(W,k)$, which means a can deter b with a lower commitment level. It follows that $e_a^*(W',k) < e_a^*(W,k)$ for $k \in [\underline{k}(W),k')$. From Lemma 4, $\tilde{e}(W') > \tilde{e}(W)$ and thus $u_a(\tilde{e},\tilde{e}) - u_a(\underline{e}_a,\emptyset)$ is decreasing in w_{gh}. Therefore, $\underline{k}$ is decreasing in w_{gh}. □

Proof of Corollary 1. (a) Following analogous arguments as in the proof of Proposition 1, when k is close to 0, all issuers plays $\tilde{e}(k)$ and share the market equally. Given any choices of the first $T-2$ issuers, issuer $T-1$ has a deterring commitment level $\underline{e}_{T-1}$ that is decreasing in k and e_t for any $t < T-1$. Similarly, issuer $T-2$ has deterring commitment levels $\underline{e}^1_{T-2}$ (with which $T-2$ and $T-1$ who chooses $\underline{e}_{T-1}$ deter T) and $\underline{e}^2_{T-2}$ (with which $T-2$ deters both $T-1$ and T) that are decreasing in k, and so forth. Hence, when k is higher, less issuers share the global usage by detering the entry of new currencies. Note that issuers may choose different commitment levels, for example, the first mover chooses a commitment level just enough for the second one to deter the remaining currencies. Hence, market shares can be asymmetric even with symmetric users.

(b) It is clear that (16) holds for any pair of currencies. This means users are more responsive to the commitment by p_i, which reinforces p_i to commit strongly.

(c) By analogous arguments as in the proof of Proposition 3, $\frac{\partial u_s(e_t,\tilde{e})}{\partial w_{gh}} < 0$ for any $e_t \in (\tilde{e}(k),1]$ and for any $s > t$, i.e., given the choices of first $t-1$ issuers, t can deter the remaining issuers with a lower commitment level. Thus, for any given k, the number of international currency issuers (weakly) decreases as the network becomes more integrated. □

Proof of Proposition 4. Since $x_{i\tau} - x_{i,\tau+c} = \sum_{t=\tau}^{\tau+c-1} d_{it}$ for any natural number $c \in [1, T-\tau]$, the statement follows directly from (13). □

B Appendix: Additinal analysis and robustness checks

	(1) USD	(2) EUR	(3) CNY
Centrality growth × Lagged invoicing currency share	0.117**	0.084***	-0.032
	(0.051)	(0.023)	(0.121)
Centrality growth	-9.922***	0.075	0.188
	(3.622)	(0.788)	(0.236)
Lagged invoicing currency share	0.656***	0.600***	0.656***
	(0.103)	(0.150)	(0.237)
Controls	✓	✓	✓
Year and country FEs	✓	✓	✓
Within R^2	0.609	0.644	0.638
Observations	526	526	526
Countries	67	67	67

*Note: S*tandard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All panels exclude the US and euro-area countries. Standard errors are clustered at the country level.

Table B1: Panel regressions with networks including trade among euro-area countries

	(1) USD	(2) EUR	(3) CNY
Centrality growth × Lagged invoicing currency share	0.171**	0.120***	-0.031
	(0.069)	(0.032)	(0.160)
Centrality growth	-13.356***	-0.301	0.170
	(4.817)	(0.821)	(0.269)
Lagged invoicing currency share	0.653***	0.600***	0.701***
	(0.103)	(0.150)	(0.212)
Controls	✓	✓	✓
Year and country FEs	✓	✓	✓
Within R^2	0.609	0.643	0.689
Observations	532	532	532
Countries	69	69	69

*Note: S*tandard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All panels exclude the US and euro-area countries. Standard errors are clustered at the country level. USD 10 is added to all bilateral flows, corresponding to the reporting floor observed in the data and is negligible relative to typical trade flows.

Table B2: Panel regressions with fully connected networks

	(1) USD	(2) EUR	(3) CNY
Centrality growth × Lagged invoicing currency share	0.114*	0.106*	-0.038
	(0.059)	(0.059)	(0.142)
Centrality growth	-9.593**	-0.538	0.196
	(4.576)	(0.974)	(0.270)
Lagged invoicing currency share	0.665***	0.685***	0.657***
	(0.079)	(0.099)	(0.236)
Controls	✓	✓	✓
Year and country FEs	✓	✓	✓
Within R^2	0.568	0.589	0.638
Observations	853	846	533
Countries	85	84	67

*Note: S*tandard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All panels exclude the US and euro-area countries. Standard errors are clustered at the country level.

Table B3: Panel regressions with maximum available sample

	(1) USD	(2) EUR	(3) CNY
Import growth × Lagged invoicing currency share	-0.027	-0.049*	-0.130
	(0.032)	(0.024)	(0.091)
Import growth	0.054	2.436***	0.048
	(3.046)	(0.700)	(0.078)
Lagged invoicing currency share	0.648***	0.582***	0.696***
	(0.108)	(0.151)	(0.221)
Controls	✓	✓	✓
Year and country FEs	✓	✓	✓
Within R^2	0.601	0.639	0.644
Observations	526	526	526
Countries	67	67	67

*Note: S*tandard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All panels exclude the US and euro-area countries. Standard errors are clustered at the country level.

Table B4: Import growth in explaining currency choice

References

ACEMOGLU, D., A. OZDAGLAR, AND A. TAHBAZ-SALEHI (2015): "Networks, shocks, and systemic risk," Working Paper 20931, National Bureau of Economic Research.

BALLESTER, C., A. CALVÓ-ARMENGOL, AND Y. ZENOU (2006): "Who's who in networks. Wanted: The key player," *Econometrica*, 74, 1403–1417.

BECK, T., A. DEMIRGÜÇ-KUNT, AND R. LEVINE (2003): "Law and finance: why does legal origin matter?" *Journal of Comparative Economics*, 31, 653–675.

BELHAJ, M. AND F. DEROÏAN (2014): "Competing activities in social networks," *The BE Journal of Economic Analysis & Policy*, 14, 1431–1466.

BONACICH, P. (1987): "Power and centrality: A family of measures," *American Journal of Sociology*, 92, 1170–1182.

BOZ, E., A. BRÜGGEN, C. CASAS, G. GEORGIADIS, G. GOPINATH, AND A. MEHL (2025): "Patterns of Invoicing Currency in Global Trade in a Fragmenting World Economy," *IMF Working Papers*, 2025, 1.

CABALLERO, R. J., E. FARHI, AND P.-O. GOURINCHAS (2008): "An equilibrium model of "global imbalances" and low interest rates," *American Economic Review*, 98, 358–393.

CHAHROUR, R. AND R. VALCHEV (2022): "Trade Finance and the Durability of the Dollar," *The Review of Economic Studies*, 89, 1873–1910.

CHEN, Y.-J., Y. ZENOU, AND J. ZHOU (2018): "Multiple activities in networks," *American Economic Journal: Microeconomics*, 10, 34–85.

——— (2022): "The impact of network topology and market structure on pricing," *Journal of Economic Theory*, 204, 105491.

CLAYTON, C., A. DOS SANTOS, M. MAGGIORI, AND J. SCHREGER (2024): "International currency competition," Working Paper 5067555, SSRN.

DALIO, R. (2021): *The Changing World Order: Why Nations Succeed or Fail*, Simon and Schuster Limited.

DOWD, K. AND D. GREENAWAY (1993): "Currency competition, network externalities and switching costs: Towards an alternative view of optimum currency areas," *The Economic Journal*, 103, 1180–1189.

EICHENGREEN, B. (2011): "The renminbi as an international currency," *Journal of Policy Modeling*, 33, 723–730.

FLANDREAU, M. AND C. JOBST (2009): "The empirics of international currencies: Network externalities, history and persistence," *The Economic Journal*, 119, 643–664.

FRANKEL, J. (2012): "Internationalization of the RMB and historical precedents," *Journal of Economic Integration*, 27, 329–365.

GINI, C. (1912): *Variabilità e mutabilità: contributo allo studio delle distribuzioni e delle relazioni statistiche.[Fasc. I.]*, Tipogr. di P. Cuppini.

GOLDBERG, L. S. AND C. TILLE (2008): "Vehicle currency use in international trade," *Journal of international Economics*, 76, 177–192.

GOPINATH, G. AND J. C. STEIN (2018): "Trade invoicing, bank funding, and central bank reserve holdings," *AEA Papers and Proceedings*, 108, 542–546.

——— (2021): "Banking, trade, and the making of a dominant currency," *The Quarterly Journal of Economics*, 136, 783–830.

ILZETZKI, E., C. M. REINHART, AND K. S. ROGOFF (2019): "Exchange Arrangements Entering

the Twenty-First Century: Which Anchor will Hold?" *The Quarterly Journal of Economics*, 134, 599–646.

ITO, H. AND M. CHINN (2014): "The Rise of the "Redback" and the People's Republic of China's Capital Account Liberalization: An Empirical Analysis of the Determinants of Invoicing Currencies," *ADBI Working Papers*, number: 473.

KATZ, L. (1953): "A new status index derived from sociometric analysis," *Psychometrika*, 18, 39–43.

LAGOS, R. AND R. WRIGHT (2005): "A unified framework for monetary theory and policy analysis," *Journal of Political Economy*, 113, 463–484.

LEE, J.-W. (2014): "Will the renminbi emerge as an international reserve currency?" *The World Economy*, 37, 42–62.

LIU, Q. AND S. SHI (2010): "Currency areas and monetary coordination," *International Economic Review*, 51, 813–836.

LIU, T., D. LU, AND W. T. WOO (2019): "Trade, finance and international currency," *Journal of Economic Behavior & Organization*, 164, 374–413.

MAGGIORI, M. (2017): "Financial intermediation, international risk sharing, and reserve currencies," *American Economic Review*, 107, 3038–3071.

MARKOWITZ, H. (1952): "Portfolio selection," *The Journal of Finance*, 7, 77–91.

MATSUYAMA, K., N. KIYOTAKI, AND A. MATSUI (1993): "Toward a theory of international currency," *The Review of Economic Studies*, 60, 283–307.

PHAM, L. (2026): "Trade Network Position and Home-Currency Invoicing," *Available at SSRN 6471619*.

PORTA, R. L., F. LOPEZ-DE SILANES, A. SHLEIFER, AND R. W. VISHNY (1998): "Law and finance," *Journal of Political Economy*, 106, 1113–1155.

QUINN, D. P. AND C. INCLAN (1997): "The origins of financial openness: A study of current and capital account liberalization," *American Journal of Political Science*, 771–813.

RAJAN, R. G. AND L. ZINGALES (2003): "The great reversals: the politics of financial development in the twentieth century," *Journal of Financial Economics*, 69, 5–50.

REY, H. (2001): "International trade and currency exchange," *The Review of Economic Studies*, 68, 443–464.

RUBBO, E. (2023): "Networks, Phillips curves, and monetary policy," *Econometrica*, 91, 1417–1455.

SARGENT, T. J. AND J. STACHURSKI (2024): *Economic networks: Theory and computation*, vol. 53, Cambridge University Press.

VAUBEL, R. (1984): "The government's money monopoly: Externalities or natural monopoly?" *Kyklos*, 37, 27–58.