Geopolitics and the Payment Demand for Reserve:

Theory and Evidence from China and U.S.*

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Abstract

Global banks' demand for U.S. reserve balances as the primary payment instrument is central to dollar dominance. This paper examines how geopolitical tension alters that demand. We build a novel over-the-counter model of interbank loans in which reserves serve both as payment and asset. Geopolitical tension appears as three forms of counterparty risks. Unlike predictions from existing models, we show that banks increase unsecured interbank borrowing under freeze and primary-sanction risks, but *increase* reserve holding and secured borrowing under secondary-sanction risk. To test these predictions, we construct a new U.S.–China geopolitical tension index using a large language model trained to classify high-frequency Chinese news, and combine it with bank-level data in China and U.S. In periods of elevated tension, U.S. banks in China hold larger reserve balances, reduce unsecured borrowing but expand secured borrowing, consistent with our predicted responses to the secondary-sanction risk. Chinese banks in the United States exhibit responses consistent with the freeze and primary-sanction risks. We also found that Chinese banks were able to shift exposures toward Hong Kong institutions. These findings indicate that geopolitical tension can *raise* the demand for payment asset; at peak U.S.–China tension, reserve holdings were about 9.6% higher. This margin is largely absent from existing studies.

JEL Classification: G1, D63, C78, D83, E44

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The global role of the U.S. dollar rests on two related facts. Global banks settle their payments through U.S. reserve balances, and these balances constitute the safest and most liquid asset in the international banking system. The payment demand for U.S. reserves is therefore a central pillar of dollar dominance. This paper studies how that demand responds to geopolitical tension. If geopolitical conflict changes the risks associated with accessing or using the U.S. reserve system, then banks adjust their reserve positions and their reliance on the interbank market, with implications for dollar dominance.

Our mechanism operates through the decentralized environment in which banks exchange reserves via payments and loans. Banks meet bilaterally in over-the-counter markets to borrow and lend reserves. These balances serve a dual role. They are the medium of payment during the day, used to settle obligations arising from stochastic payment flows. They are also a asset that earns interest at the central bank. Banks choose their reserve holdings and their dependence on interbank borrowing based on expected payment shocks, monetary policy, and the counterparty risks associated with meeting trading partners. Geopolitical tension enters by altering these counterparty risks.

Three forms of risk matter. Freeze risk blocks or delays transfers, reducing the reliability of reserves as a payment instrument. Primary-sanction risk removes access to the reserve system entirely. Secondary-sanction risk penalizes banks that transact with sanctioned entities. When interest rates are low—when the convenience yield of reserves dominates—banks respond to freeze and primary-sanction risks by holding *fewer* reserves and relying *more* heavily on unsecured interbank borrowing to meet payment needs. Secondary-sanction risk works differently. Because the risk spreads through trading networks, banks become more reluctant to extend interbank credit. Reserve balances become the more reliable way to self-insure payment shocks, so banks hold more and borrow less. Geopolitical risks *increase* the demand for reserve balances in this case.

We formalize these ideas in a continuous-time search model of the interbank market. Payment shocks accumulate during the day. Banks that meet borrow or lend reserves bilaterally to accommodate these shocks. At night banks rebalance and repay loans. The model is designed to admit closed-form solutions that yield clear comparative statics: freeze and primary-sanction risks reduce reserve demand, while secondary-sanction risk increases it; secondary-sanction risk also reduces unsecured borrowing but encourages the use of secured borrowing, which are useful to mitigate the secondary-sanction risks.

The empirical analysis examines these implications in the setting where geopolitical tension is most salient: the U.S.–China relationship. Banks from both countries operate branches and subsidiaries in each other's markets, hold local reserves, and rely on local payment systems. These institutions face the possibility of sanctions or restrictions on their access to the reserve system, and these risks vary with geopolitical conditions. To measure these conditions, we construct a new U.S.–China geopolitical tension index using a 1.3-billion-parameter language model trained on high-frequency Chinese news.

The index provides a high-granularity measure of geopolitical tension, aligned with the timing in the model.

We combine this index with detailed bank-level data on reserve holdings and interbank borrowing by U.S. banks operating in China and Chinese banks operating in the United States. The data reveal a clear pattern. During periods of elevated tension, U.S. banks in China increase their reserve balances—by roughly 9.6 percent at peak tension—and reduce unsecured interbank borrowing while expanding secured borrowing, consistent with behavior under secondary-sanction risk. Chinese banks operating in the United States show no comparable adjustments. This asymmetry reflects differences in sanction authority and geopolitical exposure. We also find that Chinese banks redirect part of their interbank activity toward Hong Kong institutions during high-tension periods, reducing expected exposure to secondary sanctions in their immediate counterparty network—precisely the mechanism emphasized by the model.

The evidence therefore supports the main theoretical result: geopolitical tension affects the demand for the hegemon's payment asset. The effect is not uniform. It depends on the nature of the risk and on the monetary environment, particularly the level of interest rates. When rates are low, reserve balances are held primarily for payment reasons, and concerns about the reliability of the payment instrument shape banks' behavior. Under secondary-sanction risk, banks self-insure by holding more reserves. These findings indicate that geopolitical tension can raise the demand for the hegemon's payment asset. This margin is largely absent from existing studies.

The results link two strands of research that have developed largely in isolation. One examines the microstructure of reserve markets and the payment role of central-bank liabilities. The other studies currency dominance, safe-asset demand, and geopolitical risk. Most work on dollar dominance focuses on marketable U.S. assets or dollar invoicing. Much less attention has been given to the demand for reserve balances themselves, even though these balances settle payments and anchor the global system. When geopolitical tension affects access to these balances, it alters the mechanisms that sustain the dollar's international role.

1 Literature Review

The key contributions of the paper are twofold. Theoretically, it develops a novel over-the-counter model of interbank reserve trading to analyze the effects of geopolitical risk on the borrowing and holding of the sanctioning country's reserve. The model generates new predictions different from the existing studies. Empirically, it constructs a new U.S.–China geopolitical tension index using a 1.3-billion-parameter language model trained to classify high-frequency Chinese news. We combine this tension index with bank-level data from China and the United States to test the model's implications.

Big picture: payment and dollar dominance. Much of the literature of currency dominance focused on the U.S. dollar's role in global trade. Gopinath & Itskhoki (2022) provide a recent survey. Farhi & Maggiori (2018) and Maggiori et al. (2019) emphasize the role of the U.S. in supplying safe assets and the depth of U.S. debt markets. Gopinath & Stein (2021) focus on the role of invoicing currency and the global banking of dollar loans and dollar deposit. Complementary to these roles, here we focus on the role of the U.S. reserve as a primary payment instrument among global banks.

Our model belongs to the monetary-theory literature that studies the payment role of central-bank reserves. In practice, reserves serve as the payment instrument among banks—for example, through Fedwire in the United States, HVPS in China and swap line arrangement (Afonso et al. (2022), Bahaj & Reis (2022)). This payment role gives reserves a convenience yield and, in turn, the exorbitant privilege associated with this central-bank liability. Poole (1968) provides the basic framework linking payment shocks to reserve demand. More recent work, such as Afonso & Lagos (2015) and Üslü (2019), models search and matching frictions in the federal funds market and, more broadly, in asset markets. Related search-theoretic formulations include Lagos & Rocheteau (2009), Chang & Zhang (2018), Lagos & Navarro (2023), and Hugonnier et al. (2020). A further set of contributions embeds interbank markets into general-equilibrium environments to study how unconventional policies shape aggregate outcomes (Ennis (2018), Williamson (2019), Bianchi & Bigio (2017)).

Geopolitical risk and payment demand for reserve. Eichengreen et al. (2018) document that changes in global currency leadership often align with shifts in geopolitical influence and competition. Related empirical work by Douglass et al. (2024) decomposes official reserves into dollar assets, other currencies, and gold, showing how shifts in global uncertainty and sanctions episodes have been accompanied by a gradual diversification away from dollar securities at the margin. Surveys of reserve managers by Central Banking, OMFIF, and Invesco reinforce this picture: since the freezing of Russian reserves in 2022, a large majority of central-bank respondents report that the "weaponisation of reserves" and U.S. sanctions risk have become significant determinants of currency allocation and residual demand for U.S. Treasury securities as reserve assets.

A search-based microfoundation allows our model to distinguish how different geopolitical risks—asset freezes, primary sanctions, and secondary sanctions—affect the payment demand for reserves. In our model, these tools generate different outcomes, and the economics literature so far has analyzed them separately (see below). To the best of our knowledge, this paper provides the first unified, microfounded framework for studying how these forms of geopolitical risk propagate through the interbank reserve market and shape the demand for the hegemon's payment asset. The framework generates testable implications directly matched with our new geopolitical tension index.

Asset freezes. Asset freezes block transfers across accounts without necessarily severing all financial relations and ownership. In practice, this includes the freezing of bank deposits, securities, and

especially central bank reserves, as shown in the case of 2022 freeze of Russian banks. Policy and legal analyses (e.g., Masters (2024)) treat asset freezes as immediate liquidity constraints while preserving the legal ownership of the asset. To capture this practice, we model asset freezes as shocks to the transferability or liquidity of reserve rather than to their payoffs and ownership. Recent evidence in Minesso et al. (2025) shows that payments are far less likely between geopolitically distant countries, consistent with geopolitical risk operating through the potential freezing of payment instruments such as central-bank reserves.

Primary sanctions. In the literature, primary sanctions typically enter as confiscation of assets. Bianchi & Sosa-Padilla (2025) study a reduced-form model in which the expectation of primary sanctions reduces the demand for dollar assets, potentially undermining the dollar's reserve-currency status. Our microfounded model nests their model as a special case. Unlike asset freezes—which eliminate the payment role of reserves by blocking transfers —primary sanctions eliminate the asset role of reserves entirely by removing the access and ownership. In our model, the risk of primary sanctions not only reduces banks' asset demand for reserves, as in Bianchi & Sosa-Padilla (2025), but also increases their interbank borrowing to satisfy the payment demand for reserves—a new implication absent from the reduced-form model. Empirically, Ongena et al. (2025) show that banks anticipating primary sanctions raise international borrowing, consistent with our model's prediction and with the patterns observed in our bank-level data.

Secondary sanctions. Studies of secondary sanctions are far fewer in the literature. Weiss (2022) emphasizes that the possibility of secondary measures—helps explain why foreign central banks' dollar reserves are concentrated in U.S. allies; countries more exposed to U.S. enforcement are more cautious in holding dollar assets. In practice, secondary sanctions extend enforcement to counterparties that transact with the primary target. They penalize banks and firms that continue to deal with sanctioned entities, for example by fines, loss of market access, or even loss of charter. In economics, secondary sanctions introduce a network externality, aptly captured by our search model. In our model, secondary-sanction risk generates an outcome distinct from both primary sanctions and asset freezes—it raises the demand for reserves. It is because, under secondary-sanction risks, banks become reluctant to lend to exposed banks, so exposed banks must self-insure by holding more reserves to satisfy payment needs. A similar mechanism of secondary sanction is also documented by Niepmann & Shen (2025), which show evidence that U.S. banks reduce cross-border lending to countries with high geopolitical risk, consistent with the interbank lending patterns we observe in our data.

Measuring geopolitical risk. Caldara & Iacoviello (2022) construct a news-based Geopolitical Risk (GPR) index back to 1900, distinguishing between "threats" and "realized" events, and show

that GPR shocks lead to lower investment, tighter credit, and reduced output. Building on such measures, a large literature examines how geopolitics affects the demand for and pricing of U.S. Treasuries and other dollar assets. Recent concern has focused on how rising geopolitical tension between the United States and China may affect dollar dominance. Over the past fifteen years, China has expanded its global financial presence through a broad network of renminbi swap lines (Bahaj & Reis (2022)), the liberalization of its government bond market (Clayton et al. (2025)), and international lending (Horn et al. (2025)). These developments suggest that geopolitical competition may influence global payment and reserve structures.

Rogers et al. (2024) quantify U.S.–China tension with a text-based index constructed from the share of U.S. newspaper articles linking both countries and referencing contentious issues. In contrast, we construct a new U.S.–China geopolitical tension index using a 1.3-billion-parameter language model trained to classify high-frequency Chinese news. This approach has two advantages. First, it provides a measure of geopolitical tension derived from the Chinese perspective rather than U.S. media, which may be more relevant for the U.S. banks operating in China and China banks operating in the U.S. in our data. Second, rather than counting articles against a predetermined list of tension-related keywords, the language model reads the news and produces a sentiment index, yielding a more accurate and naunced measure of geopolitical tension, as we illustrate in the news examples.

2 Baseline Model

Time is infinite and partitioned into periods $s = 0, 1, 2, \ldots$. Periods are discrete, but events within each period unfold in continuous time. There is unit measure of banks, holding a divisible amount of reserve balances. During the *day* interval $[s, s+T]$, with $T < 1$, each bank continuously receives payment shocks, where they must transfer reserve balances to other banks to meet their clients' payment obligations. The interbank market is also open during the day, where banks meet bilaterally to borrow or lend reserve balances to acommodate their payment shocks. Interbank loans initiated during the day are overnight and repaid at the beginning of the next period. The day concludes at time $s+T$, and the central bank pays interests on reserve balances. During the *night* interval $(s+T, s+1)$, banks rebalance their reserve holdings in preparation for the next day. The period then ends, and the same sequence of payment shocks, interbank loans, and rebalancing is repeated in the next period.

Preferences. The bank's expected payoff is given by

$$\mathbb{E} \sum_{s=0,1,\ldots} \left(\frac{1}{1+r}\right)^s \left\{ \int_0^T \mu k_{s+t} dt + U\left(k_{s+T}\right) - x_{s+1} \right\}, \text{ where} \tag{1}$$

$$k_{s+t} = k_s + B_t + q_{s+\tau} 1_{\tau \leq t} \text{ for } t \in [0, T]\,; \tag{2}$$

$$k_{s+1} = k_{s+T} + x_{s+1} - \left(1 + \rho_{s+\tau}\right) q_{s+\tau}, \tag{3}$$

where k_{s+t} is the bank's reserve balance at time t of period s. Holding reserve balances derives two sources of payoff to banks. First, they earn a linear payoff μk_t continuously, where μ captures the *convenience yield* of reserve balances arisen from the fulfilling intraday payment oligations for their clients. Second, they receive a terminal payoff $U\left(k_{s+T}\right)$ at time $s+T$, reflecting the *portfolio yield* from holding balances for their returns and meeting regulation requirements.

The dynamics of reserve balaces during the day is captured by equation (2). Starting from k_s at the beginning of period s, the reserve balances at t consists of receiving payments B_t accumulated from other banks and the reserve balances $q_{s+\tau}$ borrowed (lent if negative) in the interbank market at some previous time $\tau \leq t$. We assume that B_t follows a Brownian process with volatility σ.

The dynamics of reserve balaces across periods is captured by equation (3). Starting from k_{s+T} at the end of the day of period s, the reserve balances for the next period consists of the rebalance x_{t+1} made during the night of s and the repayment of the interbank loan at the loan rate $\rho_{s+\tau}$ made at the earlier time τ during the day of s.

Substituting x_{s+1} with equation (3), the bank's expected payoff can be recursively expressed by the following value functions:

$$V_t\left(k\right) \equiv \mathbb{E}_t\left\{\int_t^\tau \mu\left(k + B_{+z}\right) dz - \left(1 + \rho_\tau\right) q_\tau + W_\tau\left(k + B_{+\tau} + q_\tau\right)\right\}, \tag{4}$$

$$W_t\left(k\right) \equiv \mathbb{E}_t\left\{\int_t^T \mu\left(k + B_{+z}\right) dz + U\left(k + B_{+T}\right) + k + B_{+T} + Z\right\}, \tag{5}$$

$$Z \equiv \max_{k_s}\left\{-k_s + \frac{V_0\left(k_s\right)}{1+r}\right\}, \tag{6}$$

where $B_{+z} = B_{z|t} - B_t$. The bank's value before the interbank borrowing (pre-trade) is captured by $V_t\left(k\right)$ and the value after the interbank borrowing (post-trade) by $W_t\left(k\right)$.

Bargaining. Define $S_\tau\left(q, \rho; k\right)$ as the trade surplus for a bank holding k unit of balances at time τ and borrowing q additional balances at the interbank rate ρ:

$$S_\tau\left(q, \rho; k\right) \equiv W_\tau\left(k + q\right) - \left(1 + \rho\right) q - V_\tau\left(k\right). \tag{7}$$

The trade surplus consists of the gain in value to $W_\tau\left(k+q\right)$ from $V_\tau\left(k\right)$ after acquiring q units of reserve balances, minus the cost of repaying the intebank loan at rate ρ.

Consider a trader with k units reserve balances meets a trader with k' in the interbank market at τ. They negotiate the term of trade $q_\tau\left(k, k'\right)$ and $\rho_\tau\left(k, k'\right)$ to split their trade surpluses that solve a

Nash bargaining problem:

$$\left\{q_\tau\left(k,k'\right),\rho_\tau\left(k,k'\right)\right\}\equiv\arg\max_{q,\rho}S_\tau\left(q,\rho;k\right)S_\tau\left(-q,\rho;k'\right). \tag{8}$$

Denote the trade surpluse evaluated at the Nash bargaining solution as $S_\tau^*\left(k,k'\right)=S_\tau\left[q_\tau\left(k,k'\right),\rho_\tau\left(k,k'\right);k\right]$. It is straight-forward to verify that $S_\tau^*\left(k,k'\right)=S_\tau^*\left(k',k\right)$.

Matching. The interbank market is decentralized and subject to search frictions, so it takes time for a bank to find a counterparty. Each bank meets another bank at arrival rate λ, negotiates the term of loans, transfers the reserve balances and then exits the interbank market. Denote $F_t\left(k\right)$ as the measure of banks who hold reserve balances no greater than k in the interbank market at t. Thus, the law of motion for the reserve distribution follows the Komogorov forward equation (KFE):

$$\frac{\partial}{\partial t}F_t\left(k\right)=-\lambda F_t\left(k\right)+\frac{\sigma^2}{2}\frac{\partial}{\partial k}F_t\left(k\right). \tag{9}$$

The first term $-\lambda F_t\left(k\right)$ of the RHS captures the rate of of banks exiting the interbank market. The second term $\frac{\sigma^2}{2}\frac{\partial}{\partial k}F_t\left(k\right)$ captures the standard diffusion term from continuous-time stochastic processes.

Equilibrium. To yield analytical results, we follow Alvarez et al. (2016) and Üslü (2019) to assume that $U\left(k\right)$ is quadratic, where the slope of $U\left(k\right)$ is related to the parameters of monetary policy. In particular, there exists $\bar{k}$ such that the marginal asset values of balances are given by $U'\left(\bar{k}\right)=i$ and $U'\left(\bar{k}-\Delta_k\right)=i+\Delta_i$, where i is the return of reserve balances and Δ_i is the additional benefit of reserve when the balances are inadequate by Δ_k. This implies that the functional form of $U\left(k\right)$ is

$$U\left(k\right)=-\frac{\Delta_i}{\Delta_k}\frac{k^2}{2}+\left(i+\frac{\Delta_i}{\Delta_k}\bar{k}\right)k. \tag{10}$$

The special case $\Delta_i=0$ is the standard situation of linear asset return. We assume that $i<r$, i.e. reserve enjoys exorbitant privilege sustained by the payment demand. Without the payment role, banks would not hold any reserve as its return is below the discount rate.

Given the Brownian payment shock B_t, the post-trade value function $W_t\left(k\right)$ from (5) can be simplified as the following closed-form solution

$$W_t\left(k\right)=\mathbb{E}_t\int_t^T\mu\underbrace{\left(k+B_{+z}\right)}_{k_{s+z}}dz+\mathbb{E}_t\{Z\underbrace{\left(k+B_{+T}\right)}_{k_{s+T}}+k+B_{+T}\}+Z, \tag{11}$$

$$\begin{aligned}&=\mu\left(T-t\right)k+\mathbb{E}_t\left\{\int_t^T\mu B_{+z}dz+U\left(k+B_{+T}\right)+k+B_{+T}\right\}+Z,\\&=\left[1+\mu\left(T-t\right)\right]k+U\left(k\right)-\frac{\Delta_i}{2\Delta_k}\sigma^2\left(T-t\right)+Z,\end{aligned} \tag{12}$$

where we have used the Brownian properties that $\mathbb{E}_t \int_t^T B_{+z} dz = \mathbb{E}_t B_{+T} = 0$ and $\mathbb{E}_t \left(B_{+T}\right)^2 = \sigma^2 (T-t)$.

Using the definition of trade surplus $S_t^* (k, k')$, the value function $V_t (k)$ can be recursived expressed as the PDE solution to the following Hamilton-Jacob-Bellman (HJB) equations:

$$\frac{\partial}{\partial t} V_t (k) = -\mu k - \lambda \int S_t^* \left(k, k'\right) dF_t \left(k'\right) - \frac{\sigma^2}{2} \frac{\partial^2}{\partial k^2} V_t (k). \tag{13}$$

where the terminal condition is given by $V_T (k) = W_T (k) = U (k) + k + Z$. The HJB equation is derived from taking the time derivative of (**??**). The intuition is as follows. As time goes on, the time flow of the bank's value, $\dot{V}_t (k)$, derceases by the rate μk from the shorter duration remained to hold k units of reserve, and substracts the expected gain from trades, where trade surplus $S_t^* (k, k')$ arrives at the rate λ. At the end of the interbank market, the bank's value equals to the terminal value of holding reserve, i.e., $V_T (k) = W_T (k) = U (k) + k + Z$.

The following proposition summarizes the equilibrium.

Proposition 1 *Define* $K \equiv \frac{\Delta_k}{\Delta_i} (\mu T + i - r) + \bar{k}$ *and the density* $f_t (k) \equiv \frac{\partial}{\partial k} F_t (k)$. *The equilibrium is given as follows.*

i. The initial reserve balance of every bank in every period is given by $k_s = K$.

ii. The interbank borrowing is given by

$$q_\tau = q_\tau \left(k_{s+\tau}, k'\right) = \frac{k' - K - B_\tau}{2}. \tag{14}$$

iii. The density is given by

$$f_t (k) = \frac{1}{\sqrt{2\pi t}\sigma} e^{-\frac{1}{2t}\left(\frac{k-K}{\sigma}\right)^2 - \lambda t}. \tag{15}$$

iv. The pre-trade value function is given by

$$V_t (k) = W_t (k) + h (t) (k - K)^2 + D_t, \tag{16}$$

where D_t *is a function of* t *only. The post-trade value function* $W_t (k)$ *is given by (11) and* $h (t)$ *by*

$$h (t) \equiv \frac{\Delta_i}{4\Delta_k} \left[1 - e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda (T-t)} - 1\right)}\right] \geq 0. \tag{17}$$

During the day, the dispersion of reserve balances widens as payment shocks accumulate. Given the Brownian property of payment shocks, the variance of the reserve distribution is $\sigma^2 t$ at time t during the day. A wider distribution implies that some banks experience reserve shortages while others hold excess balances, so the gains from trading interbank loans increase over the course of the day.

When the two banks meet at τ during the day, the level of interbank borrowing negotiated is $q_\tau = (k' - K - B_\tau)/2$, which is increasing in the payment outflow shock $-B_\tau$ and in the level of counterparty's reserve balance k'. Banks with payment outflow therefore borrow from counterparties with payment inflow in order to share their payment shocks. The price of sharing the payment shocks is the interbank loan rate ρ_τ.

During the night, banks rebalance so that all begin the next day with the same level of reserve holding $k_s = K$, regardless of payment shocks and interbank borrowing occured during the day. As a result, the initial distribution of reserve f_t is always degenerate at $k_s = K$, mirroring the tractability of Lagos & Wright (2005).

3 Geopolitical Risk of Freeze

Now consider a few banks that, during the night of period $s-1$, learn that their reserve balances are exposed to a one-time freeze risk in period s. With probability $\delta_f \in [0,1]$, these banks are unable to transfer reserve balances for payment over the day interval $[s, s+T]$. Their reserves balances remain on account, continue to earn interest and unfreeze after $s+T$. The parameter δ_f captures the freeze risk. We assume that only a few banks are exposed to the freeze risk, thus the measure of exposed banks is zero and the equilibrium distribution of reserve balances is unaffected.

Under freeze risk, the exposed bank's choice of reserve holding k_s is given by the solution to

$$Z^f \equiv \max_{k_s} \left\{ -k_s + \frac{1}{1+r} \left\{ \delta_f \left[V_0(0) + (1+i) k_s \right] + (1-\delta_f) V_0(k_s) \right\} \right\}, \tag{18}$$

where the pre-trade and post-trade value functions $V_t(k)$ and $W_t(k)$ coincide with (4) and (5) once the freeze risk is realized. When a freeze occurs (with probability δ_f), the frozen bank cannot deploy its reserve balances for payment and therefore enters the day with pre-trade value of zero balance, $V_0(0)$. It can, however, accumulate the gross interest $(1+i) k_s$ on the frozen balance.

The following proposition summarizes the equilibrium under freeze risk.

Proposition 2 *Define*

$$K^f \equiv K - \frac{2\delta_f}{1-\delta_f} \frac{\Delta_k}{\Delta_i} \frac{r-i}{1+e^{-\frac{1-e^{-\lambda T}}{2}}}. \tag{19}$$

In the equilibrium, the initial reserve balance of the banks exposed to the freeze risk is given by $k_s = K^f$. The term of interbank loan for the exposed banks is the same as Proposition 1.

According Proposition 2, the demand for reserve balances K^f is decreasing in the freeze risk δ_f. In this case, the payment role of reserve is weakened, as there is probability δ_f that the reserve balances are frozen for transfers. As a result, banks rely on higher interbank borrowing $q_\tau = q_\tau(k_{s+\tau}, k') = \left(k' - K^f - B_\tau\right)/2$ to meet their payment shocks and reduce their initial holding of reserve balance to K^f.

Note that the effect of freeze risk on reducing the reserve demand is stronger under a lower interest rate, as the asset role of reserve is weaker so banks' demand for reserve is more sensitive to the payment role, which is affected by the freeze risk.

4 Geopolitical Risk of Primary Sanction

Now consider that, in addition to freeze risk, a few banks are also exposed to a one-time primary-sanction risk. In particular, during the night of period $s-1$, the exposed banks anticipate probability $\delta_p \in [0,1]$ that they will permanently lose access to their reserve balances and interest at $s+T$ of the next period. In this case, the sanctioned bank will no longer be able to repay their interbank loan. Unlike freeze risk, reserve balances are still transferrable during the day, but the expected terminal payoff in period s becomes

$$U^p(k) = -\frac{\Delta_i}{\Delta_k}\frac{k^2}{2} + \left[(1-\delta_p)\, i + \frac{\Delta_i}{\Delta_k}\bar{k}\right] k. \tag{20}$$

The term $(1-\delta_p)\, i$ captures the loss of reserve interest under the primary-sanction risk. The bank's expected payoff can be recursively expressed by the following value functions of period s:

$$V_t^p(k) \equiv \mathbb{E}_t\left\{\int_t^\tau \mu k_{s+z} dz - (1-\delta_p)(1+\rho_\tau^p) q_\tau^p + W_\tau^p\left(k_{s+\tau} + q_\tau^p\right)\right\}, \tag{21}$$

$$W_t^p(k) \equiv \mathbb{E}_t\left\{\int_t^T \mu k_{s+z} dz + U^p(k_{s+T}) + (1-\delta_p)\left(k_{s+T} + Z\right)\right\}, \tag{22}$$

$$Z^p \equiv \max_{k_s}\left\{-k_s + \frac{1}{1+r}\left\{\delta_f\left[V_0^p(0) + (1-\delta_p)(1+i)\, k_s\right] + (1-\delta_f) V_0^p(k_s)\right\}\right\}, \tag{23}$$

where $\{q_\tau^p, \rho_\tau^p\}$ solves the bargaining problem detailed below. The term $(1-\delta_p)\left(k_{s+T}+Z\right)$ in (22) captures the expected loss of the ownership of reserve balance under primary-sanction risk. The term $(1-\delta_p)(1+\rho_\tau^p) q_\tau^p$ in (21) captures the expected repayment of interbank loan, reduced at the factor δ_p driven by the primary-sanction risk. The trade surplus of the exposed bank becomes

$$S_\tau^p(q,\rho;k) \equiv W_\tau^p(k+q) - (1-\delta_p)(1+\rho)\, q - V_\tau^p(k). \tag{24}$$

On the other hand, the counterparty bank would lose the repayment if its borrowing bank is subject to primary sanction.[1] The trade surplus of the counterparty bank becomes

$$S_\tau^c\left(-q,\rho;k'\right) \equiv W_\tau\left(k'-q\right) + (1-\delta_p)(1+\rho)\, q - V_\tau\left(k'\right). \tag{25}$$

[1] On the flip side, the counterparty bank would gain if it borrows ($q<0$) from the bank under primary sanction, because it loses the access to the reserve system and hence the counterparty bank is no longer need to repay the interbank loan.

The term of trade $\{q_\tau^p, \rho_\tau^p\}$ solve the same Nash bargaining problem:

$$\left\{q_\tau^p\left(k,k'\right),\rho_\tau^p\left(k,k'\right)\right\}\equiv\arg\max_{q,\rho}S_\tau^p\left(q,\rho;k\right)S_\tau^c\left(-q,\rho;k'\right). \tag{26}$$

Following the previous logics, the post-trade value function under primary-sanction risk can be expressed as

$$W_t^p\left(k\right)=\left[1-\delta_p+\mu\left(T-t\right)\right]k+U^p\left(k\right)-\frac{\Delta_i}{2\Delta_k}\sigma^2\left(T-t\right)+\left(1-\delta_p\right)Z. \tag{27}$$

The following proposition summarizes the equilibrium under primary-sanction risk.

Proposition 3 *The equilibrium under primary-sanction risk is given as follows.*

i. The initial reserve balance of the exposed banks is given by

$$k_s=K^f-\delta_p\left(1+i\right)\frac{\Delta_k}{\Delta_i}\left(1+\frac{\delta_f}{1-\delta_f}\frac{2}{1+e^{-\frac{1-e^{-\lambda T}}{2}}}\right).$$

ii. The interbank borrowing of the exposed banks is given by

$$q_\tau=q_\tau^p\left(k_{s+\tau},k'\right)=\frac{k'-K^f-B_\tau}{2}+\delta_p\left(1+i\right)\frac{\Delta_k}{\Delta_i}\frac{\delta_f}{1-\delta_f}\frac{1}{1+e^{-\frac{1-e^{-\lambda T}}{2}}}, \tag{28}$$

iii. The pre-trade value function of the exposed banks is given by

$$V_t^p\left(k\right)=W_t^p\left(k\right)+h\left(t\right)\left(k-K^p\right)^2+D_t^p, \tag{29}$$

where the post-trade value function $W_t^p\left(k\right)$ is given by (27) and define $K^p\equiv K-\delta_p\frac{\Delta_k}{\Delta_i}\left(1+i\right)$.

According Proposition 3, the demand for reserve balances k_s is now further decreasing in the primary-sanction risk δ_p. In this case, the asset role of reserve is weakened, as there is probability δ_p that the reserve balances and interest are lost. To meet their payment shocks, banks rely on higher interbank borrowing q_τ, which is increasing in the primary-sanction risk δ_p.

Unlike the freeze risk, the effect of primary-sanction risk on reducing the reserve demand and on increasing the interbank borrowing is stronger under a higher interest rate. It is because as the asset role of reserve is stronger when the interest rate of reserve is higher, so banks' demand for reserve is more sensitive to the asset role, which is affected by the primary-sanction risk.

5 Geopolitics of Secondary Sanction

Now, on top of freezk risk and primary-sanction risk, consider that banks are exposed to a one-time geopolitical risk of being secondary sanctioned: a counterparty bank may be punished because it

has traded with sanctioned banks. In particular, during the night of period $s-1$, banks anticipate probability $\delta_s \in [0,1]$ that counterparty banks that have interbank loans with sanctioned banks are panelized with punishment $C(q)$, increasing in the loan size q. Thus, the trade surplus of the counterparty bank becomes

$$S_\tau^c\left(-q,\rho;k'\right) \equiv W_\tau\left(k'-q\right) + (1-\delta_p)(1+\rho)q - V_\tau\left(k'\right) - \delta_s C(q). \tag{30}$$

The exposed bank's expected payoff can be recursively expressed by the following value functions of period s:

$$V_t^s(k) \equiv \mathbb{E}_t\left\{\int_t^\tau \mu k_{s+z}dz - (1-\delta_p)(1+\rho_\tau^s)q_\tau^s + W_\tau^p\left(k_{s+\tau}+q_\tau^s\right)\right\}, \tag{31}$$

$$Z^s \equiv \max_{k_s}\left\{-k_s + \frac{1}{1+r}\left\{\delta_f\left[V_0^s(0) + (1-\delta_p)(1+i)k_s\right] + (1-\delta_f)V_0^s(k_s)\right\}\right\}. \tag{32}$$

The trade surplus of the exposed bank becomes

$$S_\tau^s(q,\rho;k) \equiv W_\tau^p(k+q) - (1-\delta_p)(1+\rho)q - V_\tau^s(k). \tag{33}$$

The term of trade $\{q_\tau^s, \rho_\tau^s\}$ solve the same Nash bargaining problem:

$$\left\{q_\tau^s\left(k,k'\right), \rho_\tau^s\left(k,k'\right)\right\} \equiv \arg\max_{q,\rho} S_\tau^s(q,\rho;k)\, S_\tau^c\left(-q,\rho;k'\right). \tag{34}$$

The following proposition summarizes the equilibrium under secondary-sanction risk.

Proposition 4 *The equilibrium under secondary-sanction risk is given as follows.*

i. The initial reserve balance of the exposed banks is given by

$$k_s = K^p - \frac{\delta_f}{1-\delta_f}\frac{\Delta_k}{\Delta_i}\frac{1+r-(1-\delta_p)(1+i)}{1-\frac{1}{1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa}\left(1-e^{-\frac{1-e^{-\lambda T}}{2}}\right)}. \tag{35}$$

ii. The interbank borrowing of the exposed banks is given by

$$q_{s+\tau} = q_\tau^p\left(k_{s+\tau},k'\right) = \frac{1}{1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa}\left[\frac{k'-K^f-B_\tau}{2} + \delta_p(1+i)\frac{\Delta_k}{\Delta_i}\frac{\delta_f}{1-\delta_f}\frac{1}{1+e^{-\frac{1-e^{-\lambda T}}{2}}}\right]. \tag{36}$$

iii. The pre-trade value function is given by

$$V_t^s(k) = W_t^p(k) + h^s(t)\left(k-K^p\right)^2 + D_t^s, \tag{37}$$

where the post-trade value function $W_t^p(k)$ is given by (27) and

$$h^s(t) \equiv \frac{1}{4\left(1+\delta_s \frac{\Delta_k}{\Delta_i}\kappa\right)} \frac{\Delta_i}{\Delta_k}\left[1-e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda(T-t)}-1\right)}\right] \geq 0. \tag{38}$$

Banks' responses to secondary-sanction risk are qualitatively different from their to freeze and primary-sanction risk. According Proposition 4, the demand for reserve balances k_s is *increasing* in the secondary-sanction risk δ_s. Furthermore, the interbank borrowing is *decreasing* in the secondary-sanction risk δ_s and less responsive to the payment shocks. Because the secondary-sanction risk spreads through trading networks, counterparty banks become more reluctant to extend interbank credit to accommodate the borrowing bank' payment shocks. As a result, reserve balances become the more reliable way to self-insure payment shocks, so banks hold more and borrow less.

The effect of secondary-sanction risk on increasing the reserve demand is stronger under a lower interest rate. Similar to the logics of freeze risk, when the interest rate is lower banks' demand for reserve is more sensitive to the payment role, which is affected by the secondary-sanction risk.

6 Repo and Mitigation of Geopolitical Risks

So far we only consider unsecured interbank loans (like the Federal fund purchased in the U.S.). Now consider now banks can choose between unsecured loans like before or entering repurchase agreements (repos). A repo is a short-term secured loan implemented as a pair of trades. In our model, the sanctioned bank sells a collateral security—typically a Treasury—to the counterparty bank for reserve balances when they meet during the day, and repurchases the security at the beginning of the next day at a slightly higher price. The price difference is the repo rate, the interest on the loan. We assume sanctioned banks hold sufficient collateral so that availability never constrains repo activity in our model. Repos are useful to mitigate secondary-sanction risks because the counterparty bank can terminate the relationship before sanctions are realized; if this occurs, the counterparty bank retains the collateral and incurs no loss.

However, it is costly for counterparty banks to monitor both the collateral and the sanction risk. In particular, the counterparty bank can reduce its exposure to secondary-sanction risk to δ_r by incurring a monitoring cost $M(\delta_r, q)$, which is decreasing in δ_r but increasing in the repo size q. We assume the monitoring cost is idiosyncratic based on the exposed bank and takes the form

$$M(\delta_r, q) \equiv [m(\delta_r) + \varepsilon_m] q^2, \tag{39}$$

where $m(\delta_r)$ is a decreasing function and ε_m is an i.i.d positive random variable following a distribution $G(\varepsilon_m)$.

The trade surplus of the counterparty bank under a repo becomes

$$S_\tau^r\left(-q,\rho;k'\right)\equiv\max_{\delta_r}\left\{W_\tau\left(k'-q\right)+\left(1-\delta_p\right)\left(1+\rho\right)q-V_\tau\left(k'\right)-\delta_r C\left(q\right)-M\left(\delta_r,q\right)\right\}. \tag{40}$$

The trade surplus of the exposed bank under a repo is the same as $S_\tau^s\left(q,\rho;k\right)$ as (33) in the previous section. The term of trade $\left\{q_\tau^r,\rho_\tau^r\right\}$ solve the same Nash bargaining problem:

$$\left\{q_\tau^r\left(k,k'\right),\rho_\tau^r\left(k,k'\right)\right\}\equiv\arg\max_{q,\rho}S_\tau^s\left(q,\rho;k\right)S_\tau^r\left(-q,\rho;k'\right). \tag{41}$$

Finally, the banks choose a repo instead of unsecured loan if trading a repo yield higher trade surplus, i.e.

$$\max_{q,\rho}S_\tau^s\left(q,\rho;k\right)S_\tau^r\left(-q,\rho;k'\right)\geq\max_{q,\rho}S_\tau^s\left(q,\rho;k\right)S_\tau^c\left(-q,\rho;k'\right) \tag{42}$$

The following proposition summarizes the equilibrium when repos are also available.

Proposition 5 *Define*

$$\bar{H}\equiv\mathbb{E}_{\varepsilon_m}\left\{1+\frac{\Delta_k}{\Delta_i}\max\left\{\delta_s\kappa,\delta_r\kappa+m\left(\delta_r\right)+\varepsilon_m\right\}\right\}^{-1}<1.$$

The equilibrium with all three types of geopolitical risk and repo is given as follows.

i. The initial reserve balance of the exposed banks is given by

$$k_s=K^p-\frac{\delta_f}{1-\delta_f}\frac{\Delta_k}{\Delta_i}\frac{1+r-\left(1-\delta_p\right)\left(1+i\right)}{1-\bar{H}\left(1-e^{-\frac{1-e^{-\lambda T}}{2}}\right)}.. \tag{43}$$

ii. A repo is chosen if

$$\delta_s\kappa\geq\max_{\delta_r}\left\{\delta_r\kappa+m\left(\delta_r\right)\right\}+\varepsilon_m. \tag{44}$$

The expected repo borrowing and unsecured borrowing of the exposed banks are given by

$$q_{s+\tau}^r=\mathbb{E}q_\tau^r\left(k,k'\right)=\frac{1}{2}\mathbb{E}_{\varepsilon_m}\left\{\frac{1\left\{\delta_s\kappa\geq\delta_r^*\kappa+m\left(\delta_r^*\right)+\varepsilon_m\right\}}{1+\left(\delta_r^*\kappa+m\left(\delta_r^*\right)+\varepsilon_m\right)\frac{\Delta_k}{\Delta_i}}\right\}\left[k'-k-\delta_p\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right], \tag{45}$$

$$q_{s+\tau}^s=\mathbb{E}q_\tau^s\left(k,k'\right)=\frac{1-G\left[\left(\delta_s-\delta_r^*\right)\kappa-m\left(\delta_r^*\right)\right]}{2\left(1+\delta_s\kappa\frac{\Delta_k}{\Delta_i}\right)}\left[k'-k-\delta_p\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right]. \tag{46}$$

iii. The pre-trade value function is given by

$$V_t^s\left(k\right)=W_t^p\left(k\right)+h^r\left(t\right)\left(k-K^p\right)^2+D_t^s, \tag{47}$$

where the post-trade value function $W_t^p(k)$ *is given by (27) and*

$$h^r(t) \equiv \frac{\Delta_i}{4\Delta_k}\bar{H}\left[1 - e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda(T-t)}-1\right)}\right] \geq 0. \tag{48}$$

Under secondary-sanction risk, banks' responses in the unsecured borrowing and in repo borrowing are opposite. According Proposition 5, the repo borrowing is *increasing* in the secondary-sanction risk δ_s. It is because when the secondary-sanction risk is higher, mitigating the exposure to the secondary-sanction risk with repos becomes more preferrable.

Taking stock, the following table summarizes the testible implications generated by all propositions.

Table 1: Testible Implications of Geopolitical Risks

	Reserve holding	Unsecured borrowing	Repo borrowing
Freeze risk	-	+	+
Primary-sanction risk	-	+	+
Secondary-sanction risk	+	-	+

7 Empirical Analysis

Having derived the model's implications under different geopolitical risks, we confront them with the data. The tasks are twofold: construct a measure of geopolitical risk and test whether its variation shifts (i) banks' demand for reserves and (ii) the equilibrium use of interbank loans.

The model yields distinct comparative statics. Higher freeze risk or primary sanctions reduces the return of reserves: the demand for unsecured borrowing increases and reserve holdings decrease. Secondary sanctions operate through discouraging counterparties: the supply of unsecured borrowing decreases, the value of self-insurance rises, and reserve holdings increase. These effects are stronger at low interest rates.

We evaluate these predictions along two margins. Reserve demand is measured by the share of reserves in assets, isolating portfolio reallocation. Interbank activity is measured by the volume and frequency of unsecured borrowing.

Empirically, we measure variation in geopolitical tension between US and China using a large language model trained to classify high-frequency Chinese news. Bank-level outcomes are related to an exogenous risk index with standard controls. Identification comes from heterogeneous exposure: we compare U.S. banks operating in China with other non-U.S. banks, and Chinese banks operating in the United States with non-Chinese banks, as geopolitical tension varies.

7.1 Data and variable construction

7.1.1 Bank-level data

The bank-level financial data are collected from various sources. In the U.S. market, we use the quarterly Consolidated Report of Condition and Income for U.S. banks and branches (commonly known as "Call reports") and Consolidated Financial Statements (Form FR Y-9C) for Bank Holding Companies (BHCs). These files report the balance sheet data of US banks at the end of each quarter, including reserve balances, Federal funds purchased (Fed funds borrowing), securities sold under agreements to repurchase (repo borrowing) and other balance sheet characteristics. Given the Fed funds are mostly overnight, the volume of Fed funds and repo trade reported in these files measures banks' Fed funds and repo borrowing on the last business day of each quarter. Our data covers the period going from 2002Q1 to 2021Q2.[2] We measure each variable at the consolidated top holder level. Aggregating the variables to the top holder level not only avoids double counting, but also eliminates the bilateral trades between subsidiaries of a bank holding company that are not implemented in the Fed funds market.

In the China market, we construct a bank-level dataset for Chinese banks from annual reports available in the China Stock Market & Accounting Research (CSMAR) database. The reports provide year-end consolidated balance sheets, which we aggregate to the top-holder level. Our sample spans 2007-2024, covering 452 banks and approximately 90% of total banking assets in China. From the annual reports, we collect data of bank reserves, unsecured interbank borrowing, repo borrowing and other balance sheet characteristics.

For each top holder in each period, we construct the following variables: (1) Volume of Federal funds purchased (or unsecured interbank borrowing) normalized by total assets (f^{ff}), i.e.

$$f^{ff} = \frac{\text{Federal funds purchased (or unsecured interbank borrowing)}}{\text{Total assets}}.$$

It measures a bank's total borrowing of Fed funds as a share of bank assets. (2) Volume of repo borrowing normalized by total assets (f^{repo}), i.e.

$$f^{repo} = \frac{\text{Repo borrowing}}{\text{Total assets}}.$$

It measures a bank's total repo financing as a share of bank assets. (3) Excess reserve balances before Federal funds and repo trade normalized by total assets (Pre-trade excess reserves per asset k), i.e.

$$k = \frac{\text{Excess reserves before Federal funds and repo trade}}{\text{Total assets}},$$

where the excess reserves before Federal funds and repo trade is given by

[2] Starting in 2021Q3, the balance sheet data of foreign banking organizations are no longer publicly available.

$$\text{Excess reserves before Federal funds and repo trade} \tag{49}$$

$$= \text{Excess reserves-Federal funds purchased+Federal funds sold} \tag{50}$$

$$\text{-Repo+Reverse Repo.}$$

The excess reserve balances before Federal funds and repo trade represent a bank's holdings of reserves in excess of its reserve requirement when it enters the Federal funds and repo markets. It captures individual heterogeneity of trade incentives in the Federal funds and repo markets. Moreover, for individual controls, we include the following balance-sheet variables: In the China market regressions, we include the following bank controls: log of bank assets, deposits-to-assets ratio, capital adequacy ratio, loan-to-deposit ratio, ROA and leverage ratio. In the US market regressions, we include the following bank controls: log of bank assets, deposits-to-assets ratio, Tier-1 capital ratio, ROA, equity-to-assets ratio, non-performing loan ratio, and high-quality liquid assets ratio. We do not include non-performing loan ratio in the China market regressions because this variable has many missing values that significantly reduce the number of observations. The summary statistics of main variables are presented in Table 2

Table 2: Summary Statistics

	U.S. Market		China Market	
	All banks	China & H.K. banks	All banks	U.S. banks
Total assets (billion USD/RMB)	11.25	18.13	1,097	50.37
	(102.07)	(34.30)	(3,920)	(39.82)
Pre-trade excess reserves/Assets	0.031	0.180	0.030	0.138
	(0.115)	(0.214)	(0.072)	(0.103)
Federal funds purchased/Assets	0.007	0.022	0.019	0.158
	(0.039)	(0.033)	(0.041)	(0.088)
Repo/Assets	0.019	0.002	0.037	0.008
	(0.050)	(0.008)	(0.042)	(0.021)
Federal funds sold/Assets	0.013	0.010	0.024	0.201
	(0.044)	(0.052)	(0.049)	(0.097)
Reverse repo/Assets	0.004	0.0004	0.038	0.019
	(0.034)	(0.002)	(0.054)	(0.028)
Obs.	122,746	158	3,087	13

Notes: This table reports means with standard deviations in parentheses. All per-asset variables are defined as the ratio to total assets. "China & HK banks" are banks headquartered in Mainland China or Hong Kong operating in the US market. "US banks" are US-headquartered banks operating in the China market.

7.1.2 U.S.–China tension indices

Our measures of U.S.–China tension is based on the U.S.–China Tension (UCT) index of Rogers et al. (2024). This index measures the intensity of bilateral tensions as reflected in major U.S. newspapers. Each month, the authors identify articles containing keywords referencing the United States, China,

and contentious issues or tension-related language, and compute the share of such articles in total newspaper coverage. The resulting series captures major episodes of geopolitical friction and closely tracks contemporaneous concerns among firms and policymakers. In our empirical analysis on the U.S. market, we use this UCT index as our measure of U.S.–China tension in the United States.

For the empirical analysis on the China market, we construct a sentiment-based U.S.–China tension index from the perspective of mainland China (Sentiment UCT-CN). The index is based on three nationally circulated newspapers that cover a broad range of political, economic, and social topics: *People's Daily*, which provides extensive reporting on major domestic and international developments; *Guangming Daily*, which focuses on policy, education, science, and cultural affairs; and *Economic Daily*, which covers macroeconomic trends, industry news, and economic policy. These outlets jointly offer comprehensive coverage of issues relevant to China's interactions with the United States.

We identify articles related to U.S.–China tensions by applying the search-term methodology of Rogers et al. (2024). Their search terms are derived from extensive review of media coverage on U.S.–China relations and are refined through repeated human audits to ensure that selected terms reliably capture episodes of strategic, economic, or geopolitical tension. An article is included only if it contains at least one term from each of the three keyword categories defined in Rogers et al. (2024).

While Rogers et al. (2024) construct their UCT-CN index by counting the share of tension-related articles in overall newspaper coverage, we augment this approach by incorporating the sentiment of each article.[3] The article sentiment is measured using the Erlangshen–MegatronBERT–1.3B-Sentiment model (IDEA-CCNL, 2021), a large-scale Chinese language model with approximately 1.3 billion parameters. The model is pre-trained on broad Chinese corpora and fine-tuned on multiple sentiment-classification datasets, achieving state-of-the-art performance on the FewCLUE and ZeroCLUE benchmarks. For each article, we remove punctuation and numerical characters, tokenize the cleaned text, and divide it into fixed-length segments so that long articles can be processed without truncation. Each segment is encoded by the BERT model to produce the probabilities of positive and negative sentiment. We map these probabilities into a continuous sentiment score,

$$S_{i,j,t} \in [-1, 1],$$

defined as the difference between the probability of positive sentiment and the probability of negative sentiment. The article-level sentiment score is the average of the segment-level scores, allowing us to capture both the direction and intensity of tone.

The Sentiment UCT-CN Index is constructed as follows. Let $N_{i,t}$ denote the total number of articles published by newspaper i in month t, $\mathcal{I}_{i,t}$ the subset of articles containing all required keyword categories, and $S_{i,j,t}$ the sentiment score for article j. For each newspaper and month, we define the

[3] The UCT-CN index in Rogers et al. (2024) is constructed using articles from *People's Daily*.

raw sentiment-adjusted tension index as

$$\widetilde{UCT}_{i,t} = \frac{1}{N_{i,t}} \sum_{j \in \mathcal{I}_{i,t}} \frac{1 - S_{i,j,t}}{2}.$$

This transformation ensures that more negative sentiment contributes more strongly to the index. We then normalize the resulting series for each newspaper to have unit standard deviation over the sample period. The aggregate Sentiment UCT-CN Index is obtained by summing the normalized newspaper-level indices and scaling the composite series to have a mean of 100 over the full sample.

7.2 Institutional Background: Interbank Markets in the U.S. and China

Interbank markets play a central role in short-term liquidity redistribution and monetary policy transmission through unsecured lending and collateralized repurchase agreements (repos). Although both the United States and China operate unsecured and secured interbank markets, the relative importance of these segments and their interactions with monetary policy differ significantly across the two systems.

7.2.1 Interbank markets in the U.S.

In the U.S., the Federal funds market is the traditional venue for unsecured overnight lending of reserve balances held at the Federal Reserve Banks. Transactions are bilateral and over the counter, with funds transferred across institutions' reserve accounts. Nearly all trades mature overnight, and borrowing in this market is not treated as deposits under Regulation D, making federal funds a flexible tool for banks to meet reserve requirements and intraday payment needs. Lenders, typically institutions holding excess reserves, earn the overnight federal funds rate.

Before the Global Financial Crisis, the Federal Reserve adjusted the supply of reserves through open market operations to steer the effective federal funds rate toward the policy target. Following the introduction of interest on excess reserves (IOER), large-scale asset purchases, and post-crisis regulatory reforms, reserves became abundant and the federal funds market contracted sharply. The Federal Reserve now operates a floor system in which the IOER serves as the upper bound of the federal funds target range, while the Overnight Reverse Repurchase (ON RRP) rate—accessible to money market funds and government-sponsored enterprises—provides a binding lower bound.

The U.S. repo market, comprising bilateral and centrally cleared repo transactions, is a secured funding market in which Treasury and agency securities are used as collateral. Repo rates—particularly Treasury general collateral (GC) repo rates—are essential benchmarks for securities financing, cash management, and monetary policy transmission. The Federal Reserve's Standing Repo Facility (SRF) and ON RRP facility stabilize repo rates and reinforce the administered-rate framework of the floor system.

The federal funds and repo markets are closely linked through arbitrage and balance-sheet management. In the pre-crisis corridor system, federal funds were the dominant policy rate and repo rates followed federal funds closely. In the post-crisis floor system, repo markets grew in importance as the federal funds market shrank and became dominated by a small set of government-sponsored enterprises lending to banks. Repo rates now play a central role in short-term rate discovery and transmission. Movements in repo rates influence the federal funds rate through balance-sheet arbitrage by banks, dealers, and money market funds, while ON RRP operations provide a common lower bound for both markets. Overall, monetary policy in the United States is now transmitted primarily through collateralized repo markets, with federal funds playing a secondary role.

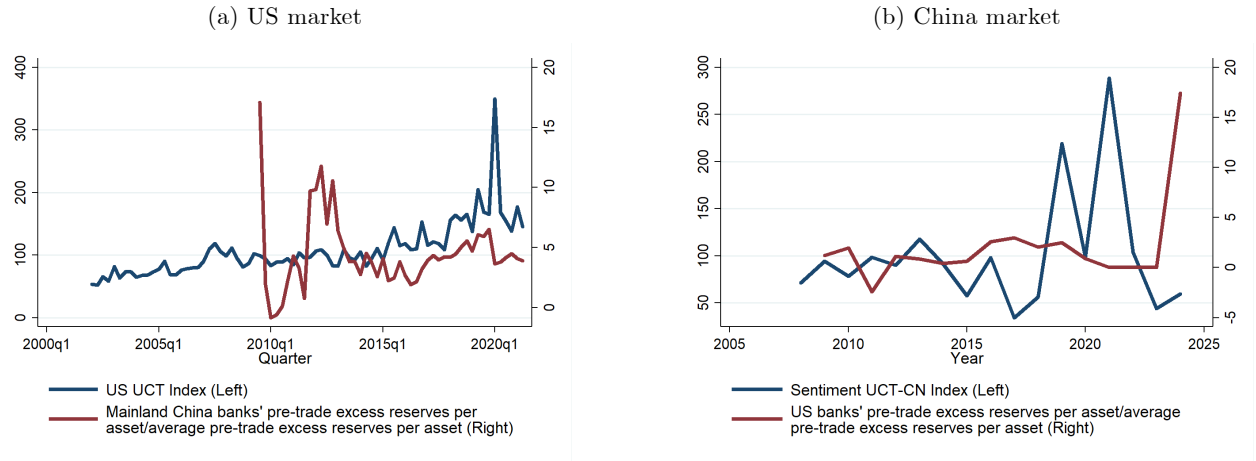
7.2.2 Interbank markets in China

In China, unsecured interbank lending is conducted through the interbank offered market, which consists of short-term lending among banks and other regulated financial institutions through the national payment system. Although overnight and very short maturities dominate, unsecured interbank lending is smaller in scale than in the United States and exhibits greater segmentation across institution types. Benchmark rates in this market, such as the Shanghai Interbank Offered Rate (Shibor), reflect liquidity conditions but are not the primary policy rates targeted by the People's Bank of China (PBC).

The interbank repo market is the central pillar of short-term funding in China. The dominant instrument is the pledged repo, in which the borrower pledges high-quality collateral—typically government bonds, policy bank bonds, or other highly rated financial bonds—while retaining ownership. These repos account for the majority of interbank trading volume and serve as the primary means of liquidity redistribution across the banking system. The key policy-relevant benchmark is the seven-day pledged repo rate (DR007), which the PBC guides using open market operations (OMOs), the Medium-term Lending Facility (MLF), the Standing Lending Facility (SLF), and reserve-requirement adjustments.

In China, the repo market is substantially larger and more influential than the unsecured interbank market. DR007 has effectively replaced unsecured interbank rates as the operational target of monetary policy. Repo rates anchor short-term funding conditions, while unsecured rates adjust around repo rates through liquidity arbitrage and balance-sheet substitution among institutions with differing collateral access. Because the Chinese financial system includes heterogeneous institutions—large state-owned banks, joint-stock banks, city commercial banks, and nonbank financial institutions—collateral availability and regulatory constraints strongly shape the linkage between unsecured and repo funding. The repo market thus serves as the primary channel through which the PBC transmits short-term policy signals, with unsecured interbank lending adapting to conditions originating in the collateralized segment.

Figure 1: Time series of UCT and bank reserves



Notes: The left panel plots the sequences of UCT index and Mainland China banks' pre-trade excess reserves per asset / average pre-trade excess reserves per asset in the US. The UCT index is from Rogers et al. (2024). The right panel plots Sentiment UCT-CN index and US banks' pre-trade excess reserves per asset / average pre-trade excess reserves per asset in China.

7.3 Validating Sentiment UCT

We validate our Sentiment UCT-CN Index in several ways. First, Appendix E provides illustrative examples of newspaper articles whose tone is not well captured by the count-based UCT-CN Index of Rogers et al. (2024). Two of these articles exhibit distinctly negative sentiment, while the other two are clearly positive. These examples highlight situations in which a simple count-based measure misses important variation in tone, underscoring the value of incorporating sentiment information into the construction of our index.

Table 3: Regressions of BERT Sentiment Score on Human Label

Dep. Var.	Article sentiment score			
	(1)	(2)	(3)	(4)
Negative human label	-0.2954***	-0.2899***	-0.2857***	-0.2589***
	(0.0338)	(0.0398)	(0.0389)	(0.0385)
Positive human label	0.0955***	0.1081***	0.1141***	0.1237***
	(0.0199)	(0.0300)	(0.0302)	(0.0304)
Human rater FE	N	Y	Y	Y
Newspaper FE	N	N	Y	Y
Year×Month FE	N	N	N	Y
Adj. R^2	0.160	0.163	0.168	0.186
Obs.	1,000	1,000	1,000	1,000

Notes: This table presents the estimation results on the OLS regression of BERT-generated sentiment score on human rated label for 1,000 randomly selected articles. Human labels have three categories: Positive, Neutral and Negative. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Second, we randomly sample 1,000 articles from our corpus and ask three research assistants to label each article as Positive, Neutral, or Negative. We then compare these human labels with the BERT-generated sentiment scores using regression analysis. In an OLS regression of sentiment scores on the human labels, articles labeled Negative score roughly 0.3 points lower than Neutral articles, while articles labeled Positive score about 0.1 points higher (Table 3). These differences are statistically significant and remain robust after controlling for human-rater, newspaper, and publication-time fixed effects.

We further estimate an ordered probit model in which the human label is coded as –1 (Negative), 0 (Neutral), and 1 (Positive), and is regressed on the sentiment score. As shown in Tabel 9 in Appendix **??**, higher sentiment scores significantly increase the likelihood that an article receives a Positive label. This relationship also persists after including fixed effects for human raters, newspapers, and publication dates. Together, these exercises demonstrate that the BERT-generated sentiment measure aligns closely with human assessment and captures meaningful variation in the tone of U.S.–China news coverage.

Figure 2 compares our Sentiment UCT-CN Index with the count-based UCT Indices of Rogers et al. (2024), with all series scaled to have a mean of 100. The count-based UCT Index in the U.S. (UCT Index in the figure) shows an upward trend and peaks between 2019 and 2021, whereas the count-based UCT-CN Index constructed from *People's Daily* moves in the opposite direction, generating a negative correlation between the two measures. Our sentiment-based approach resolves this discrepency. Both the Sentiment UCT-CN Index constructed from the three Chinese newspapers and the version based solely on *People's Daily* are positively correlated with the count-based UCT Index in the U.S., and similarly peak in 2019 to 2021. Moreover, sentiment-based indices display substantially greater variation than the count-based UCT-CN Index, indicating that they capture the intensity of bilateral tensions more effectively.

7.4 Regressions

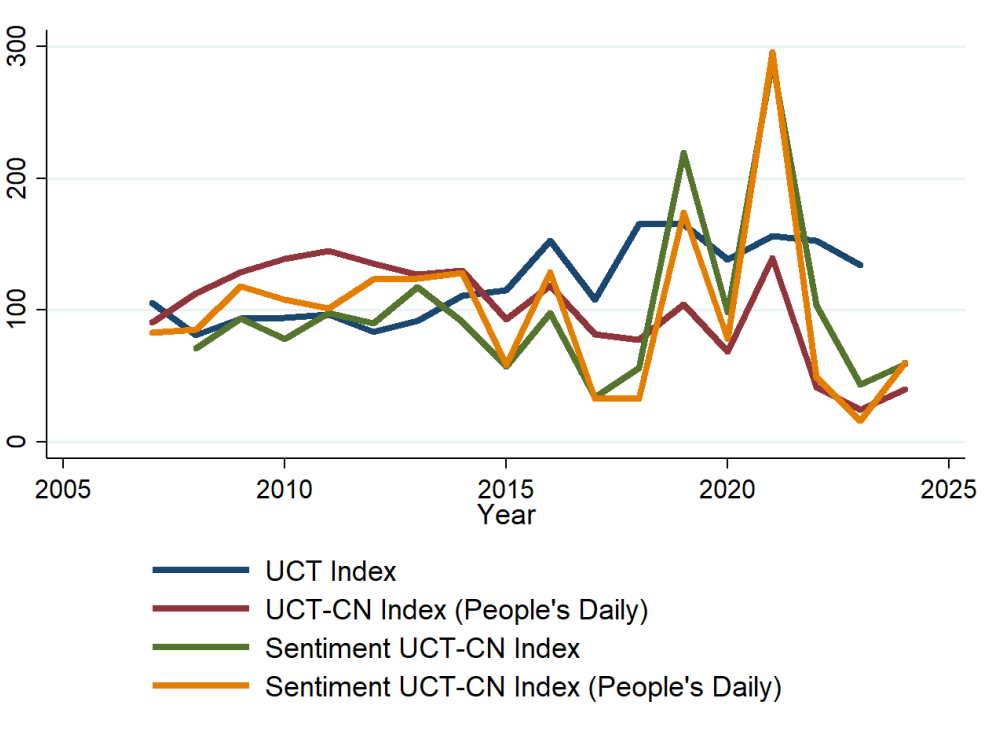
This section examines how U.S.–China tension affects banks' reserve holdings and interbank borrowing in both the U.S. and mainland China. In the China market, we study how the Sentiment UCT-CN Index influences U.S. banks operating in China relative to other banks. In the U.S. market, we analyze how the count-based UCT Index affects mainland Chinese banks operating in the United States compared with other banks.

Our first specification evaluates the effect of U.S.–China tension on banks' pre-trade excess reserves using the OLS regression

$$k_{it} = \alpha_{k,i} + \eta_{k,t} + \beta_k \cdot UCT_t \times D_i + \gamma_k \cdot controls_{it} + \varepsilon^k_{it}, \tag{51}$$

where k_{it} is a bank's pre-trade excess reserves per asset, UCT_t is the tension index, and $\alpha_{k,i}$ and $\eta_{k,t}$

Figure 2: Measures of U.S.–China Tension



Notes: This figure plots the U.S.–China tension indices in December from 2007 to 2024. "UCT Index" and "UCT-CN Index" are from Rogers et al. (2024). They are the U.S.–China tension indices based on major U.S. newspapers and *People's Daily*, respectively. "Sentiment UCT-CN Index" is our sentiment-based U.S.–China tension index constructed from *People's Daily*, *Guangming Daily*, and *Economic Daily*. "Sentiment UCT-CN Index (People's Daily)" is our sentiment-based measure using only the articles from *People's Daily*.

are bank and time fixed effects. In the China regressions, D_i is the dummy for U.S. banks; in the U.S. regressions, it is the dummy for mainland Chinese banks. The coefficient β_k measures the differential impact of the tension index on the reserve holdings of banks in the D_i group than other banks.

Next, to examine the effect of U.S.–China tension on interbank borrowing, we consider the following Tobit regression:

$$y_{it} = \alpha_{y,i} + \eta_{y,t} + \beta_{y,1} \cdot UCT_t \times D_i + \beta_{y,2} k_{it} + \gamma_y \cdot controls_{it} + \varepsilon_{it}^y, \tag{52}$$

where y_{it} is either Federal funds purchased per asset ff_assets_{it}, or repo borrowing per asset $repo_assets_{it}$, and $\alpha_{y,i}$ and $\eta_{y,t}$ are bank and time fixed effects. reflects how the effect of the tension index on interbank borrowing differs between the D_i group and all other banks.

In the U.S. regressions, we further include the dummy for Hong Kong banks operating in the United States. In all regressions, we include a dummy for placebo banks representing those unaffected by U.S.–China tension. Placebo banks are defined as those headquartered in countries geographically distant from both the U.S. and China (e.g., Europe, West Asia, South America, and Africa).

Table 4: Regressions of US bank reserves in China

Dep. Var.	Pre-trade excess reserves/assets			
	(1)	(2)	(3)	(4)
US Dummy	0.1081***	0.1026***	0.0916***	
	(0.0061)	(0.0078)	(0.0167)	
UCT-CN×US Dummy				0.0297***
				(0.0017)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Adj. R^2	0.009	0.129	0.139	0.490
Obs.	3,087	3,087	3,031	2,960

Notes: This table presents the estimation results on the OLS regression of excess reserves (51) in the China market. The sample consists of banks operating in mainland China. The sample period is from 2007 to 2024. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7.4.1 Results of China regressions

Table 4 to 6 report the results of China regressions. Column (1) to (3) of Table 4 shows that U.S. banks hold significantly more reserves before entering the interbank market than other banks. Column (4) reports a significantly positive coefficient on $UCT_t \times D_i$, indicating that when the tension index index rises, U.S. banks increase their pre-trade excess reserves substantially more than others. The estimated coefficient suggets that if the tension index increases from its pre-2018 average—before the first major public escalation of U.S.–China tensions—to its peak level, U.S. banks increase their

pre-trade excess reserves by an additional 9.60% of assets relative to other banks, or on average 4.84 billion yuan per U.S. bank.

In Table 5, column (1) to (3) show that U.S. banks engage in significantly more unsecured interbank borrowing than others in the China market. Column (4) reports a significntly negative coefficient on $UCT_t \times D_i$, indicating that rising U.S–China tension leads U.S. banks to reduce their unsecured interbank borrowing more than other banks. The magnitude of this coefficient implies that an increase in the tension index from its pre-2018 average to its peak level reduces U.S. banks' unsecured interbank borrowing by an additional 9.41% of assets relative to other banks, or on average 4.74 billion yuan per U.S. bank.

Table 5: Regressions of US banks' unsecured interbank borrowing in China

Dep. Var.	Unsecured interbank borrowing/assets			
	(1)	(2)	(3)	(4)
US Dummy	0.1626***	0.1620***	0.1052***	
	(0.0176)	(0.0186)	(0.0165)	
UCT-CN×US Dummy				-0.0291***
				(0.0015)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Pseudo R^2	-0.039	-0.048	-0.176	-0.620
Obs.	3,087	3,087	3,031	2,982

Notes: This table presents the estimation results on the Tobit regression of US banks' unsecured interbank borrowing (52) in the China market. The sample consists of banks operating in mainland China. The sample period is from 2007 to 2024. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Conversely, Table 6 shows in column (1) to (3) that U.S. banks rely significantly less repo borrowing than others. Column (4) reports a significntly positive coefficient on $UCT_t \times D_i$, indicating that rising U.S–China tension leads U.S. banks to increase their repo borrowing more than other banks. The magnitude of this coefficient implies that an increase in the tension index from its pre-2018 average to its peak level raises U.S. banks' repo borrowing by an additional 7.78% of assets relative to other banks, or on average 3.92 billion yuan per U.S. bank. These empirical results are consistent with the theoretical prediction of secondary-sanction risk on exposed banks' reserve holding, unsecured borrowing and repo borrowing in Table 1.

To assess the combined effect of $UCT_t \times D_i$ on U.S. banks' unsecured interbank borrowing and repo activity, we estimate a seemingly-unrelated regression (SUR) system and test whether the sum of the two interaction coefficients from Table 5 and 6 is significantly negative. The estimated sum equals -0.0050 and is statistically significant at 5% level (P-value=0.0192), indicating a negative joint effect.

Table 6: Regressions of US banks' repo borrowing in China

Dep. Var.	Repo borrowing/assets			
	(1)	(2)	(3)	(4)
US Dummy	-0.0304***	-0.0304***	-0.0323**	
	(0.0054)	(0.0060)	(0.0126)	
UCT-CN×US Dummy				0.0240***
				(0.0025)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Pseudo R^2	-0.024	-0.032	-0.100	-0.292
Obs.	3,087	3,087	3,031	2,982

Notes: This table presents the estimation results on the Tobit regression of US banks' repo borrowing (52) in the China market. The sample consists of banks operating in mainland China. The sample period is from 2007 to 2024. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Hence, when the tension index rises in the China market, U.S. banks' overall interbank borrowing declines more sharply than that of other banks.

Table 7 presents the placebo test, where we re-estimate the OLS regression (51) but replace the U.S.-bank dummy with the dummy for placebo banks. Column (4) shows that the interaction term between the tension index and the placebo dummy is statistically insignificant. This indicates that, unlike U.S. banks, placebo banks do not adjust their pre-trade excess reserve holdings differently from other banks when U.S.–China tension rises. The absence of any differential response supports the validity of our baseline identification and suggests that the earlier findings are not driven by spurious correlation or sample composition.

Table 7: Regressions of Placebo banks' reserves in China

Dep. Var.	Pre-trade excess reserves/assets			
	(1)	(2)	(3)	(4)
Placebo Dummy	0.1310***	0.1304**	0.1442***	
	(0.0503)	(0.0549)	(0.0576)	
UCT-CN×Placebo Dummy				0.0111
				(0.0115)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Adj. R^2	0.039	0.159	0.172	0.490
Obs.	3,087	3,087	3,031	2,960

Notes: This table presents the estimation results on the OLS regression of placebo banks' excess reserves (51) in the China market. The sample consists of banks operating in mainland China. The sample period is from 2007 to 2024. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7.4.2 Results of US regressions

Table 10 through 15 in the Appendix present the regression results for the U.S. market. Column (1) to (3) of Table 10 show that mainland Chinese banks hold significantly more reserves before entering the U.S. interbank market than other banks. Column (4) reports a significantly negative coefficient on $UCT_t \times D_i$, indicating that when the tension index index rises, mainland Chinese banks reduce their pre-trade excess reserves substantially more than others. The estimated coefficient suggets that if the tension index increases from its pre-2018 average to its peak level, mainland China banks reduce their pre-trade excess reserves by an additional 6.76% of assets relative to other banks, or on average 2.03 billion dollar per bank.

In Table 11, column (1) to (3) show that mainland Chinese banks engage in significantly more Federal funds borrowing than others in the U.S. market. Column (4) reports a significntly positive coefficient on $UCT_t \times D_i$, indicating that rising U.S–China tension leads mainland Chinese banks to increase their Federal funds borrowing more than other banks. The magnitude of this coefficient implies that an increase in the tension index from its pre-2018 average to its peak level raises mainland Chinese banks' Federal funds borrowing by an additional 0.85% of assets relative to other banks, or on average 0.26 billion dollar per bank.

Similarly, Table 12 reports in column (4) a significntly positive coefficient on $UCT_t \times D_i$, indicating that rising U.S–China tension prompts mainland Chinese banks to increase their repo borrowing more than other banks. This effect corresponds to an additional 1.47% of assets relative to other banks, or about 0.44 billion dollar per bank, when the tension index moves from its pre-2018 average to its peak. These empirical results are consistent with the theoretical prediction of freeze risk and primary-sanction risk on exposed banks' reserve holding, unsecured borrowing and repo borrowing in Table 1.

Moreover, Table 13 reports the placebo test for pre-trade excess reserves. Column (4) shows that the interaction between the tension index and the placebo dummy is statistically insignificant, indicating that placebo banks do not adjust their reserve holdings differently from other banks when U.S.–China tension rises. This null result reinforces that our baseline findings for mainland Chinese banks are not driven by spurious correlation or sample composition.

Finally, we examine whether the reduction in mainland Chinese banks' pre-trade excess reserves reflects a reallocation of funds to Hong Kong banks as a potential "safe haven" strategy. Table 14 and 15 incorporate a Hong Kong bank dummy (HK Dummy) and the aggregate ratio of pre-trade excess reserves to assets for mainland Chinese banks (Mainland China Res.). In both tables, the coefficient of double interaction term UCT×HK Dummy is significantly positive in column (4) and significantly negative in column (5). A t-test in Table 15 shows that the column-(5) coefficient is smaller than the double interaction term UCT×Mainland China Dummy for mainland Chinese banks.

The tripple interaction term "UCT×HK Dummy×Mainland China Res." captures the effect of

"safe haven" strategy. Column (5) in both tables reports a significantly positive coefficient of the tripple interaction term. This indicates that mainland Chinese banks shift part of their reserves to Hong Kong banks when the U.S.–China tension intensifies. The magnitude of the coefficient implies that, on average, about 25.95% of mainland Chinese banks' reduced pre-trade excess reserves flows into Hong Kong banks' extra reserve holdings when the tension index increases.

8 Conclusion

This paper has shown that geopolitical tension alters the demand for the hegemon's payment asset by reshaping the counterparty risks embedded in the interbank market. In a model where reserves serve both as a settlement medium and an overnight asset, freeze and primary-sanction risks weaken the asset role of reserves, while secondary-sanction risk undermines the reliability of unsecured borrowing. These risks lead banks to adjust their reserve holdings and their mix of unsecured and secured borrowing in predictable ways. Using a new geopolitical tension index derived from high-frequency Chinese news and detailed bank-level data, we document that U.S. banks operating in China increase their reserve balances and shift toward secured borrowing during periods of elevated tension, while Chinese banks operating in the United States do not. These findings highlight a margin of adjustment largely absent from existing studies: geopolitical tension can raise the demand for the hegemon's payment asset itself. Understanding this channel is essential for analyzing currency dominance and the resilience of global payment demand under elevating geopolitical tension.

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Appendices

A Proof

A.1 Proof of Proposition 1

We verify Proposition 1 by checking that the value function $V_t(k)$ given by (16) in Proposition 1 sustaining an equilibrium.

Proof of Proposition 1(i). Given $V_t(k)$ from (16), the optimal choice of the next-period reserve balance from (6) is given by

$$k_s = \arg\max_k \left\{ -k + \frac{V_0(k)}{1+r} \right\}.$$

The first order condition is given by

$$1 + r = 1 + \mu T \underbrace{- \frac{\Delta_i}{\Delta_k} k_s + i + \frac{\Delta_i}{\Delta_k} \bar{k}}_{U'(k_s)} + 2h(0)(k_s - K). \tag{A.1}$$

Using the definition $K \equiv \frac{\Delta_k}{\Delta_i}(\mu T + i - r) + \bar{k}$, then the solution of the first order condition (A.1) is $k_s = K$, which establishes part i.

Proof of Proposition 1(ii). The first order condition of ρ and q of the Nash bargaining problem (8) are given by

$$1 + \rho = \frac{W_\tau(k+q) - V_\tau(k) - W_\tau(k'-q) + V_\tau(k')}{2q}, \tag{A.2}$$

$$\frac{\partial}{\partial k} W_\tau(k+q) = \frac{\partial}{\partial k} W_\tau(k'-q), \tag{A.3}$$

where (A.3) implies $k + q = k' - q$, i.e.

$$q = \frac{k' - k}{2}.$$

Given $W_t(k)$ and $V_t(k)$ from (11) and (16), the first order condition of ρ (A.2) becomes

$$\rho = \mu(T-\tau) + \frac{U(k+q) - U(k) - U(k'-q) + U(k') + h(\tau)\left[(k'-K)^2 - (k-K)^2\right]}{2q}, \tag{A.4}$$

$$= r - \mu\tau + \frac{\Delta_i}{\Delta_k}K + \frac{-\frac{\Delta_i}{2\Delta_k}\left[(k+q)^2 - k^2 - (k'-q)^2 + k'^2\right] + h(\tau)(k'-k)(k'+k-2K)}{2q}, \tag{A.5}$$

$$= r - \mu\tau + \frac{\Delta_i}{\Delta_k}K + h(\tau)\left(\frac{k'+k}{2} - K\right) - \frac{\Delta_i}{\Delta_k}\frac{k+k'}{2}, \tag{A.6}$$

$$= r - \mu\tau - \left[\frac{\Delta_i}{\Delta_k} - h(\tau)\right]\left(\frac{k'+k}{2} - K\right),$$

which establishes part ii.

Proof of Proposition 1(iii). It is straight-forward to verify (15) satisfy the KFE (**??**) where given the initial condition that $F_0(k)$ is degenerate at $k = K$.

Proof of Proposition 1(iv). What we need to prove is to verify that (16) satisfies the HJB equation (13). Given $W_t(k)$ and $V_t(k)$ from (11) and (16), the LHS of the HJB equation (13) is

$$\begin{aligned}\frac{\partial}{\partial t}V_t(k) &= \frac{\partial}{\partial t}W_t(k) + (k-K)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t \\ &= -\mu k + \frac{\Delta_i}{2\Delta_k}\sigma^2 + (k-K)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t.\end{aligned} \tag{A.7}$$

The first order condition of ρ (A.2) implies

$$S^*_\tau(k,k') = 0.5\left[S^*_\tau(k,k') + S^*_\tau(k',k)\right], \tag{A.8}$$

$$= 0.5\left[W_\tau(k+q) - V_\tau(k) + W_\tau(k'-q) - V_\tau(k')\right], \tag{A.9}$$

$$= 0.5\left[W_\tau(k+q) - \left[W_t(k) + h(t)(k-K)^2\right] + W_\tau(k'-q) - \left[W_t(k') + h(t)(k'-K)^2\right]\right] - D_t, \tag{A.10}$$

$$= 0.5\left[U(k+q) - U(k) + U(k'-q) - U(k') - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right] - D_t, \tag{A.11}$$

$$= 0.5\left[\frac{\Delta_i}{4\Delta_k}(k'-k)^2 - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right] - D_t.$$

Hence we have

$$\int S^*_t(k,k')\,dF_t(k') = \frac{1}{2}\int\left[\frac{\Delta_i}{4\Delta_k}(k'-k)^2 - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right]f_t(k')\,dk' - e^{-\lambda t}D_t, \tag{A.12}$$

$$= \frac{1}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[e^{-\lambda t}(k-K)^2 + \int(k'-K)^2 f_t(k')\,dk'\right] - e^{-\lambda t}D_t, \tag{A.13}$$

$$= \frac{e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K)^2 + \sigma^2 t\right] - e^{-\lambda t}D_t.$$

Then the RHS of the HJB equation (13) is

$$\begin{aligned}
&-\mu k-\lambda\int S_t^*\left(k,k'\right)dF_t\left(k'\right)-\frac{\sigma^2}{2}\frac{\partial^2}{\partial k^2}V_t\left(k\right)\\
&=-\mu k-\frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k}-h\left(t\right)\right]\left[\left(k-K\right)^2+\sigma^2 t\right] \qquad \text{(A.14)}\\
&\quad+\lambda e^{-\lambda t}D_t-\frac{\sigma^2}{2}\left[\frac{\partial^2}{\partial k^2}W_t\left(k\right)+2h\left(t\right)\right]\\
&=-\mu k-\frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k}-h\left(t\right)\right]\left[\left(k-K\right)^2+\sigma^2 t\right] \qquad \text{(A.15)}\\
&\quad+\lambda e^{-\lambda t}D_t+\frac{\sigma^2}{2}\left[\frac{\Delta_i}{\Delta_k}-2h\left(t\right)\right]
\end{aligned}$$

Matching the coefficients of $\left(k-K\right)^2$ in (A.7) and (A.15), $h\left(t\right)$ must satisfies the following ODE:

$$\begin{aligned}
\frac{\partial}{\partial t}h\left(t\right)=-\frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k}-h\left(t\right)\right] &\Rightarrow \frac{\partial}{\partial t}\log\left[h\left(t\right)-\frac{\Delta_i}{4\Delta_k}\right]=-\frac{\lambda e^{-\lambda t}}{2}, \qquad \text{(A.16)}\\
&\Rightarrow h\left(t\right)=\frac{\Delta_i}{4\Delta_k}\left[1-e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda\left(T-t\right)}-1\right)}\right].
\end{aligned}$$

where we have used the fact that the terminal condition $V_T\left(k\right)=W_T\left(k\right)$ implies $h\left(T\right)=0$.

QED.

A.2 Proof of Proposition 2

Given $V_t\left(k\right)$ from (16) of Proposition 1, the first order condition of (18) is given by

$$1+r=\delta_f\left(1+i\right)+\left(1-\delta_f\right)\left[1+i+\mu T-\frac{\Delta_i}{\Delta_k}\left(k_s-\bar{k}\right)+2h\left(0\right)\left(k_s-K\right)\right], \qquad \text{(A.17)}$$

leading to

$$k_s=K-\frac{\delta_f}{1-\delta_f}\frac{r-i}{\frac{\Delta_i}{\Delta_k}-2h\left(0\right)}=K^f,$$

where

$$h\left(0\right)=\frac{\Delta_i}{4\Delta_k}\left(1-e^{-\frac{1-e^{-\lambda T}}{2}}\right).$$

QED.

A.3 Proof of Proposition 3

We verify Proposition 3 by checking that the value function $V_t^p\left(k\right)$ given by (37) in Proposition 3 sustaining an equilibrium.

Proof of Proposition 3(i). Given $V_t(k)$ from (37), the first order condition of (23) is given by

$$1+r=\delta_f(1-\delta_p)(1+i)+(1-\delta_f)\left[(1-\delta_p)(1+i)+\mu T-\frac{\Delta_i}{\Delta_k}\left(k_s-\bar{k}\right)+2h(0)\left(k_s-K^p\right)\right].$$

Using the definition $K^p\equiv\frac{\Delta_k}{\Delta_i}(\mu T+i-r)+\bar{k}-\delta\frac{\Delta_k}{\Delta_i}(1+i)$, then the solution of the above first order condition is

$$k_s=K^p-\frac{\delta_f}{(1-\delta_f)}\frac{1+r-(1-\delta_p)(1+i)}{\frac{\Delta_i}{\Delta_k}-2h(0)}$$

which establishes part i.

Proof of Proposition 3(ii). The first order condition of ρ and q of the Nash bargaining problem (26) are given by

$$1+\rho^p=\frac{W_\tau^d(k+q^p)-V_\tau^d(k)-W_\tau(k'-q^p)+V_\tau(k')}{2q^p}, \tag{A.18}$$

$$U^{p\prime}(k+q^p)+1-\delta_p=U'\left(k'-q^p\right)+1, \tag{A.19}$$

implying

$$q^p=\frac{k'-k}{2}-\frac{\delta_p}{2}\frac{\Delta_k}{\Delta_i}(1+i).$$

Evaluating at $k=k_{s+\tau}=k_s+B_\tau$, we establish part ii.

Then we have

$$U^p(k+q^p)-U^p(k)-\delta_p q^p-U\left(k'-q^p\right)+U\left(k'\right) \tag{A.20}$$

$$=-\frac{\Delta_i}{2\Delta_k}\left[(k+q^p)^2-k^2-\left(k'-q^p\right)^2+k'^2\right]-\delta_p(1+i)q^p \tag{A.21}$$

$$=-\frac{\Delta_i}{2\Delta_k}q^p\left[2k+q^p+2k'-q^p+\delta_p\frac{2\Delta_k}{\Delta_i}(1+i)\right] \tag{A.22}$$

$$=-\frac{\Delta_i}{\Delta_k}q^p\left[k+k'+\delta_p\frac{\Delta_k}{\Delta_i}(1+i)\right]$$

Proof of Proposition 3(iii). What we need to prove is to verify that (16) satisfies the HJB equation (13). Given $W_t^p(k)$ and $V_t^p(k)$ from (27) and (37), the first order condition of ρ becomes

$$\rho = \mu(T-\tau) + \frac{U^p(k+q) - U^p(k) - \delta q - U(k'-q) + U(k') + h(\tau)\left[(k'-K)^2 - (k-K^p)^2\right]}{2q} \tag{A.23}$$

$$\rho = \mu(T-\tau) - \frac{\Delta_i}{\Delta_k}\frac{k+k'+\delta\frac{\Delta_k}{\Delta_i}(1+i)}{2} + h(\tau)\left[k'+k-2K+\delta\frac{\Delta_k}{\Delta_i}(1+i)\right], \tag{A.24}$$

$$= \mu(T-\tau) - \frac{\Delta_i}{\Delta_k}K - \left[\frac{\Delta_i}{\Delta_k} - h(\tau)\right]\left(\frac{k'+k}{2} - K - \frac{\delta}{2}\frac{\Delta_k}{\Delta_i}(1+i)\right), \tag{A.25}$$

$$= -\mu\tau - (i-r) - \frac{\Delta_i}{\Delta_k}\bar{k}$$

The LHS of the HJB equation (13) is

$$\begin{aligned}\frac{\partial}{\partial t}V_t(k) &= \frac{\partial}{\partial t}W_t^p(k) + (k-K)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t^p \\ &= -\mu k + \frac{\Delta_i}{2\Delta_k}\sigma^2 + (k-K^p)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t^p.\end{aligned} \tag{A.26}$$

The first order condition of ρ (A.2) implies

$$\begin{aligned}S_\tau^*(k,k') &= 0.5\left[S_\tau^*(k,k') + S_\tau^*(k',k)\right], \\ &= 0.5\left[W_\tau^p(k+q) - V_\tau^p(k) + W_\tau(k'-q) - V_\tau(k')\right], \\ &= 0.5\left[W_\tau^p(k+q) - \left[W_t^p(k) + h^p(t)(k-K^p)^2\right] + W_\tau(k'-q) - \left[W_t(k') + h(t)(k'-K)^2\right]\right] - 0.5(D_t^p + \\ &= 0.5\left[U^p(k+q) - U^p(k) - \delta q + U(k'-q) - U(k') - h^p(t)(k-K^p)^2 - h(t)(k'-K)^2\right] - 0.5(D_t^p + D_t \\ &= 0.5\begin{bmatrix} -\frac{\Delta_i}{2\Delta_k}q(2k+q) + \left[(1-\delta)i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q \\ +\frac{\Delta_i}{2\Delta_k}q(2k'-q) - \left[i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q - \delta q \\ -h^p(t)(k-K^p)^2 - h(t)(k'-K)^2 \end{bmatrix} - 0.5(D_t^p + D_t). \\ &= 0.5\begin{bmatrix} \frac{\Delta_i}{4\Delta_k}\left[(k'-K) - (k-K^p)\right]^2 \\ -h(t)\left[(k-K^p)^2 + (k'-K)^2\right] \end{bmatrix} - 0.5(D_t^p + D_t).\end{aligned}$$

Hence we have

$$\begin{aligned}\int S_t^*(k,k')\,dF_t(k') &= \frac{1}{2}\int\left[\frac{\Delta_i}{4\Delta_k}(k'-k)^2 - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right]f_t(k')\,dk' - e0.5(D_t^p + \\ &= \frac{1}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[e^{-\lambda t}(k-K^p)^2 + \int(k'-K)^2 f_t(k')\,dk'\right] - e^{-\lambda t}D_t, \\ &= \frac{e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K^p)^2 + \sigma^2 t\right] - e^{-\lambda t}D_t.\end{aligned} \tag{A.32}$$

where we have used the fact that the terminal condition $V_T(k) = W_T(k)$ implies $h(T) = 0$.

QED.

A.4 Proof of Proposition 4

We verify Proposition 4 by checking that the value function $V_t^p(k)$ given by (37) in Proposition 4 sustaining an equilibrium.The first order conditions are

$$\frac{\partial}{\partial k}W_\tau^p(k+q) = \frac{\partial}{\partial k}W_\tau\left(k'-q\right) + \delta_s C'(q) \tag{A.34}$$

$$-\frac{\Delta_i}{\Delta_k}(k+q) + (1-\delta_p)\,i + \frac{\Delta_i}{\Delta_k}\bar{k} - \delta_p = -\frac{\Delta_i}{\Delta_k}\left(k'-q\right) + i + \frac{\Delta_i}{\Delta_k}\bar{k} + 2\delta_s\kappa q \tag{A.35}$$

$$q = \frac{k'-k-\delta_p\frac{\Delta_k}{\Delta_i}(1+i)}{2\left(1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa\right)}$$

$$S_\tau^s(q,\rho;k) = \frac{1}{2}\left[S_\tau^s(q,\rho;k) + S_\tau^c\left(-q,\rho;k'\right)\right] \tag{A.36}$$

$$= \frac{1}{2}\left[W_\tau^p(k+q) - V_\tau^s(k) + W_\tau\left(k'-q\right) - V_\tau\left(k'\right) - \delta_s C(q)\right] \tag{A.37}$$

$$= \frac{1}{2}\begin{bmatrix} \left[(1-\delta)(1+i) + \mu(T-t) + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q - \frac{\Delta_i}{2\Delta_k}\left[(k+q)^2 - k^2\right] - h^s(t)(k-K^s)^2 - D_t^s \\ -\left[1+i+\mu(T-t)+\frac{\Delta_i}{\Delta_k}\bar{k}\right]q - \frac{\Delta_i}{2\Delta_k}\left[(k'-q)^2 - k'^2\right] - h(t)(k'-K)^2 - D_t - \delta_s\kappa q^2 \end{bmatrix} \tag{A.38}$$

$$= \frac{1}{2}\begin{bmatrix} -\delta_p(1+i)q - \frac{\Delta_i}{2\Delta_k}\left[(k+q)^2 - k^2 + (k'-q)^2 - k'^2\right] \\ -h^s(t)(k-K^s)^2 - h(t)(k'-K)^2 - \delta_s\kappa q^2 \end{bmatrix} - \frac{D_t^s + D_t}{2} \tag{A.39}$$

$$= \frac{1}{2}\begin{bmatrix} \frac{\Delta_i}{\Delta_k}q\left(k'-k-\delta_p\frac{\Delta_k}{\Delta_i}(1+i) - q\right) - \delta_s\kappa q^2 \\ -h^s(t)(k-K^s)^2 - h(t)(k'-K)^2 \end{bmatrix} - \frac{D_t^s + D_t}{2} \tag{A.40}$$

$$= \frac{1}{2}\begin{bmatrix} \frac{\Delta_i}{\Delta_k}\left(k'-k-\delta_p\frac{\Delta_k}{\Delta_i}(1+i)\right)^2\left(1-\frac{1}{2\left(1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa\right)}\right)\frac{1}{2\left(1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa\right)} - \delta_s\kappa\left[\frac{k'-k-\delta_p\frac{\Delta_k}{\Delta_i}(1+i)}{2\left(1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa\right)}\right]^2 \\ -h^s(t)(k-K^s)^2 - h(t)(k'-K)^2 \end{bmatrix} - \frac{D_t^s + D_t}{2} \tag{A.41}$$

$$= \frac{1}{2}\left[\frac{1}{1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa}\frac{\Delta_i}{4\Delta_k}\left(k'-k-\delta_p\frac{\Delta_k}{\Delta_i}(1+i)\right)^2 - h^s(t)(k-K^s)^2 - h(t)\left(k'-K\right)^2\right] - \frac{D_t^s + D_t}{2}$$

$$h^s(t) = \frac{1}{1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa}\frac{\Delta_i}{4\Delta_k}\left[1 - e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda(T-t)}-1\right)}\right]$$

$$\delta_f(1+r) = \delta_f(1-\delta_p)(1+i) - (1-\delta_f)\left(\frac{\Delta_i}{\Delta_k} - 2h^s(0)\right)(k_s - K^p) \tag{A.42}$$

$$k_s = K^p - \frac{\delta_f}{1-\delta_f}\frac{\Delta_k}{\Delta_i}\frac{1+r-(1-\delta_p)(1+i)}{1-\frac{1}{1+\delta_s\frac{\Delta_k}{\Delta_i}\kappa}\left(1-e^{-\frac{1-e^{-\lambda T}}{2}}\right)}$$

Proof of Proposition 4(i). Given $V_t(k)$ from (37), the optimal choice of the next-period reserve balance from (23) is given by

$$k_s = \arg\max_{k_{+1}} \left\{ -k_{+1} + \frac{V_0^p(k_{+1})}{1+r} \right\}.$$

The first order condition is given by

$$1 + r = (1-\delta)(1+i) + \mu T - \frac{\Delta_i}{\Delta_k}\left(k_s - \bar{k}\right) + 2h^p(0)\left(k_s - K^p\right). \tag{A.43}$$

Using the definition $K^p \equiv \frac{\Delta_k}{\Delta_i}\left[\mu T + (1-\delta)i - r\right] + \bar{k}$, then the solution of the above first order condition is $k_s = K^p$, which establishes part i.

Proof of Proposition 4(ii). The first order condition of ρ and q of the Nash bargaining problem (8) are given by

$$1 + \rho = \frac{W_\tau^d(k+q) - V_\tau^d(k) - W_\tau(k'-q) + V_\tau(k')}{2q}, \tag{A.44}$$

$$U^{p\prime}(k+q) + 1 - \delta = U'\left(k'-q\right) + 1, \tag{A.45}$$

implying

$$-\frac{\Delta_i}{\Delta_k}(k+q) + (1-\delta)i + \frac{\Delta_i}{\Delta_k}\bar{k} - \delta = -\frac{\Delta_i}{\Delta_k}\left(k'-q\right) + i + \frac{\Delta_i}{\Delta_k}\bar{k}, \tag{A.46}$$

$$q = \frac{k'-k}{2} - \frac{\delta}{2}\frac{\Delta_k}{\Delta_i}(1+i)$$

Given $W_t(k)$ and $V_t(k)$ from (11) and (16), the first order condition of ρ (A.2) becomes

$$\rho = \mu(T-\tau) + \frac{U(k+q) - U(k) - U(k'-q) + U(k') + h(\tau)\left[(k'-K)^2 - (k-K)^2\right]}{2q}, \tag{A.47}$$

$$\rho = r - \mu\tau + \frac{\Delta_i}{\Delta_k}K + \frac{-\frac{\Delta_i}{2\Delta_k}\left[(k+q)^2 - k^2 - (k'-q)^2 + k'^2\right] + h(\tau)(k'-k)(k'+k-2K)}{2q} \tag{A.48}$$

$$\rho = r - \mu\tau + \frac{\Delta_i}{\Delta_k}K + h(\tau)\left(\frac{k'+k}{2} - K\right) - \frac{\Delta_i}{\Delta_k}\frac{k+k'}{2}, \tag{A.49}$$

$$= r - \mu\tau - \left[\frac{\Delta_i}{\Delta_k} - h(\tau)\right]\left(\frac{k'+k}{2} - K\right),$$

which establishes part ii.

Proof of Proposition 3(iii). What we need to prove is to verify that (16) satisfies the HJB equation (13). Given $W_t(k)$ and $V_t(k)$ from (11) and (16), the LHS of the HJB equation (13) is

$$\begin{aligned}\frac{\partial}{\partial t}V_t(k) &= \frac{\partial}{\partial t}W_t^p(k) + (k-K)^2\frac{\partial}{\partial t}h^p(t) + \dot{D}_t^p \\ &= -\mu k + \frac{\Delta_i}{2\Delta_k}\sigma^2 + (k-K^p)^2\frac{\partial}{\partial t}h^p(t) + \dot{D}_t^p. \end{aligned} \tag{A.50}$$

The first order condition of ρ (A.2) implies

$$\begin{aligned}S_\tau^*(k,k') &= 0.5\left[S_\tau^*(k,k') + S_\tau^*(k',k)\right], \\ &= 0.5\left[W_\tau^p(k+q) - V_\tau^p(k) + W_\tau(k'-q) - V_\tau(k')\right], \\ &= 0.5\left[W_\tau^p(k+q) - \left[W_t^p(k) + h^p(t)(k-K^p)^2\right] + W_\tau(k'-q) - \left[W_t(k') + h(t)(k'-K)^2\right]\right] - 0.5(D_t^p + \\ &= 0.5\left[U^p(k+q) - U^p(k) - \delta q + U(k'-q) - U(k') - h^p(t)(k-K^p)^2 - h(t)(k'-K)^2\right] - 0.5(D_t^p + D_t \\ &= 0.5\begin{bmatrix} -\frac{\Delta_i}{2\Delta_k}q(2k+q) + \left[(1-\delta)i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q \\ +\frac{\Delta_i}{2\Delta_k}q(2k'-q) - \left[i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q - \delta q \\ -h^p(t)(k-K^p)^2 - h(t)(k'-K)^2 \end{bmatrix} - 0.5(D_t^p + D_t). \\ &= 0.5\begin{bmatrix} \frac{\Delta_i}{4\Delta_k}\left[k'-k-\delta\frac{\Delta_k}{\Delta_i}(1+i)\right]^2 \\ -h^p(t)(k-K^p)^2 - h(t)(k'-K)^2 \end{bmatrix} - 0.5(D_t^p + D_t). \end{aligned}$$

Hence we have

$$\begin{aligned}\int S_t^*(k,k')\,dF_t(k') &= \frac{1}{2}\int\left[\frac{\Delta_i}{4\Delta_k}(k'-k)^2 - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right]f_t(k')\,dk' - e0.5(D_t^p + \quad (A.56) \\ &= \frac{1}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[e^{-\lambda t}(k-K)^2 + \int(k'-K)^2 f_t(k')\,dk'\right] - e^{-\lambda t}D_t, \quad (A.57) \\ &= \frac{e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K)^2 + \sigma^2 t\right] - e^{-\lambda t}D_t. \end{aligned}$$

Then the RHS of the HJB equation (13) is

$$\begin{aligned}&-\mu k - \lambda\int S_t^*(k,k')\,dF_t(k') - \frac{\sigma^2}{2}\frac{\partial^2}{\partial k^2}V_t(k) \\ &= -\mu k - \frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K)^2 + \sigma^2 t\right] \quad (A.58) \\ &\quad +\lambda e^{-\lambda t}D_t - \frac{\sigma^2}{2}\left[\frac{\partial^2}{\partial k^2}W_t(k) + 2h(t)\right] \\ &= -\mu k - \frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K)^2 + \sigma^2 t\right] \quad (A.59) \\ &\quad +\lambda e^{-\lambda t}D_t + \frac{\sigma^2}{2}\left[\frac{\Delta_i}{\Delta_k} - 2h(t)\right] \end{aligned}$$

Matching the coefficients of $(k-K)^2$ in (A.7) and (A.15), $h(t)$ must satisfies the following ODE:

$$\frac{\partial}{\partial t}h(t) = -\frac{\lambda e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right] \Rightarrow \frac{\partial}{\partial t}\log\left[h(t) - \frac{\Delta_i}{4\Delta_k}\right] = -\frac{\lambda e^{-\lambda t}}{2}, \tag{A.60}$$
$$\Rightarrow h(t) = \frac{\Delta_i}{4\Delta_k}\left[1 - e^{-\frac{e^{-\lambda T}}{2}\left(e^{\lambda(T-t)}-1\right)}\right].$$

where we have used the fact that the terminal condition $V_T(k) = W_T(k)$ implies $h(T) = 0$.

QED.

A.5 Proof of Proposition 5

We verify Proposition 5 by checking that the value function $V_t^p(k)$ given by (37) in Proposition 5 sustaining an equilibrium.

Proof of Proposition 5(i). Given $V_t(k)$ from (37), the optimal choice of the next-period reserve balance from (23) is given by

$$k_s = \arg\max_{k_{+1}}\left\{-k_{+1} + \frac{V_0^p(k_{+1})}{1+r}\right\}.$$

The first order condition is given by

$$1 + r = (1-\delta)(1+i) + \mu T - \frac{\Delta_i}{\Delta_k}\left(k_s - \bar{k}\right) + 2h^p(0)\left(k_s - K^p\right). \tag{A.61}$$

Using the definition $K^p \equiv K - \delta\frac{\Delta_k}{\Delta_i}(1+i)$, then the solution of the above first order condition is

$$0 = -\delta(1+i) + \frac{\Delta_i}{\Delta_k}K - \frac{\Delta_i}{\Delta_k}k_s + 2h(0)\left(k_s - K^p\right) \tag{A.62}$$
$$k_s = \frac{-\delta(1+i) + \frac{\Delta_i}{\Delta_k}K - 2h(0)K^p}{\frac{\Delta_i}{\Delta_k} - 2h(0)} \tag{A.63}$$
$$= K - \delta\frac{\Delta_k}{\Delta_i}(1+i) \tag{A.64}$$
$$= K^p,$$

which establishes part i.

Proof of Proposition 5(ii). The first order condition of ρ and q of the Nash bargaining problem (8) are given by

$$1+\rho=\frac{W_{\tau}^{d}\left(k+q\right)-V_{\tau}^{d}\left(k\right)-W_{\tau}\left(k'-q\right)+V_{\tau}\left(k'\right)}{2q}, \tag{A.65}$$

$$U^{p\prime}\left(k+q\right)+1-\delta=U'\left(k'-q\right)+1, \tag{A.66}$$

implying

$$-\frac{\Delta_i}{\Delta_k}\left(k+q\right)+\left(1-\delta\right)i+\frac{\Delta_i}{\Delta_k}\bar{k}-\delta=-\frac{\Delta_i}{\Delta_k}\left(k'-q\right)+i+\frac{\Delta_i}{\Delta_k}\bar{k}, \tag{A.67}$$

$$q=\frac{k'-k}{2}-\frac{\delta}{2}\frac{\Delta_k}{\Delta_i}\left(1+i\right).$$

Then we have

$$U^{p}\left(k+q^{p}\right)-U^{p}\left(k\right)-\delta q^{p}-U\left(k'-q^{p}\right)+U\left(k'\right) \tag{A.68}$$

$$=-\frac{\Delta_i}{2\Delta_k}\left[\left(k+q^{p}\right)^{2}-k^{2}-\left(k'-q^{p}\right)^{2}+k'^{2}\right]-\delta\left(1+i\right)q^{p} \tag{A.69}$$

$$=-\frac{\Delta_i}{2\Delta_k}q^{p}\left[2k+q^{p}+2k'-q^{p}+\delta\frac{2\Delta_k}{\Delta_i}\left(1+i\right)\right] \tag{A.70}$$

$$=-\frac{\Delta_i}{\Delta_k}q^{p}\left[k+k'+\delta\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right]$$

Also, we have

$$\left(k'-K\right)^{2}-\left(k-K^{p}\right)^{2}=\left(k'-K\right)^{2}-\left(k-K+\delta\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right)^{2} \tag{A.71}$$

$$=2q^{p}\left[k'+k-2K+\delta\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right]$$

Given $W_{t}^{p}\left(k\right)$ and $V_{t}^{p}\left(k\right)$ from (27) and (37), the first order condition of ρ becomes

$$\rho=\mu\left(T-\tau\right)+\frac{U^{p}\left(k+q\right)-U^{p}\left(k\right)-\delta q-U\left(k'-q\right)+U\left(k'\right)+h\left(\tau\right)\left[\left(k'-K\right)^{2}-\left(k-K^{p}\right)^{2}\right]}{2q}, \tag{A.72}$$

$$\rho=\mu\left(T-\tau\right)-\frac{\Delta_i}{\Delta_k}\frac{k+k'+\delta\frac{\Delta_k}{\Delta_i}\left(1+i\right)}{2}+h\left(\tau\right)\left[k'+k-2K+\delta\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right], \tag{A.73}$$

$$=\mu\left(T-\tau\right)-\frac{\Delta_i}{\Delta_k}K-\left[\frac{\Delta_i}{\Delta_k}-h\left(\tau\right)\right]\left(\frac{k'+k}{2}-K-\frac{\delta}{2}\frac{\Delta_k}{\Delta_i}\left(1+i\right)\right), \tag{A.74}$$

$$=-\mu\tau-\left(i-r\right)-\frac{\Delta_i}{\Delta_k}\bar{k}$$

which establishes part ii.

Proof of Proposition 5(iii). What we need to prove is to verify that (16) satisfies the HJB equation (13). Given $W_t(k)$ and $V_t(k)$ from (11) and (16), the LHS of the HJB equation (13) is

$$\begin{aligned}\frac{\partial}{\partial t}V_t(k) &= \frac{\partial}{\partial t}W_t^p(k) + (k-K)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t^p \\ &= -\mu k + \frac{\Delta_i}{2\Delta_k}\sigma^2 + (k-K^p)^2\frac{\partial}{\partial t}h(t) + \dot{D}_t^p. \end{aligned} \tag{A.75}$$

The first order condition of ρ (A.2) implies

$$\begin{aligned}S_\tau^*(k,k') &= 0.5\left[S_\tau^*(k,k') + S_\tau^*(k',k)\right], \\ &= 0.5\left[W_\tau^p(k+q) - V_\tau^p(k) + W_\tau(k'-q) - V_\tau(k')\right], \\ &= 0.5\left[W_\tau^p(k+q) - \left[W_t^p(k) + h^p(t)(k-K^p)^2\right] + W_\tau(k'-q) - \left[W_t(k') + h(t)(k'-K)^2\right]\right] - 0.5(D_t^p + \\ &= 0.5\left[U^p(k+q) - U^p(k) - \delta q + U(k'-q) - U(k') - h^p(t)(k-K^p)^2 - h(t)(k'-K)^2\right] - 0.5(D_t^p + D(\\ &= 0.5\begin{bmatrix} -\frac{\Delta_i}{2\Delta_k}q(2k+q) + \left[(1-\delta)i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q \\ +\frac{\Delta_i}{2\Delta_k}q(2k'-q) - \left[i + \frac{\Delta_i}{\Delta_k}\bar{k}\right]q - \delta q \\ -h^p(t)(k-K^p)^2 - h(t)(k'-K)^2 \end{bmatrix} - 0.5(D_t^p + D_t). \\ &= 0.5\begin{bmatrix} \frac{\Delta_i}{4\Delta_k}\left[(k'-K) - (k-K^p)\right]^2 \\ -h(t)\left[(k-K^p)^2 + (k'-K)^2\right] \end{bmatrix} - 0.5(D_t^p + D_t). \end{aligned}$$

Hence we have

$$\begin{aligned}\int S_t^*(k,k')\,dF_t(k') &= \frac{1}{2}\int\left[\frac{\Delta_i}{4\Delta_k}(k'-k)^2 - h(t)\left[(k-K)^2 + (k'-K)^2\right]\right]f_t(k')\,dk' - e0.5(D_t^p + \\ &= \frac{1}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[e^{-\lambda t}(k-K^p)^2 + \int(k'-K)^2 f_t(k')\,dk'\right] - e^{-\lambda t}D_t, \\ &= \frac{e^{-\lambda t}}{2}\left[\frac{\Delta_i}{4\Delta_k} - h(t)\right]\left[(k-K^p)^2 + \sigma^2 t\right] - e^{-\lambda t}D_t. \end{aligned} \tag{A.81, A.82}$$

where we have used the fact that the terminal condition $V_T(k) = W_T(k)$ implies $h(T) = 0$.

QED.

B Details of Bank-level Data and Measurement

In this section, we describe how we collect the bank-level data and construct various measurement we used for the summary statistics and estimation.

B.1 Sources for the U.S. data

Financial data of banks in the U.S. come from the following:

- **Call Reports**. This is the source of the subsidiary-level data. In particular, we use form FFIEC 031 for banks with both domestic and foreign offices, form FFIEC 041 for banks with domestic offices only, and form FFIEC 002 for U.S. branches and agencies of foreign banks (FBO). These forms are available for download at the Federal Financial Institutions Examination Council (FFIEC) and the Federal Reserve Bank of Chicago.[4]

- **FR Y-9C**. This is the source of the consolidated data at the level of holding companies (for bank holding companies, savings and loan holding companies, and intermediate holding companies) with total consolidated assets of $1 billion or more (prior to 2015, this threshold was just $500 million). This is available for download at the Federal Reserve Bank of Chicago and National Information Center (NIC).[5]

- **Attributes, relationships, and transformations tables**. This is the source of the ownership structure of holding companies upon their subsidiaries. They are available for download at National Information Center (NIC).[6]

- **10Q and 10K**. This is the source of government sponsored enterprises (GSE) data. These forms are available for download at the Security Examination Commission (SEC).[7] The GSE data is fully available since 2006Q1.

- **H.4.1**. This is the source of the balance sheet of the Federal Reserve System and factors affecting reserve balances of depository institutions. This is available for download at the Board of Governors of the Federal Reserve System.[8]

- **Time series of the economy**. It is available for download at the Federal Reserve Bank of St Louis (FRED).[9]

[4] https://cdr.ffiec.gov/public/ and https://www.chicagofed.org/banking/financial-institution-reports/commercial-bank-structure-data

[5] https://www.chicagofed.org/banking/financial-institution-reports/bhc-data and https://www.ffiec.gov/npw/FinancialReport/FinancialDataDownload?selectedyear=2021

[6] https://www.ffiec.gov/npw/FinancialReport/DataDownload

[7] https://www.sec.gov/edgar/searchedgar/companysearch.html

[8] https://www.federalreserve.gov/releases/h41/

[9] https://fred.stlouisfed.org/

B.1.1 Consolidated sample

Whenever possible, we always measure variables at the holding-company level. We think that holding companies are desirable sample unit because first, usually the subsidiaries' reserves, which are not directly observable in the Call reports, are corresponded by their holding company's master accounts in the Federal Reserve Banks, which are observable. Second, sometimes the decision of Federal Funds trading is delegated to the holding company. Third, it avoids double-counting the intra-holding-company Federal Funds trades, which are different from those normal interbank transactions.

Consolidation is done by referring to items filed in FR Y-9C. For the holding companies not eligible to file FR Y-9C, or items not available from FR Y-9C, we directly consolidate the Call report items from the subsidiary level up to the topmost holding-company level, based on the relationships table from NIC. In this appendix, we always refer i as the index for holding companies and j as the index for i's subsidiaries. We focus on banks that have positive amounts of asset and total reserve balances, and trade at least once in the Federal funds market in the data sample.

B.1.2 Excess Reserves

The formula to measure excess reserves bank i holds at the Federal Reserve account at the end of quarter t is given by

$$\textit{Excess Reserves}_{it} = \textit{Total Reserves}_{it} - \left\{\sum\nolimits_j \textit{Required Reserves}_{jt} - \textit{Vault Cash}_{it}\right\}_+ .$$

$\textit{Total Reserves}_{it}$ is measured by item RCFD0090 in FR Y-9C ("Balances due from Federal Reserve Banks"). $\textit{Vault Cash}_{it}$ is approximated by item RCON0080 in FR Y-9C ("Currency and coin"). The formula to calculate $\textit{Required Reserves}_{jt}$ is based on subsidiary j's net transaction accounts. For example, the formula of reserve requirement in 2010 is given by the following table:

Table 8: Reserve requirement in 2010

Net transaction accounts	% required
\$0 to \$10.7 million	0
More than \$0.7 million to \$55.2 million	3
More than \$55.2 million	10

The table is updated every year.[10] To estimate net transaction acccounts, we substract item RCON 2215 of j's Call Report ("Total Transaction Accounts") from the sum of item RCFD 0083 ("Balances due from depository institutions in the U.S.: U.S. branches and agencies of foreign banks (including their IBFs)"), item RCFD 0085 ("Balances due from depository institutions in the U.S.:

[10] The historical reserve requirement can be found on https://www.federalreserve.gov/monetarypolicy/reservereq.htm

Other depository institutions in the U.S. (including their IBFs)") and item RCON 0020 ("Cash items in process of collection and unposted debit"). Then we apply the historical reserve requirement formulas on net trans accounts to calculate $\textit{Required Reserves}_{jt}$.

To measure the excess reserves bank i holds before entering the interbank market, we subtract the net Federal funds purchase and net repo borrowing from $\textit{Excess Reserves}_{it}$. Thus the pre-trade excess reserves is given by

$$\begin{aligned}\textit{Excess Reserves pre-trade}_{it} = \textit{Excess Reserves }_{it} \text{ - } \textit{Federal funds purchased}_{it} \\ + \textit{ Federal funds sold}_{it}\text{-}\textit{Repo}_{it}+\textit{Reverse Repo}_{it}.\end{aligned} \tag{B.83}$$

By dividing the pre-trade excess reserves by bank assets, we obtain the measure k_{it} in the regressions.

B.2 Sources for the China data

We construct a bank-level dataset for Chinese banks from annual reports available in the China Stock Market & Accounting Research (CSMAR) database. The reports provide year-end consolidated balance sheets, which we aggregate to the top-holder level. Our sample spans 2007–2024, covering 452 banks and approximately 90% of total banking assets in China.

Data of reserve and interbank loans come from the following:

- **Total Reserves** – measured by "Cash and Balances with the Central Bank" (xianjin ji cunfang zhongyang yinhang kuanxiang).
- **Required Reserves** – computed as the reserve requirement ratio multiplied by a bank's total deposits (xishou cunkuan).
- **Excess Reserves** – equal to total reserves minus required reserves.
- **Unsecured Interbank Lending** – measured by "Net Placements with Banks and Other Financial Institutions" (chaichu zijin jinge).
- **Unsecured Interbank Borrowing** – measured by "Placements from Banks and Other Financial Institutions" (chairu zijin).
- **Secured Interbank Lending** – measured by "Net Financial Assets Purchased under Resale Agreements" (mairu fanshou jinrong zichan jinge).
- **Secured Interbank Borrowing** – measured by "Funds from Financial Assets Sold under Repurchase Agreements" (maichu huigou jinrong zichankuan).
- **Pre-trade Reserve Balances** – calculated as post-trade reserve balances minus secured and unsecured interbank borrowing plus secured and unsecured interbank lending.

C Description of the Erlangshen–MegatronBERT–1.3B Model

This appendix provides additional detail on the large language model used to construct our sentiment measure. We rely on the Erlangshen–MegatronBERT–1.3B model, a Chinese transformer-based language model developed by the IDEA Research Institute. The model follows the BERT architecture but scales the parameter size to approximately 1.3 billion, substantially expanding its representational capacity relative to the standard 110M-parameter BERT. The transformer layers, self-attention heads, and hidden dimensions are enlarged proportionally, allowing the model to better encode long-range linguistic dependencies and context-specific semantic information in Chinese text.

The model is pre-trained using a masked-language-modeling (MLM) objective on a large collection of Chinese textual materials. The pre-training corpus includes Chinese Wikipedia, major online news platforms, government documents, web articles, and other high-quality curated sources. These corpora span formal, journalistic, governmental, and colloquial registers, enabling the model to learn syntactic structure, semantic relationships, and contextual meaning across a wide range of domains. During pre-training, tokens are randomly masked and the model is tasked with predicting the missing words based on surrounding context, which teaches the model to internalize deep contextual representations of Chinese language.

Following pre-training, the model is fine-tuned on supervised Chinese sentiment classification datasets that contain labeled examples of positive, neutral, and negative sentiment. Fine-tuning adjusts the output layer of the model to accurately map contextual embeddings into sentiment categories. This step converts the model's general linguistic knowledge into sentiment-specific classification proficiency.

The combination of large-scale pre-training on diverse Chinese corpora, a substantial parameter count, and dedicated sentiment fine-tuning allows the Erlangshen–MegatronBERT–1.3B model to produce high-resolution sentiment assessments for Chinese text. This makes the model well suited for applications in financial text analysis, policy communication, and empirical research using news-based sentiment measures.

D Construction of the BERT-Based Sentiment Measure

This appendix describes the construction of the sentiment measure using the Erlangshen–MegatronBERT–1.3B Chinese language model. The procedure follows standard practices in transformer-based text analysis.

D.1 Preprocessing

The original newspaper articles are all in simplified Chinese, which is consistent with the model's training corpus. We then remove Chinese punctuation, special characters, and numerical strings. The cleaned text is tokenized into subword units using the model's tokenizer. Because articles often exceed the model's maximum context window (512 tokens), we partition the token sequence into non-overlapping chunks of length $L_{\text{chunk}} = 510$, reserving two positions for the `[CLS]` token at the beginning (classification token) and the `[SEP]` token at the end (separator token). This chunking procedure allows us to process arbitrarily long documents without discarding content.

D.2 Chunk-Level Classification

For each chunk, we reconstruct the corresponding text string and re-encode it using the tokenizer with fixed-length padding. Each encoded chunk is passed through the sentiment classifier, which returns a vector of logits associated with the sentiment classes. We convert the logits to class probabilities using the softmax transformation,

$$p_k = \frac{\exp(\ell_k)}{\sum_{j=1}^{K} \exp(\ell_j)},$$

where ℓ_k denotes the logit for class k and K is the number of sentiment labels. The classifier's first and last indices correspond to negative and positive sentiment, respectively. We denote the associated probabilities by $P(\text{neg})$ and $P(\text{pos})$.

D.3 Continuous Sentiment Score

We map the classifier's output into a continuous sentiment score using the difference between the positive and negative probabilities,

$$s = P(\text{pos}) - P(\text{neg}).$$

This transformation yields a bounded score in $[-1, 1]$ and captures both the polarity and the intensity of sentiment. Scores near one (negative one) indicate strongly positive (negative) sentiment, while scores near zero reflect neutral or mixed content. Using the difference rather than discrete class predictions allows us to retain information about the model's confidence and reduces sensitivity to the presence of an intermediate neutral class.

D.4 Aggregation to the Article Level

If the article includes multiple chunks, we compute the overall sentiment measure as the arithmetic average of the chunk-level scores,

$$S_{\text{article}} = \frac{1}{N} \sum_{i=1}^{N} s_i,$$

where N denotes the number of chunks. This averaging procedure smooths chunk-level fluctuations and produces a stable article-level sentiment index suitable for regression analysis and time-series applications.

E Examples of Newspaper Articles on the U.S.–China Tension

This appendix presents examples of articles on the U.S.–China tension from *People's Daily*, *Guangming Daily*, and *Economic Daily*. We present two articles that are apparently positive on the U.S.–China tension, while the other two articles that show negative sentiment on the U.S.–China tension.

E.1 Negative Article 1

Original article in Chinese:

人民日报 2018 年 12 月 15 日第 03 版要闻

标题：中方坚决反对 美国国会涉藏法案粗暴干涉中国内政

本报北京 12 月 14 日电 （记者张慧中）针对美国国会日前通过“2018 年对等进入西藏法案”，外交部发言人陆慷 14 日表示，有关法案罔顾事实，粗暴干涉中国内政，中方对此坚决反对。

当日例行记者会上，有记者问：美国国会通过法案要求允许美国外交官、记者和游客进入西藏。如果以上人士无法进入西藏，美国国会希望拒绝中国官员进入美国。你对此有何评论？

陆慷说：“美国国会通过的有关法案罔顾事实，粗暴干涉中国内政，违反国际关系基本准则，中方对此坚决反对，并已向美方提出严正交涉。”

他表示，西藏事务纯属中国内政，不容其他国家干涉。外国人员进入西藏，可以通过正常渠道办理。事实上，每年都有大量中外人士到西藏访问、旅游和经商。就拿美国来说，自 2015 年以来就有将近 4 万人次的美国人士到西藏，这其中就包括美国国会众议院少数党领袖、参议员等。这些都充分证明，美国国会法案对中方的指责完全站不住脚，也是中国政府和人民绝不能接受的。

“我们敦促美国行政部门立即采取有效措施，阻止该案签署成法，以免严重损害中美关系和两国在重要领域的合作。”陆慷说。

Translation in English:

Newspaper: *People's Daily*, December 15, 2018.

Title: China Firmly Opposes the U.S. Congress's Tibet-Related Bill that Rudely Interferes in China's Internal Affairs

(Beijing, December 14 — by reporter Zhang Huizhong) In response to the U.S. Congress recently passing the "Reciprocal Access to Tibet Act of 2018," Foreign Ministry spokesperson Lu Kang stated on the 14th that the bill ignores facts and rudely interferes in China's internal affairs, and China firmly opposes it.

At the regular press conference that day, a reporter asked: The U.S. Congress passed a bill requiring that American diplomats, journalists, and tourists be allowed to enter Tibet. If these individuals are not allowed to enter Tibet, the U.S. Congress hopes to refuse Chinese officials entry into the United States. What is your comment on this?

Lu Kang said: "The bill passed by the U.S. Congress ignores facts, rudely interferes in China's internal affairs, and violates the basic norms of international relations. China firmly opposes it and has lodged stern representations with the U.S. side."

He stated that Tibet-related affairs are purely China's internal affairs and brook no interference from other countries. Foreign personnel who wish to enter Tibet may do so through normal procedures. In fact, every year large numbers of Chinese and foreign individuals visit, travel, or conduct business in Tibet. Taking the United States as an example, since 2015 there have been nearly 40,000 American visits to Tibet, including the U.S. House Minority Leader, senators, and others. All of this fully proves that the accusations made by the U.S. Congress in its bill are completely untenable and absolutely unacceptable to the Chinese government and people.

"We urge the U.S. executive branch to immediately take effective measures to prevent the bill from being signed into law, so as to avoid seriously damaging China–U.S. relations and cooperation between the two countries in important areas," Lu Kang said.

E.2 Negative Article 2

Original article in Chinese:

光明日报 2019 年 12 月 01 日第 08 版国际新闻

标题：奉劝美方照照镜子，摒弃人权双重标准

（新华社北京 11 月 30 日电　新华社评论员）

日前，美方将所谓“2019 年香港人权与民主法案”签署成法，打着所谓“人权”与“民主”的幌子粗暴干涉中国内政，在香港亟须止暴制乱、恢复秩序的时刻为暴力分子撑腰打气，再次暴露其在人权领域的伪善面目和赤裸裸的双重标准。

美方惯于对他国人权状况指手画脚，动辄以所谓维护人权为名义对别国发起制裁，却对自身劣迹斑斑的人权纪录避而不见。

暴力犯罪案件 120 多万起、谋杀案件 1.7 万多起、强奸案件 13 万多起……从美国联邦调查局有关 2017 年美国犯罪情况的报告中已可管窥美国公民权利遭受侵害之现状。枪击事件在美国社会越发司空见惯，然而在利益集团的掌控下，控枪早已被认定为美国社会不可能实现的目标。

美国长期存在系统性种族歧视。非洲裔更容易成为警方枪击的受害者，少数族裔遭受司法歧视，涉种族歧视的仇恨犯罪屡创新高。更有网络监控侵犯个人隐私、不人道的移民政策强制儿童与父母分离，这些糟糕的人权纪录受到许多国际机构的公开批评。设在新西兰的“人权评估计划”联合创始人安妮·玛丽·布鲁克指出：“在国家所提供的安全保障方面，美国的表现远低于其他国家。”

美国海外人权纪录之糟糕同样触目惊心。多年来，美国在海外持续展开军事行动，造成大量无辜平民伤亡，引发众多国家政府和民众强烈愤怒。美政府还利用军事干涉、政府更迭等手段造成他国局势动荡，通过任意制裁和封锁置他国人民于水深火热之中，造成人权灾难比比皆是。从关塔那摩监狱的酷刑黑狱，到拒绝推动联合国一系列核心人权公约的批准进程，美国欠下的人权账数不胜数。

尽管如此，美国一些政客却始终把“人权”二字挂在嘴边，大搞双重标准。新中国成立 70 年来，中国人民享受着前所未有的权利和自由，中国人权事业取得举世公认的成就。香港回归以来，“一国两制”“港人治港”、高度自治的方针得到贯彻落实，香港居民享有的各项权利和自由依法得到充分保障。然而，美方一些政客不仅对此选择无视，反而假借“人权”之名为香港暴力犯罪分子张目，为激进势力提供保护伞，将广大香港市民的生命和财产安全置于危险的境地。

美方的行径，越发让包括香港同胞在内的 14 亿中国人民看清，他们哪里是在关心别人的人权？利用人权问题干涉别国内政，以人权为幌子遏制他国发展，以人权为“遮羞布”攫取自身政治经济利益，才是藏在“人权卫士”假面下的真实意图。

美方的司马昭之心，遮不了世人的眼睛。俄联邦委员会国际事务委员会主席科萨切夫指出，美国将人权问题作为对不屈从美国的国家实施制裁和打击的手段。比利时鲁汶大学教授、政治评论员让·布里克蒙认为，美国政府对人权的承诺就是一个“笑话”，人权一直被美国用作发动战争、采取单边主义行动和攻击他人的“武器”和“借口”。

中国古语云：“君子有诸己而后求诸人，无诸己而后非诸人。”奉劝美方好好照照镜子，在挥舞人权大棒之前，怎么也得洗洗自己在人权问题上的一身污泥。

Translation in English:

Newspaper: *Guangming Daily*, December 1, 2019.

Title: Urging the U.S. Side to Look in the Mirror and Abandon Its Human Rights Double Standards

(Xinhua News Agency, Beijing, November 30 — Commentary by a Xinhua News Agency commentator)

Recently, the U.S. signed into law the so-called "Hong Kong Human Rights and Democracy Act of 2019," using the banners of "human rights" and "democracy" to rudely interfere in China's internal affairs. At a time when Hong Kong urgently needs to stop violence and restore order, the U.S. is cheering on violent offenders, once again exposing its hypocritical face and naked double standards in the field of human rights.

The U.S. is accustomed to pointing fingers at other countries' human rights conditions and frequently imposes sanctions on other countries in the name of so-called human rights protection, yet it turns a blind eye to its own human rights record, which is full of stains.

More than 1.2 million violent crime cases, over 17,000 murders, over 130,000 rapes... From the FBI's report on U.S. crime in 2017, one can already see the situation of American civil rights being violated. Gun violence has become increasingly commonplace in American society, yet under the control of interest groups, gun control has long been deemed an impossible goal for the United States.

The U.S. has long had systemic racial discrimination. African Americans are more likely to fall victim to police shootings; minorities face judicial discrimination; hate crimes involving racial discrimination repeatedly hit new highs. In addition, online surveillance infringes on personal privacy, and inhumane immigration policies forcibly separate children from parents. These terrible human rights records have been openly criticized by many international organizations. Anne-Marie Brook, co-founder of the Human Rights Measurement Initiative in New Zealand, pointed out: "In terms of the security provided by a state, the performance of the United States is far below that of other countries."

The U.S. human rights record overseas is equally shocking. For many years, the U.S. has carried out continuous military operations abroad, resulting in large numbers of innocent civilian casualties and inciting strong anger among the governments and peoples of many countries. The U.S. government has also caused turmoil in other countries through military intervention and government overthrows, and has plunged foreign populations into misery through arbitrary sanctions and blockades, producing one human rights disaster after another. From the torture and dark prisons of Guantamo Bay to its refusal to advance the ratification of a series of core UN human rights conventions, the U.S. owes a massive human rights debt.

Despite this, some American politicians always keep the words "human rights" on their lips and vigorously apply double standards. In the 70 years since the founding of New China, the Chinese people have enjoyed unprecedented rights and freedoms, and China's human rights achievements have

earned global recognition. Since Hong Kong's return, the principles of "One Country, Two Systems," "Hong Kong people administering Hong Kong," and a high degree of autonomy have been thoroughly implemented, and the various rights and freedoms enjoyed by Hong Kong residents have been fully protected in accordance with the law. Yet some U.S. politicians not only ignore this, but instead use the name of "human rights" to speak up for violent criminals in Hong Kong, provide a protective umbrella for radical forces, and place the safety of the lives and property of the vast majority of Hong Kong residents in danger.

The actions of the U.S. make the 1.4 billion Chinese people, including compatriots in Hong Kong, increasingly see clearly: are they really concerned about others' human rights? Interfering in other countries' internal affairs under the pretext of human rights, using human rights as a cover to contain the development of other countries, and using human rights as a "fig leaf" to seize their own political and economic interests—this is the true intention hidden behind the mask of the so-called "human rights defender."

The ulterior motives of the U.S. cannot blind the world. Konstantin Kosachev, chairman of the International Affairs Committee of Russia's Federation Council, pointed out that the U.S. uses human rights issues as a means to sanction and attack countries that refuse to obey the United States. Jean Bricmont, professor at the University of Leuven in Belgium and political commentator, believes that the U.S. government's commitment to human rights is a "joke," and that human rights have always been used by the U.S. as a "weapon" and "excuse" to wage wars, take unilateral actions, and attack others.

As an ancient Chinese saying goes: "A gentleman first demands of himself before demanding of others; he condemns others only when he himself is free of faults." We advise the U.S. to look carefully in the mirror. Before waving the human rights stick, it should at least wash off its own filth on human rights.

E.3 Positive Article 1

Original article in Chinese:

人民日报 2007 年 12 月 07 日第 01 版要闻

标题：胡锦涛主席同布什总统通电话

新华社北京 1 2 月 6 日电 国家主席胡锦涛 6 日晚应约同美国总统布什通电话。

胡锦涛表示，在即将过去的一年里，中美关系进一步向前发展。双方在战略层面的对话交流深入进行，经贸关系持续快速发展，其他重要领域的合作取得积极成果，在重大国际和地区问题上保持着密切磋商和协调。第三次中美战略经济对话和第五次中美战略对话即将在华举行，中方愿同美方一道努力，推动对话达成更多共识、取得更多成果，为全面推进中美建设性合作关系作出新贡献。

胡锦涛指出，妥善处理台湾问题是确保中美关系稳定健康发展的关键。台湾当局正变本加厉地推行“入联公投”等“台独”分裂活动，对台海和平稳定构成严重威胁和挑战。坚决反对和制止“台独”，维护台海和平稳定，符合中美共同战略利益。

布什说，美中关系很重要，美方高度重视。美中战略经济对话和美中战略对话是双方开展合作的成功平台，希望对话取得更多进展。布什表示，美方将同中方在台湾问题上保持合作。

在谈到伊朗核问题时，布什表示，美方愿通过对话等外交手段解决伊朗核问题，希望联合国继续采取必要行动，促使伊朗暂停铀浓缩活动。

胡锦涛强调，中方一贯主张，通过外交谈判和平解决伊朗核问题，维护地区和平稳定，符合各方共同利益。中方愿为妥善解决伊朗核问题继续发挥建设性作用。

关于朝鲜半岛核问题，胡锦涛指出，目前共同声明起步行动得到全面落实，第二阶段行动已顺利启动，各方应抓住难得机遇，坚持对话，逐步实现半岛无核化目标。

布什表示，六方会谈是解决朝核问题的最佳途径，美方高度赞赏中方发挥的重要作用，美方愿同其他各方继续努力，推动六方会谈进程。

Translation in English:

Newspaper: *People's Daily*, December 7, 2007.

Title: President Hu Jintao Speaks by Telephone with President Bush

Xinhua News Agency, Beijing, December 6 — On the evening of December 6, President Hu Jintao spoke by telephone with U.S. President George W. Bush at Bush's request.

Hu Jintao stated that over the past year, China–U.S. relations have made further progress. The two sides have conducted in-depth dialogue and exchanges at the strategic level, economic and trade relations have continued to grow rapidly, cooperation in other important areas has achieved positive results, and the two countries have maintained close consultation and coordination on major international and regional issues. The third round of the China–U.S. Strategic Economic Dialogue and the fifth round of the China–U.S. Strategic Dialogue will soon be held in China. China is willing to work together with the U.S. side to push these dialogues to reach more consensus, achieve more results, and make new contributions to comprehensively advancing the China–U.S. constructive cooperative relationship.

Hu Jintao pointed out that properly handling the Taiwan issue is key to ensuring the stable and healthy development of China–U.S. relations. The Taiwan authorities are intensifying their "referendum on joining the United Nations" and other "Taiwan independence" separatist activities, which pose a serious threat and challenge to peace and stability in the Taiwan Strait. Resolutely opposing and stopping "Taiwan independence," and safeguarding peace and stability in the Taiwan Strait, conforms to the shared strategic interests of China and the United States.

Bush said that U.S.–China relations are very important and that the U.S. side attaches great importance to them. The U.S.–China Strategic Economic Dialogue and the U.S.–China Strategic Dialogue are successful platforms for cooperation between the two sides, and he hopes the dialogues will yield further progress. Bush stated that the U.S. side will maintain cooperation with China on the Taiwan issue.

Regarding the Iranian nuclear issue, Bush said that the U.S. is willing to resolve the Iranian nuclear issue through dialogue and other diplomatic means, and hopes that the United Nations will continue to take necessary actions to urge Iran to suspend its uranium enrichment activities.

Hu Jintao emphasized that China has always advocated resolving the Iranian nuclear issue peacefully through diplomatic negotiations, and that maintaining regional peace and stability accords with the common interests of all parties. China is willing to continue to play a constructive role in properly resolving the Iranian nuclear issue.

Concerning the nuclear issue on the Korean Peninsula, Hu Jintao pointed out that the initial actions of the Joint Statement have been fully implemented, the second-phase actions have been smoothly launched, and all parties should seize this valuable opportunity, persist in dialogue, and gradually achieve the goal of denuclearizing the peninsula.

Bush stated that the Six-Party Talks are the best way to resolve the DPRK nuclear issue. The

U.S. side highly appreciates the important role China has played, and the U.S. is willing to continue working with all parties to promote the Six-Party Talks process.

E.4 Positive Article 2

Original article in Chinese:

经济日报 2010 年 12 月 17 日第 03 版要闻

标题：中美商贸联委会在华盛顿举行

新华社华盛顿 12 月 15 日　　（记者蒋旭峰　刘丽娜　杜静）　第二十一届中美商贸联委会于 14 日至 15 日在美国首都华盛顿举行，中国国务院副总理王岐山与美国商务部部长骆家辉、贸易代表柯克共同主持会议。

王岐山表示，当前世界经济正在缓慢复苏。面对极为复杂的形势，中美作为最大的发展中国家和最大的发达国家，要坚定信心，加强合作，共同应对挑战，促进两国以及全球经济强劲、可持续、平衡增长。

王岐山指出，经贸合作是中美关系的重要基石。中美经济的高度互补性决定了双方不是零和博弈的对手，而是互利共赢的伙伴。当前，中国正在制定“十二五”规划，加快转变经济发展方式，调整经济结构，扩大内需，改善民生。美国也在推动经济转型，发展新能源等新兴产业，实施出口倍增计划。中美商贸联委会是两国经贸合作的重要平台，为中美关系健康稳定发展发挥了重要作用。希望双方以本届联委会为契机，努力达成更多互利共赢的成果。

骆家辉和柯克表示，美中互为重要经贸伙伴，保持两国经贸关系健康发展，对于两国和世界经济至关重要。美中两国应共同努力，通过商贸联委会平台，增加交流沟通，妥善处理经贸合作中的问题，扩大互利共赢成果，造福两国人民。

会议总结了上届联委会以来双方的工作，就当前双边经贸关系中的重要问题进行了讨论，取得了一系列共识。双方同意，积极推进中美全面经济合作；继续保持商业和投资环境开放、公平、透明，对外国投资持开放态度；积极推进农业、能源环保、智能电网国际标准制定、快递监管等领域的交流与合作；探讨建立知识产权双边合作框架。

中方重申，在基于科学原则、满足中国检验检疫条件的前提下，恢复进口 30 月龄以下剔骨牛肉和带骨牛肉。中方宣布，解除对爱达荷州、肯塔基州的禽流感禁令；深入开展打击侵犯知识产权和制售假冒伪劣商品专项行动，并积极推进软件正版化工作；将在 2011 年提交修改后的加入世贸组织《政府采购协定》第三份出价清单；在国家级风电特许权项目机组招标中，对风电设备在国内外应用的业绩同样对待；在 2011 年对到期的《重大技术装备自主创新指导目录》做出调整；对 4G 技术标准，电信运营企业可以根据市场原则和自身需要相关范围中自主选择；进一步简化手机型号核准与进网许可检测程序，调整收费标准；尽快设立假冒药品投诉举报中心；实施中国公民赴美团队旅游合作谅解备忘录框架下第三阶段计划。

美方表示，将认真考虑中方对市场经济地位的关注，愿意与中方加强沟通，加快最终承认中国市场经济地位的进程；在推进出口管理体制改革进程中，认真考虑中方提出的评论意见；积极考虑中方企业关于进口受控民用高技术物项的申请；遵循世贸组织规则，慎用贸易救济措施；尽快解决中国熟制禽肉输美问题；在 2011 年上半年完成中国亚洲梨的风险评估程序，尽快出台亚洲梨输美的法规草案；尽快公布最终的《中国木制工艺品输美法规》将法规适用范围缩小为可能存在风险的产品，并按照双方同意的加热处理方式恢复贸易；双方同意成立盆景检疫技术专家组，研究解决存在的问题；美方将加快中国西电捷通公司专利申请的审批程序；尽快实施对中方商标审查员的培训项目。

双方还签署了多项经贸合作文件，内容涉及投资促进、农业、检验检疫、能源、水利、贸易统计等领域。

Translation in English:

Newspaper: *Economic Daily*, December 17, 2010.

Title: China–U.S. Joint Commission on Commerce and Trade Held in Washington

Xinhua News Agency, Washington, December 15 — (Reporters Jiang Xufeng, Liu Lina, Du Jing)

The 21st Session of the China–U.S. Joint Commission on Commerce and Trade (JCCT) was held in Washington, D.C., from December 14 to 15. Chinese Vice Premier Wang Qishan co-chaired the meeting together with U.S. Secretary of Commerce Gary Locke and U.S. Trade Representative Ron Kirk.

Wang Qishan stated that the world economy is currently recovering slowly. Facing an extremely complex situation, China and the United States — the largest developing country and the largest developed country — must strengthen confidence, enhance cooperation, jointly respond to challenges, and promote strong, sustainable, and balanced growth of the economies of both countries and the world.

Wang Qishan pointed out that economic and trade cooperation is an important cornerstone of China–U.S. relations. The high degree of complementarity between the two economies means that the two sides are not opponents in a zero-sum game, but rather partners for mutual benefit and win-win results. At present, China is formulating its Twelfth Five-Year Plan, accelerating the transformation of its economic development model, adjusting its economic structure, expanding domestic demand, and improving people's livelihood. The United States is also promoting economic transformation, developing new energy and other emerging industries, and implementing its National Export Initiative. The JCCT is an important platform for bilateral economic and trade cooperation and has played an important role in promoting the healthy and stable development of China–U.S. relations. It is hoped that both sides will take this session of the JCCT as an opportunity to strive to achieve more mutually beneficial and win-win outcomes.

Locke and Kirk stated that the United States and China are important economic and trade partners for each other, and maintaining the healthy development of bilateral economic and trade relations is vital for both countries and for the world economy. The United States and China should work together, increase communication through the JCCT platform, properly handle issues in economic and trade cooperation, expand mutually beneficial outcomes, and bring benefits to the peoples of both countries.

The meeting reviewed the work achieved since the previous JCCT, discussed major issues in current bilateral economic and trade relations, and reached a series of consensuses. Both sides agreed to proactively advance comprehensive China–U.S. economic cooperation; continue to maintain an open, fair, and transparent commercial and investment environment; keep an open attitude toward foreign investment; and actively promote exchanges and cooperation in agriculture, energy and environmental protection, international smart grid standards, express delivery regulation, and other areas; and explore establishing a bilateral cooperation framework on intellectual property rights.

The Chinese side reaffirmed that, on the basis of scientific principles and meeting China's inspection and quarantine requirements, it would resume imports of deboned and bone-in beef from cattle under 30 months of age. The Chinese side announced that it would lift avian influenza-related bans on Idaho and Kentucky; carry out in-depth special campaigns to combat intellectual property infringement and the production and sale of counterfeit and substandard goods, and actively promote software legalization; submit by 2011 a revised third offer to join the WTO Government Procurement Agreement; treat domestic and foreign performance records equally in national wind-power concession project bidding; adjust the Catalogue of Major Technical Equipment for Independent Innovation when it expires in 2011; allow telecommunications operators to independently choose among relevant 4G technology standards according to market principles and their own needs; further simplify the procedures for mobile phone model approval and network access testing and adjust related fees; establish a complaint center for counterfeit medicines as soon as possible; and implement Phase III of the memorandum of understanding on Chinese group travel to the United States.

The U.S. side stated that it would seriously consider China's concerns about market economy status and is willing to strengthen communication with China to accelerate the final recognition of China's market economy status; seriously consider China's comments in the course of reforming its export control system; actively consider applications by Chinese enterprises for importing controlled civil high-technology items; adhere to WTO rules and use trade remedies prudently; promptly resolve the issue of imports of cooked poultry from China; complete the risk assessment procedures for Chinese Asian pears in the first half of 2011 and issue draft regulations on their import as soon as possible; promptly release the final rule on U.S. imports of wooden handicraft products from China, narrow its scope to products that may pose risks, and resume trade according to mutually agreed heat-treatment methods; establish a technical expert group on bonsai quarantine to study and resolve existing problems; accelerate the approval process for the patent application of China IWNCOMM Co., Ltd.; and implement training programs for Chinese trademark examiners as soon as possible.

The two sides also signed multiple cooperation documents in economic and trade fields, covering investment promotion, agriculture, inspection and quarantine, energy, water resources, and trade statistics.

F Figures and Tables

F.1 Regression results

Table 9: Regressions of Human Label on BERT Sentiment Score

Dep. Var.	Human label			
	(1)	(2)	(3)	(4)
Article sentiment score	1.3309***	1.3764***	1.3940***	1.3661***
	(0.1150)	(0.1185)	(0.1169)	(0.1208)
Human rater FE	N	Y	Y	Y
Newspaper FE	N	N	Y	Y
Year×Month FE	N	N	N	Y
Pseudo R^2	0.079	0.091	0.094	0.108
Obs.	1,000	1,000	1,000	1,000

Notes: This table presents the estimation results on the ordered probit regression human rated label on BERT-generated sentiment score for 1,000 randomly selected articles. Human labels have three categories: Positive, Neutral and Negative. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Regressions of Mainland China banks' reserves in US market

Dep. Var.	Pre-trade excess reserves/assets			
	(1)	(2)	(3)	(4)
Mainland China Dummy	0.2752***	0.2543***	0.4484***	
	(0.0636)	(0.0644)	(0.0337)	
UCT-US×Mainland China Dummy				-0.0112***
				(0.0016)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Adj. R^2	0.004	0.055	0.187	0.680
Obs.	122,746	122,746	109,209	109,116

Notes: This table presents the estimation results on the OLS regression of mainland China banks' excess reserves (51) in theUS market. The sample consists of banks operating in US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Regressions of Mainland China banks' interbank borrowing in US market

Dep. Var.	Federal funds purchased/assets			
	(1)	(2)	(3)	(4)
Mainland China Dummy	0.1666***	0.1680***	0.1062***	
	(0.0442)	(0.0424)	(0.0245)	
UCT-US×Mainland China Dummy				0.0014**
				(0.0007)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Pseudo R^2	0.352	0.459	3.065	3.290
Obs.	122,746	122,746	109,209	109,209

Notes: This table presents the estimation results on the Tobit regression of mainland China banks' Federal funds purchased (52) in the US market. The sample consists of banks operating in the US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Regressions of Mainland China banks' repo in US market

Dep. Var.	Repo/assets			
	(1)	(2)	(3)	(4)
Mainland China Dummy	0.0513	0.0523	-0.1100***	
	(0.0497)	(0.0505)	(0.0270)	
UCT-US×Mainland China Dummy				0.0024***
				(0.0004)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Pseudo R^2	-0.386	-0.399	-0.569	-0.668
Obs.	122,746	122,746	109,209	109,209

Notes: This table presents the estimation results on the Tobit regression of mainland China banks' repo (52) in the US market. The sample consists of banks operating in the US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Regressions of Placebo banks' reserves in US market

Dep. Var.	Pre-trade excess reserves/assets			
	(1)	(2)	(3)	(4)
Placebo Dummy	0.0942***	0.0946***	0.0763***	
	(0.0208)	(0.0202)	(0.0274)	
UCT-US×Placebo Dummy				0.0091
				(0.0063)
Bank controls	N	N	Y	Y
Bank FE	N	N	N	Y
Year FE	N	Y	Y	Y
Adj. R^2	0.016	0.067	0.189	0.680
Obs.	122,746	122,746	109,209	109,116

Notes: This table presents the estimation results on the OLS regression of placebo banks' excess reserves (51) in theUS market. The sample consists of banks operating in US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Regressions of Hong Kong banks' reserves in US market

Dep. Var.	Pre-trade excess reserves/assets				
	(1)	(2)	(3)	(4)	(5)
HK Dummy	-0.0189***	-0.0236***	0.0098		
	(0.0018)	(0.0019)	(0.0156)		
UCT-US×HK Dummy				0.0281***	-0.0145***
				(0.0033)	(0.0050)
UCT-US×HK Dummy×Mainland China Res.					0.0572***
					(0.0079)
Bank controls	N	N	Y	Y	Y
Bank FE	N	N	N	Y	Y
Year FE	N	Y	Y	Y	Y
Adj. R^2	0.000	0.051	0.175	0.680	0.680
Obs.	122,746	122,746	109,209	109,116	109,116

Notes: This table presents the estimation results on the OLS regression of Hong Kong banks' excess reserves (51) in theUS market. "Mainland China Res." denotes the aggregate pre-trade excess reserves to assets ratio for mainland Chinese banks. The sample consists of banks operating in US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Regressions of China banks' reserves in US market

Dep. Var.	Pre-trade excess reserves/assets				
	(1)	(2)	(3)	(4)	(5)
Mainland China Dummy	0.2752***	0.2543***	0.4485***		
	(0.0636)	(0.0644)	(0.0339)		
HK Dummy	-0.0187***	-0.0234***	0.0145		
	(0.0018)	(0.0019)	(0.0156)		
UCT-US×Mainland China Dummy				-0.0112***	-0.0112***
				(0.0016)	(0.0016)
UCT-US×HK Dummy				0.0281***	-0.0145***
				(0.0033)	(0.0050)
UCT-US×HK Dummy×Mainland China Res.					0.0572***
					(0.0079)
Test H0: $\beta_{\text{UCT-US×HK Dummy}} - \beta_{\text{UCT-US×Mainland China Dummy}} \leq 0$					
t stat				14.370	-0.658
p-value				[0.000]	[0.745]
Bank controls	N	N	Y	Y	Y
Bank FE	N	N	N	Y	Y
Year FE	N	Y	Y	Y	Y
Adj. R^2	0.004	0.055	0.187	0.680	0.680
Obs.	122,746	122,746	109,209	109,116	109,116

Notes: This table presents the estimation results on the OLS regression of China banks' excess reserves (51) in theUS market. "Mainland China Res." denotes the aggregate pre-trade excess reserves to assets ratio for mainland Chinese banks. The sample consists of banks operating in US. The sample period is from 2002Q1 to 2021Q2. Standard errors clustered by banks are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.