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A silver transformation: Chinese monetary integration in times of political disintegration, 1898–1933†

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This article provides the first systematic econometric study on the evolution of Chinese silver exchange and monetary regimes during the period 1898–1933. Using high-quality datasets of monthly and daily prices of silver dollars, we apply the threshold autoregressive models to estimate the silver points between Shanghai and 18 other cities in northern and central China. We find a noticeable improvement in monetary integration between Shanghai and Tianjin from the 1910s, which then spread to other cities in our sample throughout the 1920s and 1930s. We supplement our analysis with new datasets on volumes and costs of silver flows and with an in-depth historical narrative. This article re-evaluates the efficiency of the silver regime and China's economic performance in the Republican era.

Whether the 1842 Sino-British Opium War and the forced opening of Qing China to Western imperialism and global trade marked the beginning of a century of Chinese humiliation or an era of awakening to modernity may be a matter of perspective. However, the years 1898–1933, covered in this study, saw China's best and worst of times, straddling several sub-periods of a tumultuous era in modern Chinese history. It started with China's disastrous military defeat by Japan in 1894–5 and then by Western (and Japanese) allied forces over the suppression of the Boxer Rebellion in 1901. In the wake of this defeat, the Qing dynasty embarked on a bold modernization reform in 1905, modelled after Japan's Meiji Restoration, but the dynasty collapsed in 1911. China's subsequent Republican era (1911–49) began with the Beiyang decades of 1911–27—also known as the Warlord era—when the country was ruled by the so-called Northern regime in Beijing. This was followed by the Nanjing Decade, led by the Nationalist Government based in the capital of Nanjing, which was disrupted by a full-scale Japanese invasion in 1937.

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In spite of the political turmoil, this era also saw fundamental economic and industrial transformations.[1] However, the monetary and financial aspect of this transformation is still not well understood. Throughout this period, China remained the large silver outlier at a time when most of the world were aspiring to join the gold club for prestige and respectability.[2] China's adherence to a silver standard in a twentieth-century world had long been bemoaned as a symptom of its political and economic woes and a throwback to a bygone world once dominated by Spanish American silver. Furthermore, the Chinese silver regime defies easy classification in that its silver basis was not in coinage, but in the form of horseshoe-shaped ingots called sycee, denoted by a unit of account called the tael. Sycee were minted privately, varying in shape, weight, or fineness from city to city. Sycee circulated alongside other media of exchange, such as Spanish, Mexican, and later other Chinese silver dollars, while at the same time copper cash—the only small denomination currency coined by the Imperial government—remained the dominant media for small transactions. It is important to note that as copper cash was not just a subsidiary currency, its exchange rates with silver also fluctuated across time and localities depending upon market conditions. While copper cash was mostly used for local retail transactions, China's long-distance and wholesale trade mainly relied on silver, which is the focus of our current study.

Apart from a couple of recent studies that focus on either the world silver standard in general or China's external silver exchange,[3] relatively little has been written about the operation of the silver exchange and the monetary regime within China. This is in sharp contrast to the large literature on the operation of the gold standard during the nineteenth and early twentieth centuries, especially on the degree of efficiency achieved by currency exchange arbitrage. This article presents an in-depth analysis of China's unique silver regime and offers the first systematic econometric assessment of Chinese silver market integration during the years 1898–1933.[4] We compile a large dataset culled from newspapers, professional journal publications, and governmental reports on exchange rates between the silver dollar and the tael across 19 cities in northern and central China. Our core datasets consist of monthly exchange rate data between Shanghai and Tianjin in 1898–33 and daily rates of 19 cities during the 1920s and 1930s. Drawing on the mechanism of gold point arbitrage, we formalize the theory of silver point arbitrage in the presence of transaction costs across spatial markets within China and offer a threshold time series methodology for measuring silver integration comparable to that on gold points.[5] We test our findings against data on actual quantities of silver flows and shipping costs during the 1920s.

Our econometric results reveal that monetary integration between Shanghai and Tianjin improved from the 1910s—precisely during the Warlord era of national disintegration and civil strife—and these improvements spread to other cities in central and northern China in the 1920s and 1930s. We offer a historical analysis of

[1] Brandt, Ma, and Rawski, 'From divergence to convergence'.
[2] For example, Bordo and Rockoff, 'Gold standard'; Meissner, 'New world order'; Mitchener, Shizume, and Weidenmier, 'Why did countries adopt the gold standard?'.
[3] Fernholz, Mitchener, and Weidenmier, 'Pulling up the tarnished anchor'; Jacks, Yan, and Zhao, 'Silver points'.
[4] Many of the historical studies on Chinese market integration were based exclusively on agricultural commodities. See, for example, Shiue, 'Transport costs'; Shuie and Keller, 'Markets in China'.
[5] Canjels, Prakash-Canjels, and Taylor, 'Measuring market integration', pp. 871–5.

the causes of monetary integration at a time of political disintegration, attributing a central role to China's financial and infrastructure improvements during this period. In this regard, our study of China's modern evolution reveals new insights into the limits of the country's traditional monetary and financial development, an issue neglected in the ongoing great divergence debate.[6]

The rest of the article is organized as follows. We introduce the monetary system in China in the early twentieth century in section I. Section II presents our econometric results on currency market integration using the monthly frequency data for Shanghai and Tianjin in 1898–1933 and daily data for 19 cities for the 1920s and 1930s. Section III provides robustness checks on our silver points based on the quantity and cost data for silver flows. Section IV provides the historical narrative behind the money market integration. The last section concludes.

I

As the basis of the Chinese monetary system until the 1935 fiat currency reform, silver served as the denomination currency for China's international and interregional trade and as the unit of account and reserves for paper notes and interbank accounts for traditional and modern Chinese banks. Sycee, the most important traditional silver currency, were the principal medium for wholesale transactions and tax payments such as customs duties.[7] They were not produced by a central authority, but minted by a private smelting firm called Lufang, whose imprint was stamped on every shoe of sycee it produced. The sphere of circulation of any particular kind of sycee was usually confined to a local trading area. As they varied in fineness, shape, and weight, sycee had to be constantly assessed in exchange, and were often melted down and re-cast to conform to local standards whenever they circulated outside their local area.

The second physical form of silver currency in China was standardized silver coins (dollars), first introduced to China from Spanish America during the early sixteenth century. The so-called Carolus dollars had become the most popular coins in China followed by Mexican dollars (or eagle dollars) after the collapse of the Spanish Empire in South America and the founding of the new independent Republic of Mexico in the early nineteenth century. Over the centuries other dollars have made their appearance, but none have enjoyed the prestige and popularity of the eagle dollar in China. It was estimated that the total amount of eagle dollars circulating in China in 1911 was 500 million, accounting for more than half of the total silver dollars circulating in China at that time.[8]

In 1889, the south-east province of Guangdong struck China's first silver coin, the dragon dollar. Over the next 10 years, other provinces also established mints, which began to proliferate. All dragon dollars were modelled after the eagle dollar but the lack of uniformity hampered their appeal and diffusion. The number of dragon dollars was estimated to be only 100 million as of February 1918,

[6] Brandt et al., 'From divergence to convergence', p. 37.
[7] Fetter and Bratter, 'China and the flow of silver'.
[8] Kann, *Currencies of China*, p. 145. As an example, salt revenue (the second largest government revenue after custom revenues), railway fares, and postage telegram fees were officially prescribed in eagle dollar. People's Bank of China, *Shanghai Qianzhuang*, p. 570.

Table 1. *Silver content of Chinese currencies*

Silver currency	*Description*	*Fine silver (Troy oz)*	*Fine silver (g)*	*Parity (to Shanghai tael)*
Shanghai tael	Unit of account	1.0802	33.5989	1.0000
Tianjin tael	Unit of account	1.1398	35.4515	1.0551
Hankou tael	Unit of account	1.1169	34.7413	1.0340
Eagle dollar[a]	Coin	0.7880	24.5101	0.7295
National dollar[b]	Coin	0.7699	23.9475	0.7127

Notes: a According to an official assay conducted by the Chinese Mint, the eagle dollar contains 0.7880 oz of fine silver, equal to 0.7295 Shanghai tael; Zhang, *Zhonghua Bizhishi*, pp. 49–56.
b The *National Currency Regulations* required that the national dollar contain 23.9779g (or 0.7709 oz) of fine silver, and the ratio of the difference between the weight and fineness of silver coins and those of legal tender was not to exceed 3/1,000. An assay conducted by the Japanese Government Mint showed that it contained 0.7699 oz of pure silver, with the error being 1.2/1,000. See Kann, *Currencies of China*, pp. 161–3; Yu, 'Zhengjin Zhoubao'.
Sources: The silver content of the Shanghai tael, and the parity of the Tianjin tael and the Shanghai tael, are taken from Young, 'Shangai tael', p. 683; Wu, 'Yige Xinde Waihui Zhishu', p. 470. The parity of the Hankou tael and the Shanghai tael are taken from Jin, *Guonei Shangye*, p. 9.

accounting for less than 10 per cent of total silver dollar stocks in China at that time.[9] The founding of the new Republic brought the introduction of the national dollar (also known as the Yuan Shih-kai dollar) in 1914. To facilitate this introduction, the Beijing government arranged for the Bank of China, the Bank of Communications, and the official provincial banks to exchange, free of charge, the old dragon dollars for the new national dollars. The uniformity and reliability of the national dollar made it into an unparalleled success, quickly driving out various dragon dollars, and eventually eagle and other foreign dollars. According to a survey in 1924, out of the 960 million silver dollars in circulation, 750 million were national dollars.[10]

Until its official abolition by the 1933 currency reform, sycee had been in concurrent circulation with silver dollars in most places of commerce. The need for a common unit of account for the different silver currencies led to the existence of various imaginary or bookkeeping tael units for different trading zones in China. Though bearing no equivalence to any actual currencies circulated, these taels served as common units of account for the amalgam of currencies in circulation. Likewise, the silver contents of these abstract tael units also varied from city to city depending on local custom. Among them, the Shanghai tael was the best-known, being quoted in foreign exchange markets and recognized by the Shanghai Foreign Exchange Bankers Association. After the Shanghai tael, other widely used local taels were the Tianjin tael, the Hankow tael, and so on, whose weight ranged approximately from 500 to 550 grains. In table 1, we summarize the silver content of several of the most important tael units and silver dollars.

During the study period, China's silver currencies moved across space through a system of bills of exchange but increasingly by cable order. With extensive branches or agents in other cities, Shanghai native banks together with modern banks played

[9] People's Bank of China, *Shanghai Qianzhuang*, p. 164.

[10] Kuroda, 'Collapse', p. 114. A number of other dollars with different designs, but with weight and fineness equal to those of the Yuan Shih-kai dollar, had been issued under the Republic. The only ones issued in large quantities were those bearing the figure of Sun Yat-sen, the Sun Yat-sen dollars. See Fetter and Bratter, 'China and the flow of silver', p. 36.

the leading nationwide role in silver exchange.[11] With the varying tael units of account in China, a transfer of silver dollars often involved the conversion of multiple exchange rates, as noted by Kann:

> When Shanghai is requested to remit dollars to Tianjin, both these places are required to forget that a uniform dollar is supposed to be currency in China. The transaction will invariably be coupled with the tael currency in both places. Shanghai will have to ascertain the dollar–tael rate in Tianjin and Shanghai, and Shanghai's rate for Shanghai taels against Tianjin taels.[12]

In other words, for a Shanghai merchant to remit dollars to Tianjin, he first needed to exchange silver dollars into Shanghai taels which would then be converted into Tainjin taels (subject to the current exchange rate of the Shanghai tael to the Tianjin tael) in order finally to obtain silver dollars from banks in Tianjin.

The most important indicator of China's silver currency market is the dollar–tael rate, called in Chinese (and hereafter referred to as) yangli (洋厘), that is, the actual market price of silver dollars expressed by their respective abstract tael units. We now illustrate the long-term trend in yangli using the case of Shanghai and Tianjin, the two most important financial centres in central and northern China.[13] Yangli could deviate from its parity rate (the ratio of the fixed silver content between dollar and tael) to reflect the changing market demand for dollars in China. At the meetings held daily in the morning and early afternoon, representatives of the native banks monitored and set yangli in accordance with actual demand and supply conditions. In Tianjin, there had always been only one unified exchange market for dragon, eagle, and national dollars throughout.[14] In contrast, before August 1915, there existed in Shanghai two separate dollar exchange markets for the eagle dollar and dragon dollar (against the Shanghai tael) respectively. After August 1915, the dragon dollar market was replaced by the national dollar market in Shanghai. Furthermore, by May 1919, the eagle dollar market was closed down, leaving the national dollar as the sole currency quoted in the Shanghai dollar–tael market.[15] Whatever the type, the silver contents of dragon and national dollars approximated that of eagle dollars, as revealed in table 1.[16]

We have collected the monthly observations of Shanghai and Tianjin yangli, which were the average of trading days in the respective month for the period from January 1898 to March 1933, with a total of 423 observations.[17] We denote

[11] 'Shanghai native banks' and 'modern banks' are very different kinds of banks in China. 'Native banks' refers to old-style Chinese traditional banks, which differed from modern banks.

[12] Kann, *Currencies of China*, p. 173.

[13] During the 1920s and 1930s, Shanghai had been China's largest commercial and financial centre, absorbing about half of its foreign trade, foreign direct investment (FDI), and modern manufacturing. Tianjin, located in northern China, ranked as China's second most important commercial, financial, and industrial city and the centre for trade in agricultural commodities, with a population that increased from 200,000 in 1840 to 1.5 million in the 1930s. See Ma, 'Economic growth', p. 359; Ma, 'Traditional finance', p. 344.

[14] Jin, *Guonei Shangye*, p. 233.

[15] People's Bank of China, *Shanghai Qianzhuang*, p. 573.

[16] The principal dragon dollar circulated in Tianjin was the Beiyang dollar, which accurately resembled the eagle dollar. In addition, the difference of the silver contents between dragon dollars minted in major provincial mints, such as the Beiyang, Guangdong, Hubei, and Jiangnan Mints, were limited to within 1%. Zhang, *Zhonghua Bizhishi*, pp. 49–56.

[17] Data are taken from Kong, ed., *Nankai Jingji Zhishu*, pp. 475–96. The sample period begins with Jan. 1898 because the data in Tianjin began their successive records only from that month. It ends in March 1933 as the

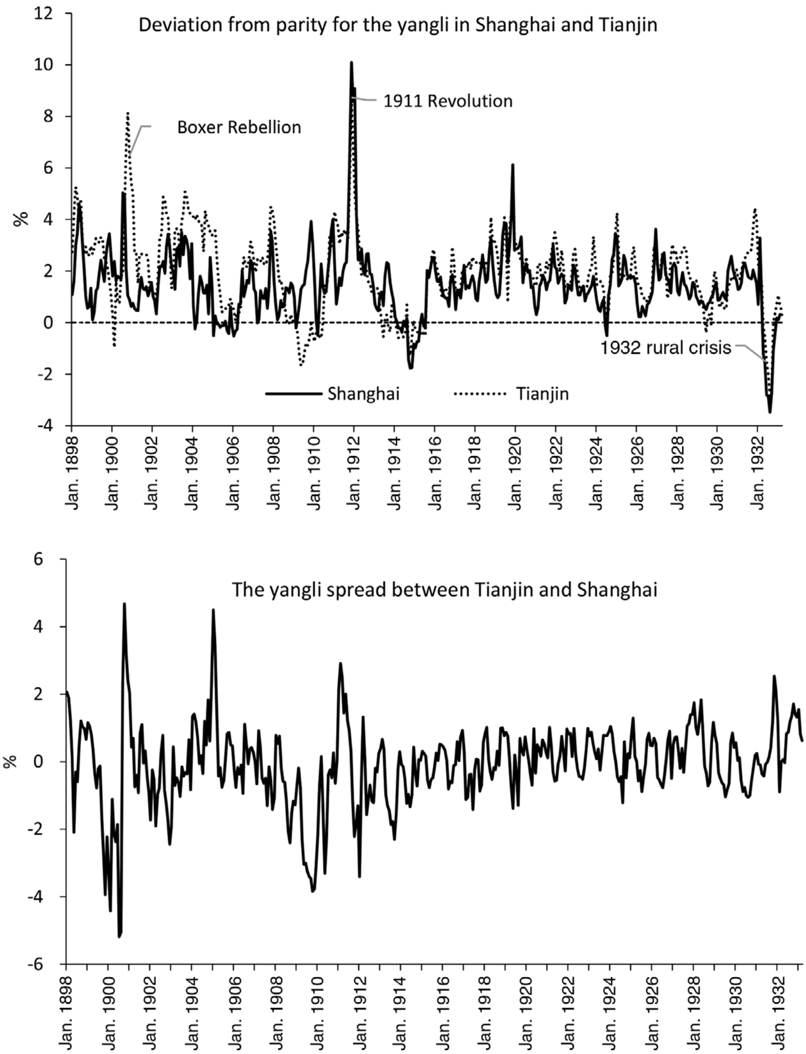

Figure 1. *Yangli in Shanghai and Tianjin, monthly data, Jan. 1898–March 1933*

Notes: The upper panel shows deviation (in %) from parity for the yangli series. The lower panel measures the yangli spread as the deviation between Tianjin and Shanghai.
Sources: Kong, ed., *Nankai Jingji Zhishu*, pp. 475–8, 495–6.

Tianjin and Shanghai yangli at time *t* with their respective taels as $y_{T,t}$ and $y_{S,t}$. Figure 1 (upper panel) plots these two series, in the form of deviation (in per cent) of silver dollars from their parity. In general, figure 1 shows positive deviation from parity in both cities, indicating that the silver dollar was valued higher than its metallic content, a premium associated with the convenience of a 'countable'

dollar/tael exchange markets were closed off by the abolition of the sycee and tael system and thus a single silver dollar standard was officially established in China. The yangli data in Shanghai are those for the eagle dollar before Aug. 1915 and for the national dollar thereafter.

coin.[18] Overall, yangli fluctuated widely over time and was a sensitive indicator of comprehensive political and economic factors as well as consumer confidence in the money market in China. Important political events such as the Boxer Rebellion fiasco around 1900 and the fall of the Qing Empire in late 1911 led to a sharp surge in yangli. There are also notable drops as well, such as that in 1932, which reflects the draining of silver from China's crisis-stricken rural sector to cities, due to stagnation in agricultural commodity exports during the Great Depression. Interestingly, this was one of the few occasions when yangli dipped substantially below parity. Besides the common global, national, and regional forces impacting on yangli, there is a seasonal component in the yangli series related to agricultural harvests, as the vast majority of dollars were transferred to facilitate agricultural trade in China. It has long been observed that May corresponded to the peak season of cocoon and tea purchases in China's central and southern regions, whereas October and November corresponded to the harvest season for cotton in northern China and rice in central China.[19] We will return to the issue of seasonality later in the article.

To compare the price of silver dollars in the two cities, we collected the market exchange rates of the Shanghai tael to the Tianjin tael, called *neihui* in Chinese, which also fluctuated daily and deviated from their parity values of 1.0551, as shown in table 1. We multiply the Tianjin yangli series with the market exchange rate of Tianjin/Shanghai taels (denoted as $E_{TS,t}$) to place both yangli series on the common unit of Shanghai taels. If the strong form of the law of one price holds, then the price of silver dollars measured in Shanghai taels should be the same in both markets; that is, the yangli spread (in per cent) at time t defined as $x_t = 100 \cdot \ln(y_{T,t}E_{TS,t}/y_{S,t})$ equals zero. Given frictions in the form of information and trade costs, one might naturally expect deviations from the law of one price. The lower panel of figure 1 displays the monthly series for x_t. Here, a positive (negative) value for x_t suggests that the dollar is relatively overvalued (undervalued) in the Tianjin market. Clearly, x_t does not exhibit random walk or explosive behaviour, but rather is stable, apart from relatively large fluctuations during the first decade of our sample period.[20]

Figure 2 plots the standard deviation of x_t in a moving window of 60 observations, which reveals a sharp decline in the 1910s. Using January 1912 as the break point, the Qing and Republic sub-periods account for about 40 per cent and 60 per cent of the full observations, respectively. While the mean of x_t during the entire period is −0.10 per cent with a standard deviation of 1.23 per cent, the average in the first sub-period is −0.34 per cent (with a standard deviation of 1.65 per cent), which shrinks dramatically to only 0.07 per cent in the second sub-period (with a standard deviation of 0.80 per cent). To confirm this structural break without imposing prior knowledge of the locations of breaks, we adopt endogenous breakpoint tests developed by Bai and Perron on the 60-month moving window standard deviation

[18] The average of deviation from parity for yangli in Shanghai and Tianjin are 1.49% and 1.96% respectively, higher than the minting cost of the national dollar, which is 0.926%. See National Dollar Regulations, 'State council bulletin', 631 (1914).

[19] Yang, *Zhongguo Jinronglun*, pp. 208–13.

[20] The augmented Dickey–Fuller test statistic also comes in at a highly significant −7.87. Thus, we assume stationarity in all that follows.

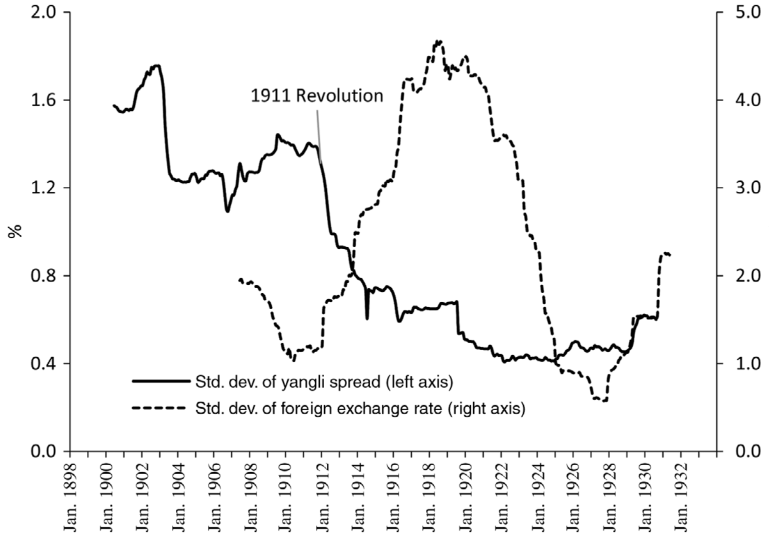

Figure 2. *Standard deviations of domestic exchange rate and foreign exchange rate, 60-month moving window, Jan. 1898–March 1933*

Notes: This figure shows the standard deviations of the yangli spread between Shanghai and Tianjin, and the standard deviations of the foreign exchange rate (deviation from parity) for the Shanghai tael against US dollars, in a moving window of 60 observations.
Sources: See fig. 1 for the yangli spread. Foreign exchange rates are taken from Wu, 'Yige Xinde Waihui Zhishu', pp. 487–95.

series of x_t.[21] The sequential test results confirm one endogenous break in October 1913, which is very close to the date of the political regime change.[22]

For the purposes of comparison, figure 2 also plots the standard deviation of the Shanghai tael–US dollar exchange rate (deviation from mint parity), which is a good measure of Shanghai's linkage with the global market.[23] It shows that while the First World War wreaked havoc on the Shanghai–New York foreign exchange market, the same period saw a rapid and sustained decline in the standard deviations in the domestic exchange market in China. In other words, it seems that improvements in Chinese money market integration and efficiency gained momentum precisely at a time when the rest of the world was engulfed in turmoil.

II

As the process of silver arbitrage in spatial markets incurs costs, the shipment of silver is thought to occur only if the inherent price of the silver dollar in one port is above (or below) that in the other port by a sufficient margin. In other words, one price would not prevail simultaneously in every market at all times, as differences within the bounds of silver movement costs would remain. As Kann noted, 'The

[21] Bai and Perron, 'Estimating'.
[22] We also calculate the standard deviation of x_t in a 36-month or 48-month moving window. The results are quite close to that of a 60-month moving window. Specifically, the corresponding break date is April 1913 for the series in a 36-month moving window, and Feb. 1913 for the series in a 48-month moving window.
[23] As a silver-standard country, China was obliged to derive the parity value of its nominal exchange rate from the price of silver in New York commodity markets. Unlike the parity of two gold currencies, the parity exchange rate is not constant in the case of the Chinese silver standard.

cost of making remittances through banks in China from one place to another ought not to exceed the cost of actually shipping the coins. Otherwise, the debtor port will ship coins instead of making remittances'.[24]

The mechanism of silver arbitrage discussed above finds its close econometric representation in the threshold autoregression (TAR) model. Our estimating equation is the following error correction mechanism (TECM) for the yangli spread, x_t:

$$\Delta x_t = \begin{cases} k_1 - \lambda_1 (x_{t-1} - \theta) + v_t, & x_{t-1} > \theta \\ v_t, & |x_{t-1}| \leq \theta \\ k_2 - \lambda_2 (x_{t-1} + \theta) + v_t, & x_{t-1} < -\theta \end{cases} \quad (1)$$

where Δx_t is the first difference of x_t, k_1 is a constant, and v_t is an exogenous disturbance term and is assumed to be serially uncorrelated. Equation 1 incorporates a simple formulation of the relevant silver points, θ. We refer to these estimated thresholds as 'silver points' in direct parallel to the literature on gold points.[25] If the current yangli spread is above θ, exploitable arbitrage opportunities emerge and silver will flow into Tianjin, leading to a reversion of the yangli spread at a speed of convergence defined by λ_1. The case of silver outflows from Tianjin is analogous to that above. When the spread is less than $-\theta$ silver will be shipped from Tianjin and the spread will revert toward $-\theta$. Finally, when $|x_{t-1}| \leq \theta$, the spread is not large enough to overcome the costs of arbitrage, so there are no shipments for arbitrage purposes. To sum up, if the contemporaneous spread is in the outer regimes, then it will revert toward the edge of the band. In the middle regime, the yangli spread will not demonstrate any tendency towards convergence, with the process of x_t following a random walk within the 'neutral band'.

Equation 1 is a special case of a three-regime TAR model:

$$x_t = \begin{cases} \beta_0^u + \sum_{i=1}^{n} \beta_i^u x_{t-i} + \varepsilon_t, & x_{t-1} > \theta \\ \beta_0^m + \sum_{i=1}^{n} \beta_i^m x_{t-i} + \varepsilon_t, & |x_{t-1}| \leq \theta \\ \beta_0^l + \sum_{i=1}^{n} \beta_i^l x_{t-i} + \varepsilon_t, & x_{t-1} < -\theta \end{cases} \quad (2)$$

where ε_t is an exogenous disturbance term. In this model AR(n) dynamics obtain in each regime.[26] The process switches between three autoregression linear mechanisms dependent on the position of the lagged value of the process. Here, x_t is no longer restricted to follow a random walk process in the middle

[24] Kann, *Currencies of China*, p. 172.
[25] For example, Canjels et al., 'Measuring market integration', p. 875.
[26] If we restrict $n = 1$, $\beta_1^u = \beta_1^l$, $\beta_i^m = 1$, and some appropriate constraints on constants, equation 2 is reduced to equation 1.

Table 2. *Restricted (TECM) model, monthly yangli spread between Shanghai and Tianjin*

		Sub-periods	
	Full period (Jan. 1898–March 1933)	*Qing Empire (Jan. 1898–Dec. 1911)*	*Republican era (Jan. 1912–March 1933)*
θ	1.441 [0.393, 1.929]	2.485 [2.375, 3.043]	0.879 [0.327, 0.973]
λ_1	0.222 (0.215)	0.250 (0.534)	0.063 (0.286)
λ_2	0.746*** (0.136)	1.933*** (0.383)	0.707*** (0.223)
k_1	−0.347 (0.281)	−0.864 (0.701)	0.374** (0.150)
k_2	−0.377 (0.204)*	−1.452 (0.522)***	0.164 (0.148)
σ	0.841	1.051	0.607
Q_3	8.236**	9.585**	9.813**
Chan test	12.073**	3.666	8.060
Log likelihood	−524.03	−243.32	−232.882
Regime (T)			
Upper	21	6	34
Middle	360	147	192
Lower	42	15	30

Notes: Standard errors are reported in parentheses. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. The 90% asymptotic confidence intervals of threshold, θ, reported in brackets, are calculated using the likelihood ratio approach given by Hansen, 'Inference in TAR models'. Q_3 is the Ljung-Box Q statistics up to order 3 for testing additional autocorrelation, and the Chan test for non-linearities, in the residual series.
Sources: See fig. 1.

regime.[27] All our threshold models will be estimated using conditional least squares (CLS) estimators. The CLS approach estimates the parameters by minimizing the predictive sum of squared errors. The optimization need only be done with θ searched over some interval that guarantees any regimes have adequate data for estimation.[28]

II.1. Monthly data for Shanghai and Tianjin, 1898–1933

We first estimate the restricted model, as in equation 1, on our Shanghai–Tianjin yangli spread, using the full sample period of 1898–1933.[29] We restrict the grid search to values such that the upper and lower regimes combined have at least 10 per cent, and at most 70 per cent, of the observations. The results are presented in table 2. The threshold is estimated to be 1.44 per cent for the entire sample. To acknowledge the dramatic changes in the yangli spread series in the 1910s, we also estimate equation 1 using January 1912 as the break date for two sub-periods. The results indeed show dramatic changes in the thresholds in two sub-periods. The silver point is estimated to be 2.48 per cent in the Qing Empire era before 1912 but reduces substantially to 0.88 per cent in the Republican era, shrinking by

[27] Once the effect of speculation is considered, x_t in the middle regime within the silver point band can still be characterized as a stationary process. See the analogous mechanism on the gold standard in Officer, 'Remarkable efficiency', pp. 13–14.

[28] This approach has the advantage that the threshold parameter can be searched without any constraints. Under mild conditions, including stationarity and that the true conditional mean function is a discontinuous function, the CLS method is consistent; Cryer and Chan, *Time series*, p. 403.

[29] All commonly used methods for testing linear versus non-linear models that appear in the literature—including the Tsay test and the likelihood ratio test (Chan, 'Percentage points')—strongly reject linearity for x_t, suggesting that a threshold model is more appropriate than a linear AR model.

almost two-thirds.[30] The changes in threshold strongly point to increasing market integration from the 1910s. It should be noted that, for each period, the residual series are clearly not uncorrelated over time, as reflected by the highly significant Ljung-Box Q statistics. Meanwhile, the Chan statistics suggest that remaining non-linearities are somewhat problematic for equation 1 as applied for the full period.[31] We suppose that the problems might be caused by strict constraints, such as a single lag in AR processes in the outer regimes or the unit root in middle regime.

We now proceed to estimate using the general TAR model, as in equation 2. This allows for higher-order AR processes and non-random walk behaviour in the inner band. To discriminate between models with different values of n, we choose $n = 3$ or 2, as these serve to minimize the values of the Schwarz information criterion. Table 3 shows the results from the entire period and sub-periods. For each period, there is no material change in the silver point estimates using either the restricted model or the general model. In particular, both models confirm a significant decline in the silver points after the 1910s. Compared to the earlier results, the Chan statistics are now much smaller and insignificant, suggesting that there is little remaining non-linearity. Moreover, each residual series is uncorrelated over time. We view these results as offering some support for the general TAR model.

Of the 423 monthly observations, the upper regime accounts for 22 observations. Silver shipments from Shanghai to Tianjin were, therefore, profitable in these months. The lower regime accounts for 42 observations, where silver shipments in the opposite direction were profitable. The remaining 359 observations, representing 85 per cent of the entire sample, lie in the middle regime. Thus, exploitable arbitrage opportunities did occasionally emerge in the study period, but they did not persist.

We now further test the possibility that the change in silver points occurred gradually over time, rather than instantaneously with the switch to the new regime, by using a moving window method to estimate the changes of thresholds. Taking a moving window of 120 observations (10 years), we estimate the silver point for each window. The window is shifted by 12 observations each time to limit the computational burden; that is, we re-estimate the restricted model and the general model using the sub-periods of January 1898–December 1907, January 1899–December 1908, and so on. Figure 3 reveals that the silver points drop steadily in the 1910s, rather than declining gradually over the entire period. Thus, the turning point is very likely to be somewhere in the mid-1910s, which is roughly consistent with the result of endogenous breakpoint tests on the yangli spread series. Clearly, a rapid improvement in market integration occurred in the 1910s.

II.2. Daily data for 19 cities in the 1920s and 1930s

We now turn to a new yangli dataset with daily frequency, which allows us to capture the high-frequency dynamics that may be obscured by the monthly data. Our daily

[30] All threshold models are stationary given the estimated coefficients in tab. 2. Note that the region of stationarity for a TAR model is substantially larger than the region defined by the linear AR model inspired constraints $|1 - \lambda_1| < 1$ and $|1 - \lambda_2| < 1$; Cryer and Chan, *Time series*, p. 399.

[31] In the Chan test, the null hypothesis is an AR model versus the alternative hypothesis of a two-regime TAR model with constant noise variance. See Chan, 'Percentage points'.

Table 3. *TAR model, monthly yangli spread between Shanghai and Tianjin*

	Full period (Jan. 1898–March 1933)			*Sub-periods*					
				Qing Empire (Jan. 1898–Dec. 1911)			*Republican era (Jan. 1912–March 1933)*		
θ		1.441 [1.380, 1.461]			2.211 [2.182, 2.275]			0.744 [0.593, 1.237]	
T		423							
$logL$		−498.34			−217.82			−220.65	
σ		0.798			0.941			0.585	
Q_3		2.851			1.725			5.875	
Chan test		1.733			3.121			6.770	
Regime	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
β_0	0.074	−0.016	-1.485^{***}	2.015	-0.146^{*}	-4.319^{***}	0.069	0.006	-0.483^{*}
	(0.527)	(0.042)	(0.359)	(1.67)	(0.082)	(0.826)	(0.248)	(0.046)	(0.257)
β_1	1.033^{***}	0.673^{***}	0.413^{**}	0.544	0.710^{***}	0.009	0.715^{***}	0.669^{***}	0.076
	(0.212)	(0.073)	(0.16)	(0.619)	(0.106)	(0.263)	(0.239)	(0.122)	(0.214)
β_2	-0.427^{***}	0.015	-0.216^{*}	-0.469^{*}	0.060	-1.460^{***}	−0.037	-0.192^{**}	0.325^{**}
	(0.094)	(0.06)	(0.127)	(0.247)	(0.115)	(0.267)	(0.14)	(0.077)	(0.15)
β_3				0.115	−0.052	1.125^{***}			
				(0.213)	(0.089)	(0.211)			
T	22	359	42	9	137	22	50	172	34
$1-\sum_{i=1}^{n}\beta_i$	0.394	0.311	0.803	0.810	0.282	1.326	0.322	0.523	0.599

Notes and sources: See tab. 2.

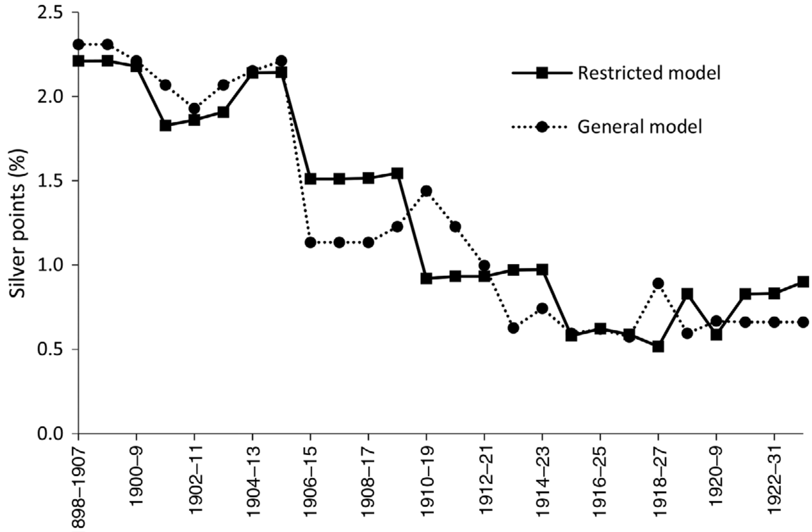

Figure 3. *Threshold estimates in 10-year moving windows, Jan. 1898–March 1933*

Notes: This figure shows the estimates of silver points from the restricted model and the general TAR model, respectively. The threshold in each sub-period is estimated in a moving window of 120 months. The window is shifted by 12 months each time.
Sources: See fig. 1.

data extend our geographic coverage to a total of 19 cities, including Shanghai and Tianjin, but only for the period of the 1920s and early 1930s. We first examine the relationship of daily yangli data for Shanghai, Tianjin, and Hankou for the 1920s. Hankou ranked after Shanghai and Tianjin as the most important financial centre in the heartland of China. We have to discard the Hankou data after 1927 due to the serious disruption caused by the Nationalist-led Northern Expedition and the subsequent decree banning silver outflow there.[32] We have at our disposal a total of 2,589 and 1,170 daily yangli observations for the estimation of Shanghai–Tianjin and Shanghai–Hankou markets, respectively, for the periods of January 1921 to December 1929 and January 1923 to December 1926.[33]

We estimate the general TAR model for the two pairs of cities and report the results in table 4.[34] For the Shanghai–Tianjin markets the estimated silver point is 0.97 per cent, substantially larger than the corresponding result (0.74 per cent) generated from the monthly data for the second sub-period using the TAR model. This higher threshold value in the daily data reveals that the monthly data to

[32] The radical left wing of the Kuomintang and the Communists occupied Hankou by force and issued a decree placing a total embargo on silver on 17 April 1927. The decree imposed the circulation of only paper notes issued by government banks and prohibited the circulation and outflow of silver from Hankou; *North-China Daily News*, 19 April 1927, p. 11. The decree effectively took Hankou off the silver standard. With the founding of the Nationalist regime in Nanjing, Hankou restored the silver standard and re-established the Hankou tael in Mar 1928. See Dai, *Zhongguo Jindai Yinliangshi*, p. 194.

[33] Data for Tianjin yangli are drawn from the *Bankers' Weekly* (1921–9) and the *Economic Statistics* (1923–9). Data for Hankou yangli are drawn from the *Bankers' Magazine* (1923–6) and the *Economic Statistics* (1923–6). Data for Shanghai yangli and the exchange rates between the Shanghai tael and the Tianjin (or Hankou) tael are drawn from the *Shenbao* newspaper (1921–9).

[34] We also estimate the restricted model as in equation 1 using daily data. There is no material change in the results for silver points.

Table 4. *TAR model, daily yangli spread*

	Shanghai–Tianjin (Jan. 1921–Dec. 1929)			*Shanghai–Hankou (Jan. 1923–Dec. 1926)*		
θ	0.974 [0.713, 1.099]			0.650 [0.646, 0.952]		
T	2589			1170		
lnL	−27.27			−524.54		
σ	0.245			0.380		
Q_3	5.160			5.922		
Chan test	4.462			3.325		
Regime	Upper	Middle	Lower	Upper	Middle	Lower
β_0	−0.020	−0.001	−0.028	0.134**	−0.003	0.021
	(0.063)	(0.005)	(0.063)	(0.056)	(0.013)	(0.054)
β_1	0.730***	0.840***	0.817***	0.898***	0.690***	0.705***
	(0.064)	(0.024)	(0.066)	(0.077)	(0.061)	(0.044)
β_2	0.231***	0.131***	0.070	−0.173**	0.283***	0.228***
	(0.049)	(0.023)	(0.057)	(0.072)	(0.048)	(0.041)
T	271	2167	151	202	834	133
$1-\sum_{i=1}^{n}\beta_i$	0.039	0.029	0.113	0.275	0.027	0.067

Notes: See tab. 2.
Sources: See fig. 6.

some extent obscure or 'smooth' the high-frequency volatility. The middle regime is estimated to encompass almost 85 per cent of the observations, implying that yangli in the two cities seldom strayed from each other even in the context of daily frequency data. The upper and lower regimes encompass 10 per cent and 5 per cent of the observations, respectively. Thus, we find some asymmetry in both the speed of adjustment and the number of observations underling the two outer regimes. The results from daily data confirm the validity of the unit root behaviour in the middle regime and the outer-regime convergence toward the thresholds. That is, the middle regime shows very slow convergence, at a speed of a mere 2.9 per cent within one day, or equivalently, a half-life of 24 days. In contrast, in the upper and lower regimes, deviations greater (in absolute value) than the estimated silver point are reduced by 11.3 per cent and 3.9 per cent, respectively, within one day.

The estimate for the silver points for the Shanghai–Hankou markets is 0.65 per cent, smaller than the estimates of silver points for Shanghai–Tianjin markets. This is consistent with the fact that Hankou is only 1,000 kilometres away from Shanghai and is well connected to it by the Yangtze River; for comparison, there is a 1,300-kilometre distance between Tianjin and Shanghai. The estimates of convergence speed also match well with the findings of the silver point arbitrage model. In other words, the outer regime shows fast convergence and the middle regime has a root much closer to unity. The dollar was overvalued in the Hankou market more frequently than in the Shanghai market, a result that is consistent with Hankou's net inflow of silver dollars.

We now turn to the second set of daily data for a total of 19 cities for the brief periods 1921–4 and 1930–1. Figure 4 presents a map of all the cities in our sample.[35] The yangli data for 1921–4 are taken from the *Monthly Report of Native Bankers' Association* (1921–4), and for 1930–1 from the *Ten-Day Bulletin of*

[35] Other than Shanghai, Tianjin, and Hankou, there are six cities in Zhejiang province (the sample period is reported in parentheses): Hangzhou (Jan. 1921–Jan. 1923; July 1930–Dec. 1931), Huzhou (Jan. 1921–Dec.

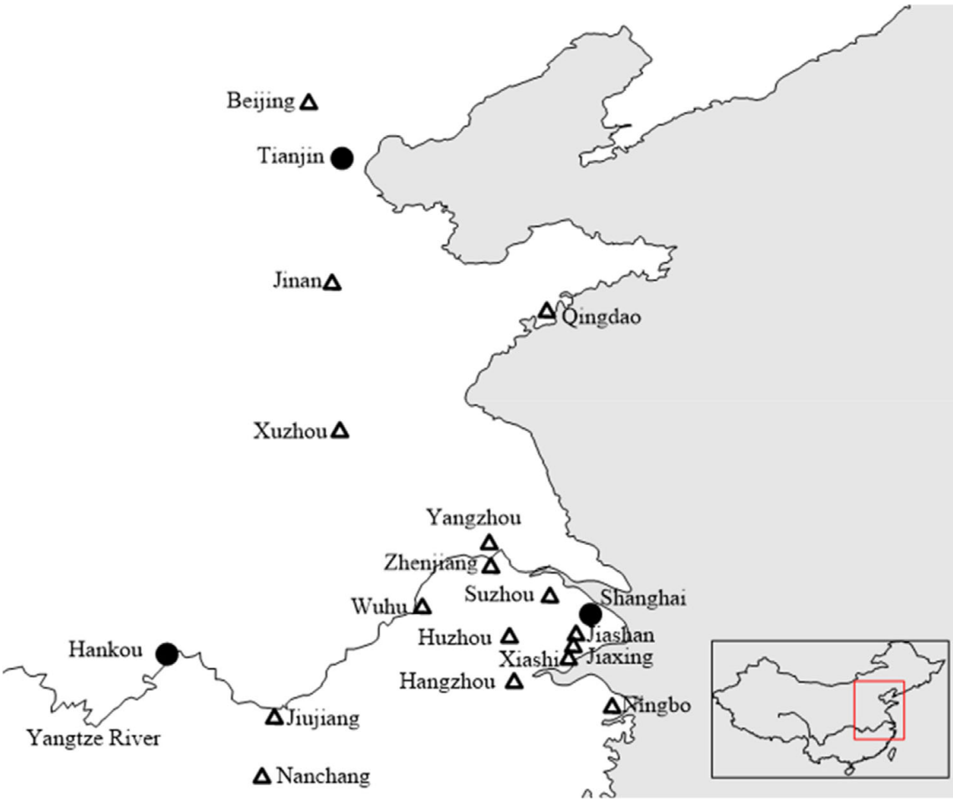

Figure 4. *Spatial distribution of sample cities*
[Colour figure can be viewed at wileyonlinelibrary.com]

Notes: The small chart shows the location of the map in present-day China. Each small triangle represents the location of a sample city. The larger circles show major commercial centres.
Source: The locations of cities are derived from Shangwu Yinshuguan, ed., *Zhongguo Xinyutu*, figs. 7–15.

the Central Bank (1930–1).[36] We use an analogous TAR model, as in equation 2, to estimate the silver points between Shanghai and each of these cities.[37] Figure 5 makes a simple linear plot between the estimated silver points of these cities (paired

1922), Jiashan (Jan. 1921–Dec. 1922), Jiaxing (Jan. 1921–Dec. 1922), Ningbo (Jan. 1921–Dec. 1922), Xiashi (Jan. 1921–Dec. 1922); four cities in Jiangsu province: Suzhou (Jan. 1921–Jan. 1923), Xuzhou (Nov. 1930–Oct. 1931), Yangzhou (July 1930–Dec. 1931), Zhenjiang (Jan. 1921–Nov. 1921; July 1931–Dec. 1931); one in Anhui province: Wuhu (Oct. 1930–Dec. 1931); two in Jiangxi province: Jiujiang (July 1930–Dec. 1931) and Nanchang (July 1930–Dec. 1931); two in Shandong province: Jinan (Sept. 1930–Dec. 1931) and Qingdao (July 1930–Dec. 1931); and one in Zhili province: Beijing (Jan. 1921–Dec. 1924).

[36] *Qianye Yuebao* [*Monthly Report of Native Bankers' Association*] (1921–4), 'Waibu Yinyang Hangshibiao' ['Tables on yangli in other cities'] column; *Zhongyang Yinhang Xunbao* [*Ten-Day Bulletin of the Central Bank*] (1930–1), 'Yinyang ji Huidui Hangshibiao' ['Tables on yangli and exchange rate'] column. Note that market exchange rates between taels in different cities only existed in major cities such as Shanghai, Tianjin, and Hankou. Elsewhere parity ratios (the ratios of silver content) between taels were used in calculating the yangli spread. The parity ratios are taken from Jin, *Guonei Shangye*, p. 233.

[37] We do not measure integration across the network of all these cities, partly due to data limitations. Nevertheless, we believe that it does not affect our basic conclusions, as the Chinese financial network was hierarchical, with Shanghai at the centre. Thus, an active exchange market developed between Shanghai and the other cities, but not between any pairs of the other cities. An official report observed that, 'Shanghai has long been China's financial

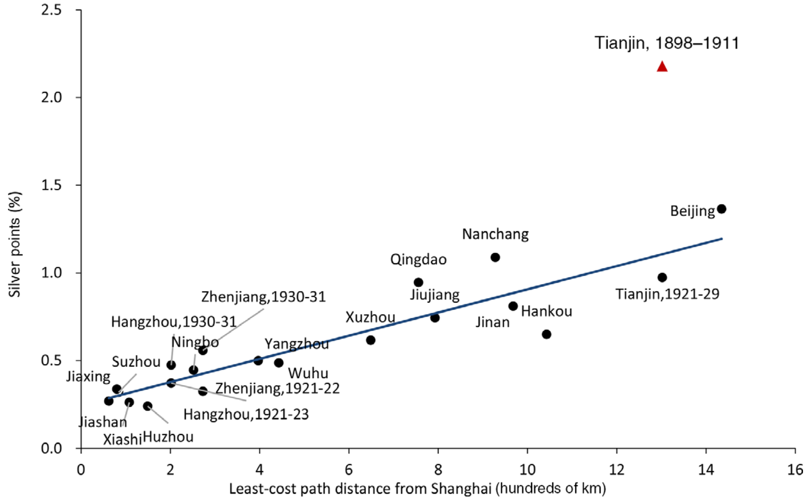

Figure 5. *Silver points and distance*
[Colour figure can be viewed at wileyonlinelibrary.com]

Notes: The silver point between Shanghai and each of these cities is estimated from a general TAR model. Cities with period labels have data for two separate periods, whereas cities with no period labels only have data for one period.
Source: See section II.

with Shanghai) and the least-cost path distance from Shanghai.[38] To capture more fully the determinants of the magnitude of the silver points, we run the following regression:

$$\theta_i = c_0 \ + c_1 Dis_i + c_2 d_{rail,i} + c_3 d_{BE,i} + c_4 d_{LY,i} + c_5 d_{BE,i} \cdot d_{LY,i} + \varepsilon_i \qquad (3)$$

where the dependent variable θ_i is the estimated silver point between city i and Shanghai; Dis_i is the corresponding least-cost path distance; and $d_{BE,i}$ is an indicator variable showing that the sample period for city i was in the Warlord era (that is, it takes a value of 1 in the Warlord era and 0 in the Nanjing decade). $d_{rail,i}$ is an indicator variable showing that city i is connected to Shanghai by railway. $d_{LY,i}$ is an indicator variable showing that city i is situated in the Lower Yangtze region. The interaction term captures the difference in the slope coefficient of $d_{LY,i}$ between the Warlord era and the Nanjing decade. The reason for controlling for regional difference between the two periods is that researchers generally believe that commerce and transportation in the Lower Yangtze were better developed, and the Nanjing government's rule was centred in the Lower Yangtze. ε_i is a random error.

The results of equation 3 are presented in table 5. We arrive at a significant and positive coefficient of Dis, which means every increase of 100 kilometres in distance from Shanghai increases the silver points by about a 0.07 percentage point. The significant negative coefficient of d_{rail} reveals the silver point would decrease by an additional 0.15 percentage point for cities connected by railway. The lack of

clearing house ... Each area constantly ships its spare funds to Shanghai in order for them to be transferred to cash-short areas'; Shiyebu Guoji Maoyiju, *Zhongguo Shiye Zhi*, p. 243.

[38] The least-cost paths for silver transportation are derived by taking the minimal transport costs from among rail, waterways, and sea shipping in the 1920s, which are taken from Jin, *Guonei Shangye*, pp. 18–21.

Table 5. *Silver points and the distance from Shanghai*

Dependent variable: silver point (mean = 0.589%)	*Least-cost path*		*Linear distance*	
	(1)	*(2)*	*(3)*	*(4)*
Dis	0.066*** (0.007)	0.068*** (0.007)	0.090*** (0.009)	0.092*** (0.008)
d_{rail}		−0.149*** (0.052)		−0.177*** (0.048)
d_{BE}		−0.077 (0.056)		−0.076 (0.051)
d_{LY}		0.155 (0.108)		0.138 (0.098)
$d_{BE} \cdot d_{LY}$		−0.038 (0.115)		−0.017 (0.106)
Constant	0.245*** (0.047)	0.330*** (0.059)	0.224*** (0.046)	0.328*** (0.054)
R^2	0.844	0.907	0.843	0.922
σ	0.126	0.110	0.126	0.101

Notes: Standard errors are reported in parentheses. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. The dependent variable is the silver points between city i and Shanghai. The distance variable (Dis)—scaled in 100-kilometre units—denotes the least-cost path in cols. 1 and 2, and the linear distance in cols. 3 and 4, between city i and Shanghai.
Sources: See fig. 5.

significance of the coefficient estimates of $d_{BE,i}$ and the interaction term indicates that there was no substantial difference in the level of integration between the two regions and the two periods.[39] If anything, these improvements had occurred in the 1910s. We show this more dramatically by adding to figure 5 the 1898–1911 Shanghai–Tianjin silver point estimate (from table 3), which stood at 2.21 per cent compared with the 0.97 per cent figure for the 1920s (see table 4). If we use linear distances in equation 3 rather than least-cost paths from Shanghai, the results shown in table 5 remain basically unchanged.

III

So far, all our tests on money market integration are inferred through indirect observation, based on the dynamics of yangli. We now try to test inferred silver points against actual quantities of silver flows and the measured costs of silver movement derived from contemporary accounts. We have compiled a dataset on actual silver flows, which allow us specifically to test whether our estimated silver points help predict corresponding transaction volumes. Our dataset is weekly records of the actual volume of silver dollar shipments from Shanghai to Tianjin/Hankou, and silver dollars arriving in Shanghai from Tianjin/Hankou, for the period 1922–30, taken from the *North-China Daily News* in its 'Weekly exchange notes' column (reported every Friday). The weekly frequency of our silver flow data does not perfectly match the nine days' shipping time between Shanghai and Tianjin markets, or the six days between Shanghai and Hankou. In figures 6 and 7, we have made an adjustment by using the maximum of the yangli spread in the three days before the actual shipment from Shanghai, or the

[39] In some cases, silver points, such as those between Shanghai–Zhenjiang and Shanghai–Hangzhou shown in fig. 5, even increased in the Nanjing era relative to the Beiyang decade. In fact, our regression for all pairs of cities here shows that, controlling for other factors, silver points in the Nanjing era are slightly higher than the Beiyang decade, but not statistically significant (tab. 5). While it is difficult to interpret a statistically insignificant result, one possible explanation is that both international and domestic environments during the 1930s were more volatile than in the 1920s.

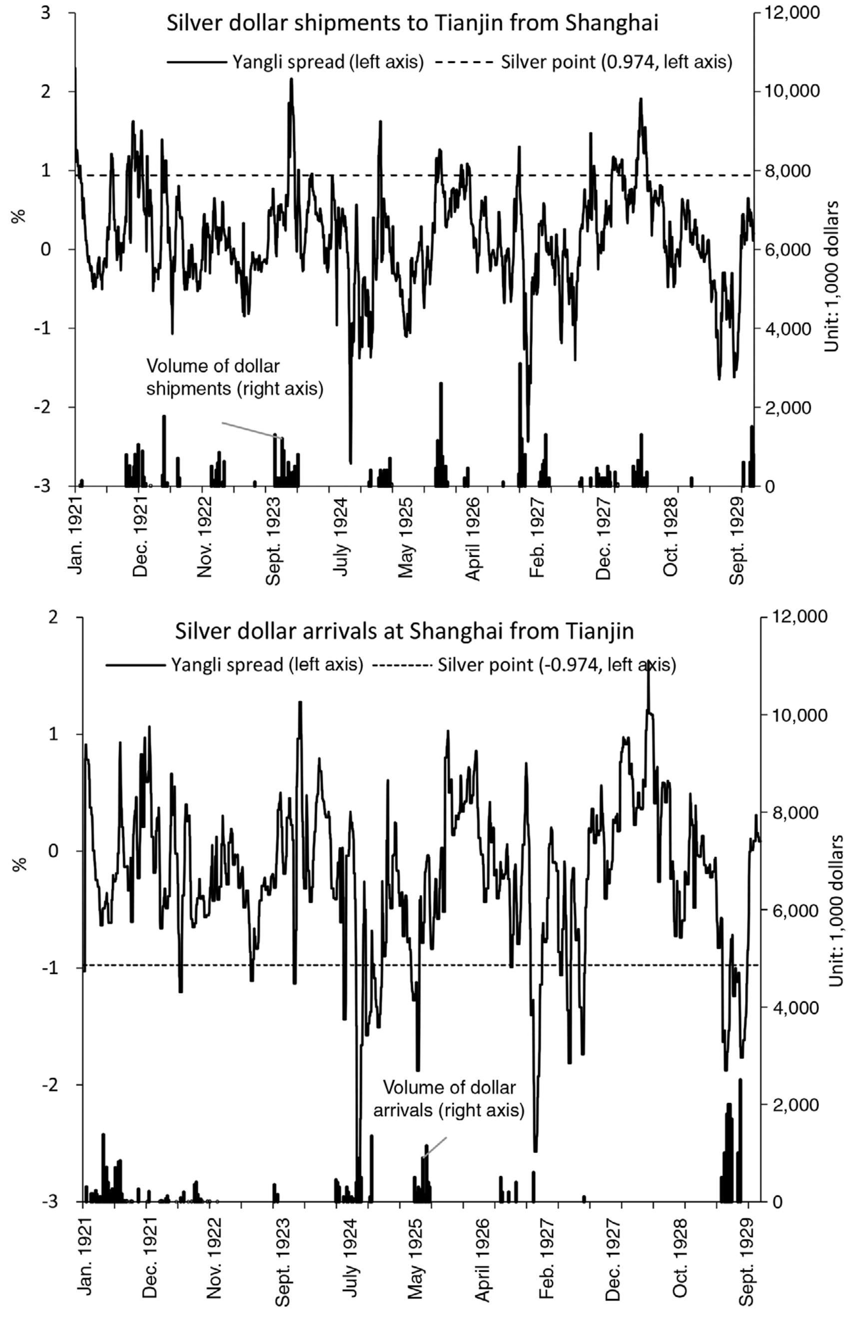

Figure 6. *Yangli spread, estimated silver points, and silver dollar flows across Shanghai and Tianjin, Jan. 1922–Dec. 1929*

Note: The silver point estimates (±0.974%) are from the general TAR model using daily data.
Sources: Yangli data are drawn from the *Shenbao* newspaper (1921–9), the *Bankers' Weekly* (1921–9), and the *Economic Statistics* (1923–9). The volume of silver dollar movement is obtained from the *North-China Daily News* (1921–9) 'Week's exchange notes' column.

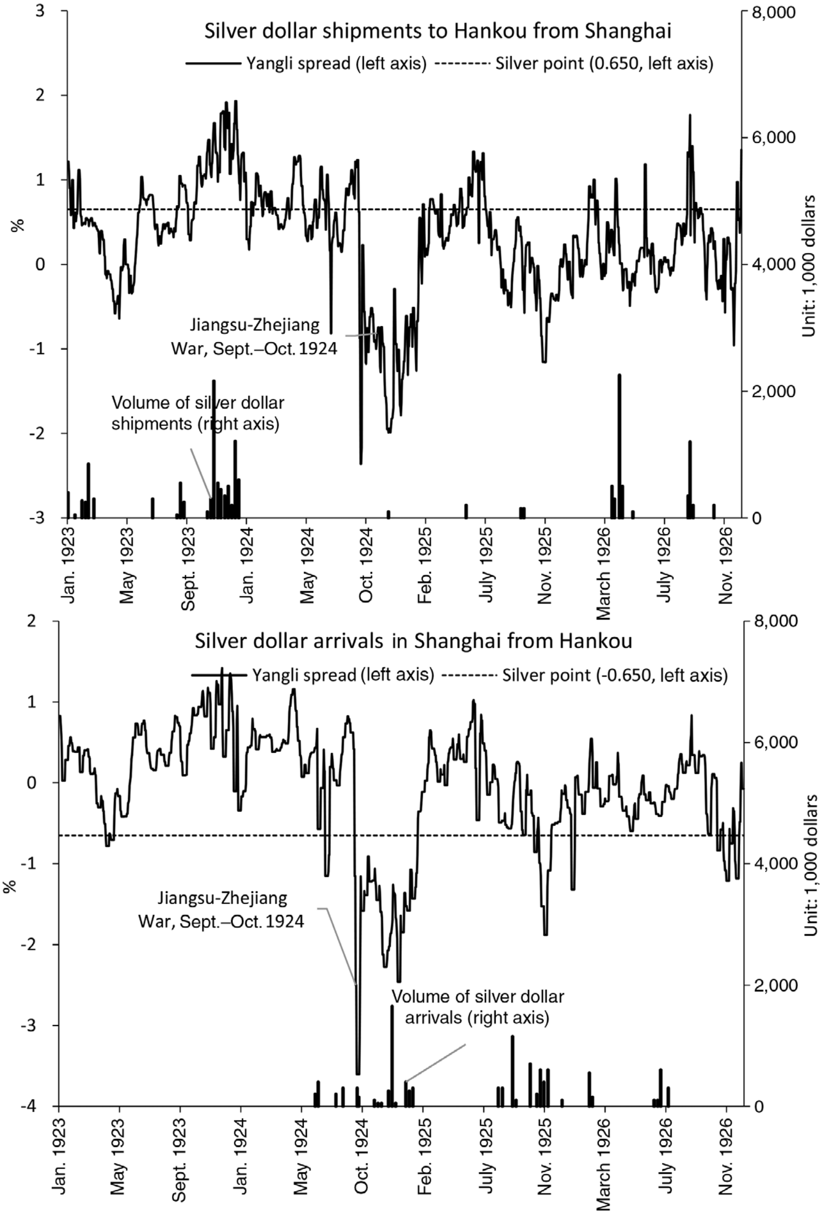

Figure 7. *Yangli spread, estimated silver points, and silver dollar flows across Shanghai and Hankou, Jan. 1923–Dec. 1926*

Note: The silver point estimates (±0.650%) are from the general TAR model using daily data.
Sources: See fig. 6.

minimum of the yangli spread in the 10 (or seven) days before the actual arrival in Shanghai from Tianjin (or Hankou). In these figures we also plot our silver point estimate from the TAR models using daily data. At the bottom of these figures we show the actual volume of silver dollar movement.

Table 6. *Probit model*

	A. Shanghai–Tianjin, Jan. 1921–Dec. 1929		*B. Shanghai–Hankou, Jan. 1923–Dec. 1926*	
	Shanghai→Tianjin	*Tianjin→Shanghai*	*Shanghai→Hankou*	*Hankou→Shanghai*
d_{ys}	0.672*** (0.119)	0.401*** (0.124)	0.407*** (0.153)	0.728*** (0.168)
d_{aut}	0.382*** (0.106)	−0.521*** (0.178)	0.351* (0.211)	0.168 (0.236)
d_{war}	0.107 (0.128)	−0.356** (0.163)	0.004 (0.318)	−0.269 (0.334)
Constant	−1.967*** (0.062)	−1.761*** (0.054)	−2.176*** (0.105)	−2.201*** (0.101)
McFadden-R^2	0.050	0.030	0.038	0.066
LR	44.72***	24.07***	11.71***	19.35***

Notes: The dependent variable is an indicator representing the occurrence of silver flow, and → shows the direction of silver flow. d_{ys} is an indicator showing the instance of yangli spread that exceeds our preferred silver point estimate. d_{aut} and d_{war} are indicators representing the agricultural trade season and major military conflicts. The likelihood ratio (LR) statistic is used to test the joint null hypothesis of all the coefficients (except for the intercept) equalling to zeros. Standard errors are reported in parentheses. ** and *** denote significance levels of 5% and 1%, respectively.
Sources: See fig. 5.

A visual inspection of the figures reveals a general correspondence between the magnitude of the yangli spread exceeding the silver points and the actual flows of silver dollars. Almost all of the large exports from Shanghai occurred when the yangli spread was above the estimated thresholds, with only limited flows when the spread fell within the bounds of the silver points. Figures 6 and 7 also reveal other factors that account for silver movements. Agricultural seasonality for Shanghai and Tianjin (usually late autumn and early winter harvests) is one relatively independent factor. Another factor is major disruptions in silver exchanges caused by events such as the Jiangsu-Zhejiang War (September and October of 1924) and the Northern Expedition (1927–8).

We now formally test our insights by estimating a probit model. In this model, the dependent variable is a dummy which equals one when there is an occurrence of silver flows between the pair of cities. The key explanatory variable ($d_{ys,t}$) is a dummy variable which equals one when the yangli spread exceeds our preferred silver point estimate (that is, >0.97 per cent or <-0.97 per cent for the Shanghai-Tianjin markets, and >0.65 per cent or <-0.65 per cent for the Shanghai−Hankou markets). Additional controls include dummy variables for the period of the Jiangsu-Zhejiang War and the Northern Expedition for the Shanghai/Hankou trade, and for the months of October and November, to represent the peak agricultural harvest season in northern China.[40] As shown in table 6, we arrive at positive and highly significant coefficients for $d_{ys,t}$ while coefficients for other control variables have the expected signs. For example, in the case of silver flows from Shanghai to Tianjin, the coefficient of d_{ys} is estimated to be 0.67, implying that the probability of the occurrence of silver flows when $d_{ys} = 1$ (when the yangli spread exceeds the silver point) is about four times that when $d_{ys} = 0$ (when the spread falls within the bounds of the silver points). Thus, the economic and statistical significance of this measure is substantial, leading to a measure of

[40] The Northern Expedition lasted longer, but our dummy only controls the period from Jan. to Dec. 1927 when Shanghai was affected.

corroboration between the estimates of our model and independent volume flow data.[41]

We now compare our silver point estimates to contemporary accounts of silver dollar movement costs, which are available for the mid-1920s. In the Tianjin–Shanghai silver trade, there were two principal routes: from Shanghai by steamer to Tianjin which entailed a cost of 0.76 per cent (including freight and insurance premium); or from Shanghai by the Tianjin–Nanjing Railroad and the Shanghai–Nanjing Railroad which entailed a cost of 0.74 per cent.[42] Adding a nine-day interest with an annualized 5 per cent rate would raise the total cost to 0.88 per cent by steamer or 0.86 per cent by railroad, respectively. These contemporary accounts of silver shipping costs are close to or slightly lower than our silver point estimates of 0.97 per cent for the Shanghai–Tianjin markets in the 1920s, which is quite reasonable as silver point estimates may well include a risk premium for the volatility of yangli.

Analogously, the silver point estimate for the Shanghai–Hankou markets also matches well with the actual costs of the silver trade. The cost of shipping silver dollars from Shanghai to Hankou by steamer via the Yangtze River was 0.51 per cent, and adding a six-day interest would increase the total cost to 0.60 per cent.[43] Also, our silver point estimate is only slightly higher than actual costs. Given this close correspondence, there were apparently no significant informational barriers to the silver trade within China in this period.

We can also make a comparison of our Shanghai–Tianjin silver point estimates with those between Shanghai and New York City at that time. There are three routes for the New York–Shanghai silver trade: from New York by direct steamer (or through bill of lading by steamer via San Francisco) which entailed a cost of 1.71 per cent; or from New York via Seattle, Vancouver, or Victoria by rail which entailed a cost of 2.05 per cent; or from New York via London which entailed a cost of 2.65 per cent.[44] These costs are consistent with recent studies by Jacks et al. which show their silver point estimates across Shanghai and New York to be about 2.0 per cent in the 1920s.[45] Thus, both the silver point estimates and reported shipping costs of New York–Shanghai are consistently about two to three times those for Shanghai–Tianjin.

Finally, we can make a comparison of our silver point estimates with the well-known estimates for the gold points under classical gold standard between London and New York City. Officer, for instance, estimates gold points of 0.61–0.69 per cent for the period 1890–1906, while Canjels et al. estimate gold points of 0.67 per cent for the period 1879–1913.[46] Although not so different in magnitude, these pairs of estimates are not exactly comparable as they are for different periods, for different distances (Tianjin and Shanghai being far closer to each other than London and New York), and different value-to-weight ratios (with silver being much lower than gold). With these caveats, our available silver points estimates

[41] We also conduct a tobit test with the dependent variable as the actual quantities of silver flows. The results are similar to our probit estimation here.
[42] Jin, *Guonei Shangye*, pp. 19–21.
[43] Ibid., p. 18.
[44] Kann, *Currencies of China*, p. 10.
[45] Jacks et al., 'Silver points', p. 382.
[46] Officer, 'Remarkable efficiency', p. 32; Canjels et al., 'Measuring market integration', p. 867.

and shipping costs data from the three different comparisons lead us to conclude that by the 1920s, Chinese financial market integration was moving closer to the standard of advanced countries.

IV

Our study has demonstrated significant improvements in China's silver market integration from the late nineteenth century onward and reveals surprising new insights into China's Warlord era—one of the most eventful decades in world and Chinese history—as the beginning of a major breakthrough in monetary and financial markets, in the aftermath of the First World War on the international front and the collapse of Qing Empire domestically. Although our findings are based on rigorous econometric analysis, we should qualify our findings by acknowledging two limitations to our current datasets. First, we only have one yangli data series for the period before the 1920s, namely, the monthly data of the Shanghai–Tianjin series for 1898–1933.[47] Second, most of the 19 cities in our 1920s and 1930s data series are located in central and northern China. These are largely due to the fact that the formal yangli market was not properly established in other areas or periods. In many cities in northern and south-western parts of China, eagle, Beiyang, and various dragon dollars, along with national dollars, co-existed throughout the 1920s. In Chongqing, Guangzhou, and north-eastern parts of China that were partly colonized by the Japanese, other forms of silver taels and dollars circulated.[48] In spite of that, we have reasons to believe that monetary integration occurred at a national level, perhaps with varying degrees of depth. Our discussion of silver integration, below, is focused on northern and central China.

One plausible driving force behind this enhanced integration was the rise of new transport and information infrastructure. Most notably, the Tianjin–Nanjing Railway, completed in 1912, together with the Shanghai–Nanjing Railway and the Shanghai–Hangzhou Railway constructed in 1908 and 1916 respectively, became a major artery linking China's north and south. Compared with road or water transport, railroads offered much faster, cheaper, and safer delivery, an advantage far more significant for high-value silver shipments than low-value bulky commodities. For example, in the 1930s, trains only needed four hours (or six hours in 1908) to travel between Shanghai and Hangzhou, compared with 24 hours needed by water.[49] The gradual decline in rail freight made rail transport even cheaper than waterways by the 1920s and 1930s, especially along the Yangtze

[47] Nevertheless, the financial integration between these two major cities was reflective of the urban economy in their respective macro-regions. Given the hierarchical financial network, with Tianjin serving as the centre of northern China and Shanghai as the centre of both the Lower Yangtze and the whole of China, they acted to balance the peaks and troughs of cash expenditures in different cities. As Ma, 'Traditional finance', p. 353, observes, during the peak season for trade in northern agricultural products, silver currency was shipped from Shanghai to Tianjin and thence distributed to other places through the Tianjin money market. When enormous amounts of currency were moved to northern markets, millions of silver dollars were shipped into Shanghai from areas with surplus currency in South China. That is, currency was not shipped directly to the north from southern cities, but with Shanghai and Tianjin as the centres intermediating between them.

[48] In Chongqing, the main currency was a 10-tael unit sycee, with the national and other silver dollars used as subsidiaries. See, for example, Anonymous, 'Chongqing zhi Tongyong Huobi' ['The currency in Chongqing'], *Yinhang Zhoubao* [*Banker's Weekly*], 10, 23 (1918), p. 19. In Guangzhou, the principal currency was the haoyang, which contained 18.81 grams of fine silver; Lewis and Wang, 'Wholesale prices', p. 92.

[49] Yue, 'Jindai Changjiang', p. 160.

River.[50] More importantly, with modern insurance, rail transport was far more secure than traditional land routes.[51] As seen in table 5, railroads reduced silver points by over 0.15 percentage points, a substantial reduction given that the average silver point is 0.59.

Likewise, the expansion of new information infrastructure such as postal services and telegraphs from the late nineteenth century on also rapidly enhanced money market integration, as vividly captured in the following newspaper report on 26 August 1932: 'Yesterday morning, a certain native bank in Tianjin received a telegram saying there was a surge in the price of the silver dollar in Shanghai; this was immediately followed by a spike in the silver dollar in Tianjin. But shortly that afternoon, another telegram arrived to say this was false information. Very quickly the silver dollar market in Tianjin returned to its original state'.[52]

Another more consequential factor is the monetary and financial transformation marked by the rise of the modern banking system from the end of the nineteenth century. By 1911, China saw the establishment of important government banks such as the Bank of China and the Bank of Communication, as well as 17 private commercial banks, mostly clustered in western treaty ports such as Shanghai which offered relative security and favourable property rights regimes, particularly during the recurrent phases of national instability following the 1911 political regime change. Shanghai saw the rise of a strong and largely autonomous banking community led by the Chinese Bankers' Association (CBA) and the Native Bankers' Association (NBA), established in 1915 and 1917, respectively. They coordinated collective action, established trading standards, and published important financial statistics.

Although it was the Beijing government that issued the national dollar, banking communities played a key role in defending its reputation and purity.[53] It was the CBA that coordinated with modern Chinese banks to close the exchange market for the dragon dollar and eagle dollar in 1915 and 1919 in Shanghai, respectively, and to opt for a single national dollar exchange market. Over time, the 'countable' dollar outperformed 'weighable' sycee as a medium of exchange, gaining an increasing share in China's monetary system. For instance, in the silver reserve of Shanghai banks, the ratio of silver dollars relative to silver ingots (sycee and bar silver) measured in value was 0.37 in 1918, but rose dramatically to 0.63, 0.88, 1.00, and 2.29 in 1921, 1925, 1928, and 1931, respectively.[54] This eventually paved the way for the currency reform of 1933 under the Nanjing government, which abolished sycee and taels and retained the dollar as the sole monetary standard.

[50] For example, in the 1920s, silver shipments by rail for Shanghai–Nanjing and Shanghai–Zhenjiang routes cost 0.14% and 0.15% compared with 0.33% and 0.27% respectively for waterways; Jin, *Guonei Shangye*, pp. 19–20.

[51] The robbery of silver shipments on the land route was frequently reported in the *Shenbao* newspaper. See, for example, the issues for 2 Nov. 1902, p. 12; 8 Sept. 1906, p. 17; 31 March 1907, p. 12.

[52] Morota, 'Money supply', p. 378.

[53] A prominent example was the debasement incident in 1925. When it was brought to light that thousands of debased dollars were circulating in Shanghai, the CBA and NBA telegraphed the Ministry of Finance, the Jiangsu civil authorities, and the Nanjing Mint; *North-China Daily News*, 28 Aug. 1925, p. 12. After an investigation order by the Jiangsu provincial governor, within a week the Shanghai constabulary discovered the mint and models of the debased dollars. At the request of the CBA and NBA, the debased dollars were finally redeemed by the Jiangsu provincial authorities and destroyed; *China Press*, 16 Sep. 1925, p. 1.

[54] People's Bank of China, *Shanghai Qianzhuang*, p. 584.

Another monetary transformation was the increasing popularity of banknotes and deposits, associated partly with the rapid growth of new financial instruments such as public debt.[55] The system of Chinese bank note issuance was largely run on a model of free banking with multiple public and private banks, Chinese or foreign, issuing silver-convertible banknotes based on a reputation mechanism. Again, the Chinese banking communities initiated efforts to enhance the reputation of banknotes by publishing statistics on bank reserves of note-issuing banks and establishing independent monitoring committees as well as other institutional innovations.[56] The substitution effect of banknotes over silver specie became increasingly obvious, as Feng observed: 'In recent years, banknotes are widely used in Inland and agricultural producing areas ... Even in times of political unrest and economic turmoil, banknotes remain unblemished in creditability and convertibility'.[57] Newly compiled macro-statistics reveal that while total money supply (M1) increased at an annual rate of 4.3 per cent, the banknote and deposit components of M1 surged at a remarkable annual rate of 9.5 per cent in the years 1910–35.[58] It seems that the turning point marked by a sharp uptick in the overall trend of banknotes and deposits fell around the year 1917/18, which broadly corresponds to the timing of the rise of Chinese modern banking, transportation, and information infrastructure.

Understandably, Shanghai played a key role in China's monetary transformation, with convertible banknotes issued by large banks, sometimes generally referred to as 'Shenchao' (Shanghai notes), circulating in major commercial centres with no discount by the 1920s.[59] We can examine the impact of banknotes on money supply by examining the seasonal patterns in banknotes issued and the silver reserves of the banks in Shanghai. As we can see in figure 8, the seasonal patterns in banknote issue and silver reserves have an inverse relationship, indicating that banks adjusted note issues and reserve ratios to mitigate cyclical demand for cash. In figure 8, we also insert the seasonal patterns in Shanghai yangli, calculated by regressing the Shanghai yangli on 12 seasonal dummies, with the monthly coefficients normalized to sum to 1 over a 12-month period. It shows that the quantitative patterns of banknote issues more or less track the peak and trough of yangli (with highs during peaks in agricultural trade and during the squaring of accounts at the end of the Chinese lunar year, and lows in the summer).[60] Given that the 1910s marked the rise of modern banking, this may indicate that increasing note issues provided a

[55] The rise of Chinese governmental bonds was closely connected with China Maritime Customs, administered mostly by British staff. The domestic banks were the largest bondholders, which held bonds both for investment and as a reserve to cover banknotes. China's banking regulations allowed banks to use governmental bonds—in the range of 40%—to serve as reserves for banknotes, with the rest in some form of specie; Brandt and Sargent, 'Interpreting new evidence', p. 34.

[56] Yang, *Zhongguo Jinronglun*, pp. 124–5.

[57] Feng, 'Yangli yu Yinchai', p. 42.

[58] Rawski, *Economic growth*, p. 157.

[59] For the circulation of banknotes outside the borders of the issuing branch, and in particular the circulation of Shenchao in Hankou during the 1920s, see Kuroda, 'Collapse', p. 116. On the circulation of Shenchao in Tianjin, see Morota, 'Money supply', p. 388.

[60] The amplitude of the seasonal pattern in Shanghai yangli is approximately 0.8% of parity value. That is, yangli is approximately 0.4% higher than average in the autumn and February, and 0.4% lower than average in the summer. The seasonal patterns of yangli in Hankou roughly correspond with the Shanghai series.

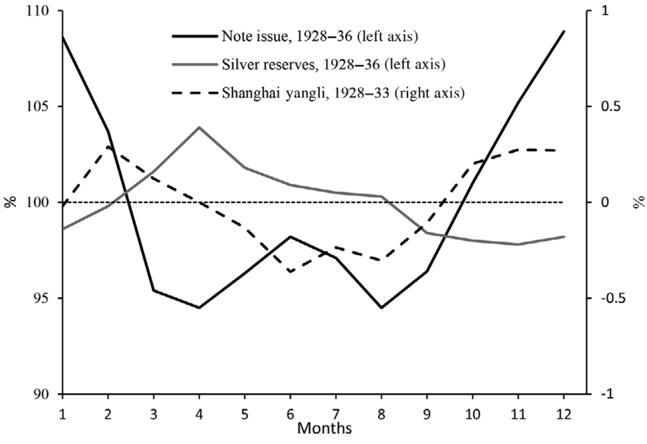

Figure 8. *Seasonal patterns in yangli, note issue, and silver reserves of banks in Shanghai, 1928–36*

Notes: Note issue represents the total volume of the 10 biggest banks in Shanghai. 'Silver reserves' are the total reserves of all banks in Shanghai.
Sources: The data for the seasonal patterns in note issue and silver reserves are taken from Wu and Hu, 'Shanghai Jinrongzhi Jijie', p. 480. Seasonal patterns in yangli are estimated by the authors.

much more elastic currency to smooth the seasonality of the money market and enhance market integration across Shanghai, Tianjin, and beyond.[61]

V

Based on the compilation of high-frequency monetary data and rigorous econometric tests, this article has contributed new insights into Chinese monetary integration and economic performance in the late Qing and Republican eras and the workings of silver regimes in historical eras. Throughout the whole tumultuous period in our sample, the years 1898–1911 were relatively stable under a single government until the collapse of the Qing dynasty in 1911 which heralded a period of economic and political disruption. But it was precisely from the 1910s that Chinese monetary and financial transformation took off, and continued throughout the 1920s and 1930s in spite of disruptions from warfare and revolution.[62] While political changes alone were not solely responsible for the financial transformation during China's Republican era, it seems that a combination of domestic improvements coalesced to improve the efficiency of China's silver regime. In particular, China's move from sycee and imported silver dollars toward a single national silver dollar, and eventually toward credible banknotes convertible to silver, became the hallmark of its transformation in its domestic monetary system. Prolific discussion in the literature on the choice of the

[61] There is much literature on the change in the seasonality of monetary markets in gold standard countries. In particular, studies have emphasized that following the creation of the Federal Reserve System in 1914, seasonality in nominal rates almost completely disappeared, partly due to the Fed's anti-seasonal monetary policy to smooth interest rates at that time. See, for example, Miron, 'Financial panics'; Meltzer, *History*.

[62] Like many other market integration studies, our data are limited to major urban centres along the coast or main transport routes only.

gold versus the silver standard for China has neglected this most critical element of the country's internal monetary issues.[63]

More importantly, the monetary and financial transformation occurred in a context of institutional revolution, championed by China's civil and commercial group from below, during the country's relatively rare political decentralization phase in the Beiyang period. It was ironic that monetary fragmentation that had actually prevailed under China's traditionally highly centralized political regime was gradually overcome in an era of political decentralization and disintegration during the early twentieth century. Hence, our study also hints at the central role of political institutions as a possible key to understanding the great divergence between western Europe and China in the early modern era.

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[63] For example, Brandt and Sargent, 'Interpreting new evidence'; Friedman, 'Franklin D. Roosevelt'; Rawski, 'Milton Friedman'; Shiroyama, *China during the Great Depression*, pp. 16–36.

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