The London School of Economics and Political Science

Interest Rates and Financial Market Integration – A Long-run Perspective on China

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Declaration

I certify that the thesis I have presented for examination for the Phil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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I declare that my thesis consists of 65,233 words, inclusive of footnotes and appendices but exclusive of bibliography.

Abstract

This thesis takes interest rates as the topic of interest, and studies financial market integration in China.

Paper I studies structural determinants and temporal coefficients of interest rates scattered over 6th-20th century China. Detailed findings concern intrinsic loan features (such as maturity and creditor type, among others) and how they affected the interest rate level. Overall, interest rates decreased in the markets under study, with fluctuations corresponding with dynastic cycles, up-and-down. The two interest rate troughs are found around the 9th-11th century of the Song dynasty and the 19th century of the late Qing period. Significant events of political economy (wars and recovery, international relations and trade, etc.) significantly affected interest rates, but mostly through temporary shocks; economic development and its ensuing financial advancement (in institution, innovation, markets, etc.) tended to show qualitative and long-run impact on financial markets and interest rates.

Part II estimates financial integration regarding 14th-20th century China.

Firstly estimated is pair-wise integration based on time-series data in 18th-20th century China. Before 1840, distance was the major (but not the only) determinant of financial integration. The maximum range of financial integration at the time was up to 1,400 kilometres, which was slightly farther than that of commodity (grain) integration and confirms the macro-region theory of Skinner in that there was little cross-regional market interplay. However, the overall integration performance for the period before 1840 was limited, with large gaps between distance groups regarding both interest divergence and adjustment speed. A national financial market did not seem to emerge until the 19th century, when both local and cross-regional capital markets became more homogeneous (with converging interest rate gaps and synchronising arbitrage speed). However, the final wars (the 2nd anti-Japanese war and the 2nd civil war in China) before the People's Republic of China (PRC) stopped this integration process.

Secondly, overall integration among 23 provincial markets scattered over 57 years in the Ming and Qing period may be explained by three factors: education, population, and the relative position of the local market to all other markets. The spatial autoregressive coefficients were negative, suggesting that a local provincial market was negatively related to all other markets. Education and population represent the influence of innovation and commerce on overall integration respectively. They are positively associated with interest rate gaps, hence negatively connected to integration. However, such negative relationships might denote financial development in local markets, which lowered local interest rates and temporarily enlarged the interest rate gaps. Neither arable land nor warfare involvement was significant in explaining overall financial integration.

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Introduction

Market integration indicates a level of sophistication in an economy, many studies of development economics stem from integration research.[1] This thesis takes interest rates as the object of interest, and studies financial market integration in China. It consists of two parts: Part I studies interest rates scattered over 6th-20th century China and their structural determinants; Part II gauges and explains financial integration in markets and years under study in 14th-20th China. Part I paves way to Part II with a historical background in both data and financial development.

The thread of reasoning that ties together all the chapters is geographical influences on interest rates and financial markets. Specifically, Chapter 1 addresses the following questions:

- How did interest rates develop in markets under study from 6th to 20th century China? Meanwhile, how did financial markets, institutions and credit tools develop?
- What internal features of loans defined interest rates, and to what extent?
- What external social-economic factors influenced interest rate levels? How significant was geographic determination (provincial and regional location) of the interest rate?

Chapter 2 gauges pair-wise integration performances based on interest rate data

[1] For example, please see:
Süleyman Özmucur and Sevket Pamuk, "Did European Commodity Prices Converge before 1800?," in *The New Comparative Economic History: Essays in Honour of Jeffrey G. Williamson*, ed. Timothy J. Hatton, Kevin H. O'Rourke, and Alan M. Taylor (Cambridge MA, 2007), 59–85.
Giovanni Federico and Gunnar Persson, "Market Integration and Convergence in the World Wheat Market, 1800-2000," in *The New Comparative Economic History: Essays in Honour of J. Williamson*, ed. Kevin and Alan M. Taylor Hatton, Tim, O'Rourke (Cambridge, 2007), 87–114.
Giovanni Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy," *Explorations in Economic History* 44, no. 2 (2007): 293–316.
Carol H. Shiue and Wolfgang Keller, "Markets in China and Europe on the Eve of the Industrial Revolution," *American Economic Review* 97, no. 4 (2007): 1189–1216.
Jan Tore Kloveland, "Commodity Market Integration 1850-1913: Evidence from Britain and Germany," *European Review of Economic History*, no. 9 (2005): 163–97.
David S. Jacks, "Intra- and International Commodity Market Integration in the Atlantic Economy, 1800-191," *Explorations in Economic History* 42, no. 3 (2005): 381–413.
Rafael Dobado and A. Marrero Gustavo, "Corn Market Integration in Porfirian Mexico," *Journal of Economic History* 65, no. 1 (2005): 103–28.

scattered over 18th to 20th century China. Specifically, the following research questions are discussed:

- Statistically, two aspects of financial integration are measured: market convergence and market efficiency. Detailed research questions include:

  How large were interest rate gaps between two capital markets? (divergence)
  How similar was the movement of their interest rates? (correlation)

  How fast could traders in different markets eliminate interest rate gaps by arbitrage? (adjustment speed) or, how fast was interest fluctuation smoothed? (efficiency)

- Historically:

  When did a national financial market begin to form in China?
  How did financial markets perform compared with commodity (grain) markets regarding market integration?
  Did Chinese financial markets correspond with the Macroregion framework of G. William Skinner?[2]

Lastly, Chapter 3 looks into overall integration among multiple provincial markets over 57 scattered years during the Ming-Qing period (1368-1910). Detailed research questions cover: What factors explained the overall integration among the multiple provincial markets? How did the explanatory variables (such as the acreage of arable land, the size of population, the level of education and political stability) affect financial integration at a macro-level among provinces? Did the result of macro-level integration here match that of pair-wise integration at a micro-level in Chapter 2?

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[2] The Nine Physiographic macroregions are defined by Skinner based on his studies on China's rural market structure. According to his theory, because of the differences in geomorphological features, travel-constraining factors, social economic conditions, etc. these regions experienced unsynchronized developmental macrocycles; there was little connection between or among these regional economies. For further references, please see:

G. William Skinner, "Regional Urbanization in Nineteenth-Century China," in *The City in Late Imperial China*, ed. G. William Skinner (Stanford: Stanford University Press, 1977), 211–49.

G. William Skinner, "Marketing and Social Structure in Rural China, I," *Journal of Asia Studies* 24, no. 4 (1964): 3–43.

G. William Skinner, "Marketing and Social Structure in Rural China, II," *Journal of Asia Studies* 25, no. 1 (1965): 195–228.

First of all, here is an introduction of the core concept. Research on "financial market integration" largely requires the same theoretical and methodological tools as research on commodity markets. It sheds light on pricing mechanisms and market development. Cournot described an integrated market as "an entire territory of which the parts are so united by the relations of unrestricted commerce that prices take the same level throughout with ease and rapidity".[3] Namely, the pillar of integration theories is convergence, a process by which prices (or interest rates) become more similar. Namely, to which degree markets complied with the Law of One Price?[4] Here we stress "the degree", because a price gap of zero between or among markets is barely reached or maintained. The law of one price stands for an ideal equilibrium where all identical goods must have only one price across markets. However, such a perfect integration status cannot be fully achieved; it is impossible due to an omnipresent transaction cost for any two markets to maintain perfect correlation. The status of interdependence is always somewhere in between full integration and complete fragmentation, in which sense it becomes a matter of degree.

Barrett and Li further modified the concept by taking it as a dynamic process. According to them, market integration is defined as "tradability or contestability between markets including the market clearance process (in which the demand, supply, and transaction costs in distinct markets jointly determine prices and trade flows), as well as the transmission of price shocks from one market to another, or both".[5] This transmission process involves co-movement or arbitrage between or among markets. It concerns the following questions: How long could "an initially localized scarcity"[6] (of goods or

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[3] Augustin Cournot, *Mathematical Principles of the Theory of Wealth* (London: Macmillan, 1897), 51., or

Augustin Cournot, *Mathematical Principles of the Theory of Wealth* (New York, 1971), 51-52.

Augustin Cournot, *Recherches Sur Les Principles Mathematiques de La Theorie Des Richessesses* (Paris, 1838).

[4] Giovanni Federico, "How Much Do We Know about Market Integration in Europe?," *The Economic History Review* 65, no. 2 (2012): 470–97.

O.A. Lamont and R.H. Thaler, "Anomalies: The Law of One Price in Financial Markets," *Journal of Economic Perspectives* 17 (2003): 191–202.

[5] Christopher B. Barrett and Jau Rong Li, "Distinguishing between Equilibrium and Integration in Spatial Price Analysis," *American Journal of Agricultural Economics* 84 (2002): 292–307.

[6] Martin Ravallion, "Testing Market Integration," *American Journal of Agricultural Economics* 68 (1986): 102–9.

capital) persist? How soon did prices return to their equilibrium level after a shock?[7] Or, how quickly did traders of different markets react to market gaps and arbitraged them away? In this sense, the other pillar of the integration research concerns adjustment speed, or efficiency.

Information transmitting plays a key role in determining when and how to start arbitrage, as indicated by the Efficient Market theory of Fama.[8] However, in the real world, the market clearance process involves not only price transmission; social economic institutions and their transaction costs could also affect price synchronisation and market integration. Indeed, "In financial markets, these depend on fees, liquidity or supply of credit, and so on; and in commodity markets on transport costs as well. A market can be perfectly efficient in the analytical framework of Fama, but very operationally inefficient, and vice versa."[9] In other words, news travels fast enough, but goods or capital cannot make the move in time, say, due to redundant administrative procedures, or paralysed transport systems.

0.1 Why Market Integration?

Markets play a critical role in economic evolution, hence an intriguing theme of debate. Scholars may relate market development to commercialisation, urbanisation, and the intensive growth of modernisation and many other fields of research. It is not strange that since Adam Smith,[10] mainstream economists have long stressed the significant role played by markets in long-term economic growth. From a micro-economic perspective of producers, market development enhances the division of labour and specialisation.

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[7] Federico, "How Much Do We Know about Market Integration in Europe?", 471.

[8] The Efficient Market theory defines markets into several categories. A weakly efficient market is a market where market agents know only information of prices; a semi-strongly efficient market is a market where market participants know other relevant information than just prices; and a strongly efficient market is where market players have access to all the related information. For details, see

F. Eugene Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance* 25, no. 2 (1970): 383–417.

M Lo, "Market Efficiency Hypothesis," in *Encyclopedia of Finance*, ed. C.F. Lee and Lee A.C. (New York, 2006), 585–90.

Philip H. Dybvig and Stephen A. Ross, "Arbitrage," in *The New Palgrave Dictionary of Economics*, ed. J Eatwell, M Milgate, and P Newman (London and Basingstoke, 1987), 100–109.

[9] Federico, "How Much Do We Know about Market Integration in Europe?", 476.

H.S. Houthakker and P.J. Williamson, *The Economics of Financial Markets* (New York and Oxford, 1996).

[10] Smith Adam, *An Inquiry into the Nature and Causes of the Wealth of Nations*, ed. E. Cannan (New York, 1937).

Then follows a series of economic changes, such as technological progress, productivity growth, comparative advantages based on enhanced skills, and increasingly intensive competition. As a result, resource-allocation becomes more efficient and capital return increases, leading to more capital accumulation and economies of scale.[11] From a macro-perspective, market expansion is a process during which small regional markets integrate and merge into a larger entity. It is an overall result of regional dynamics or of the interaction among sub-markets. The process not only involves commodity or capital flows, but also the spill-over of price information and diffusion of technologies,[12] and eventually regional or national growth.

Market integration has been a hot topic in recent decades. European commodity markets, especially grain markets, forged the starting point for this field of research. As of the end of 2009, there have been at least 61 studies using empirical methods to deal with the integration of over 200 European commodity markets.[13]

Specifically, regarding market integration on a national scale, Federico studied the wheat market integration in 19th century Italy. He showed that wheat prices converged before political unification during 1859-1861, but the integration process stopped in the 1860s until its revival in the 1870s and 80s. He attributed the first wave of integration to market efficiency improvement and the second to a reduction in transport cost. Similar works can be found regarding Britain,[14] France,[15] Germany,[16] Poland,[17]

[11] Paul Krugman and J. Anthony Venables, "Globalization and the Inequality of Nations," *Quarterly Journal of Economics* CX, no. 4 (1995): 857–80.
[12] Keller Wolfgang, "Are International R & D Spillovers Trade-Related? Analyzing Spillovers among Randomly Matched Trade Partners," *European Economic Review* 42 (1998): 1469–81.
[13] Federico, "How Much Do We Know about Market Integration in Europe?", 471-473.
[14] Mette Ejrnæs, Karl Gunnar Persson and Søren Rich, *Feeding the British, Convergence and Market Efficiency in 19th Century Grain Trade*, Discussion Paper (28) 2004, Department of Economics, University of Copenhagen.
[15] Mette Ejrnæs and Karl Gunnar Persson, 'Market Integration and Transport Costs in France 1825–1903: A Threshold Error Correction Approach to the Law of One Price', *Explorations in Economic History*, 37.2 (2000): 149–73.
[16] Carol H. Shiue, "From Political Fragmentation towards a Customs Union: Border Effects of the German Zollverein, 1815 to 1855," *European Review of Economic History* 9, no. 2 (2005): 129–62.
[17] Carsten Trenkler and Nikolaus Wolf, "Economic Integration across Borders: The Polish Interwar Economy," *European Review of Economic History* 9 (2005): 199–231.

Russia,[18] the U.S.A,[19] and Mexico.[20]

On a continental or intra-European scale, Özcumur and Pamuk denied the existence of "pan-European integration" from the 17th to the early 19th century.[21] It may be interesting to check their understanding against various thoughts of other scholars. More optimistic is the idea of Persson, who detected a regional integration trend in the 18th century for wheat markets.[22] Bateman inspected European markets for grain; mostly wheat markets as well. Her work demonstrated that European markets experienced a U shape path of integration, with a higher level of market integration at the beginning (15th century) and the end (the eve of industrialisation), while with poor performance in the middle (16th and 17th century). Since Industrialisation occurred after poor market development, her findings challenge conventional wisdom since Adam Smith that takes market development as the engine of development and long-term growth.[23] Following this timeline, another study of Federico focused on the period from the mid-18th century to the eve of the first globalisation, looking into European markets for wheat, rye and candles. It found that price dispersion remained constant until the Revolutionary and Napoleonic Wars when it soared. The post-war years saw a steady integration trend again until an all-time low in the 1860s. Thus he concluded that integration level during most of the time studied here was determined by war and political events.[24]

What is more, there is literature on a cross-continental scale of research. O'Rourke and Williamson [25] believed that despite the growth trade connection there was no

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[18] J. Metzler, "Railroad Development and Market Integration: The Case of Tsarist Russia," *Journal of Economic History* 34 (1974): 529–49.

[19] C.A Harrison, *Wholesale Commodity Prices in the United States 1700-1861* (Cambridge: Harvard University, 1938). J. G Williamson, "Greasing the Wheels of Sputtering Export Engines: Midwestern Grains and American Growth," *Explorations in Economic History* 17 (1980): 189–217.

[20] Dobado and Gustavo, "Corn Market Integration in Porfirian Mexico."

[21] Özmucur and Pamuk, "Did European Commodity Prices Converge before 1800?"

[22] Karl Gunnar Persson, *Grain Markets in Europe, 1500–1900 Integration and Deregulation* (Cambridge, 1999), 100.

[23] Victoria N. Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price," *Discussion Paper Series, Department of Economics,University of Oxford* 350 (2007).

[24] Giovanni Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870," *Working Papers HEC, of Department of History and Civilization, European University Institute* 1 (2008).

[25] K. H. O'Rourke and J. G. Williamson, "When Did Globalization Begin?," *European Review of Economic History* 6 (2002): 23–50.

transatlantic integration in the early modern era,[26] whereas Rönnbäck[27] stood up with integration evidence in some commodity markets. Federico and Persson examined the co-movement between the United States and the United Kingdom from 1800 to 2000. They concluded that trade policies on duties, rather than international transport cost, determined the integration level of transatlantic wheat markets.[28]

In general, findings about market integration so far may be summarized as follows.[29] First, the late Middle-Ages and the early modern period featured a succession of waves of integration and disintegration without a clear trend both within Europe and/or between the continent and its colonial empires. Second, the domestic markets of the major European countries integrated from the early 19th century and the process was completed by the First World War, if not before. Third, the integration across countries increased in the first half of the 19th century, but afterwards the process was slowed down or reversed by protectionist reactions, until the market disintegrated during the Great Depression.

Current literature on integration may be limited in spatial coverage; major efforts have been made on European markets. By contrast, much less work has been produced on continents or areas of late development, such as many countries and regions in the Middle East, Africa or Asia; this is understandable, since Europe was where industrialisation began. Adam Smith took market as a source of modern growth, and that became a motive for researchers to study the relationship between market integration and growth. European markets of course were the first to come into the spotlight. Not to mention the theory of integration, which also originated from European academics, and it is a natural tendency for people to start from something that they are

[26] In history, the early modern period of modern history follows the late Middle Ages, but the chronological limits of the period are open to debate. In the case of Europe, it usually refers to the period from the 14th century to the 18th century, for example, see Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price." Hereafter, the timeframe in the case of China spans the dynasties of Ming (1368-1644) and Qing till the Opium War (1644-1840).
[27] K. Rönnbäck, "Integration of Global Commodity Markets in the Early Modern Era," *European Review of Economic History* 13 (2009): 95–120.
[28] Federico and Persson, "Market Integration and Convergence in the World Wheat Market, 1800-2000", 93-97.
[29] Federico, "How Much Do We Know about Market Integration in Europe?"

familiar with. In addition, there is always the issue of data availability. Many studies in this field of research were data-driven. Therefore, this paper means to enrich this field of research with more of an Asian perspective of story, specifically, with some new sources of financial data in China.

0.2 Why Financial Market and Interest Rates?

Integration research can cover both product and factor markets. The former involves the circulation of commodities and moneys such as trade and its ensuing exchange activities; the latter, that of production factors such as capital (credit and investment behaviour) and labour (cross-regional migration). The amount of literature on capital market integration is smaller, though it has increased with the development of modern and international financial markets. However, compared with commodity markets, financial markets may present economic historians with a greater value of research.

Firstly, financial markets are more influential upon the economic structure and the economic efficiency in resource allocation. Capital is an essential productive factor, which has the high power of mobilising other input factors (such as raw materials and labour) and commodities (such as semi-manufactured goods). Financial markets are a metabolic system that can convey capital to every part of an economy. Commodity flow always involves money flow in a reverse direction; where most lucrative businesses are, capital also clusters. Understandably, there has indeed been a lot of literature studying the relationship between finance and the macro-economy. For instance, R.W. Goldsmith[30] detected a positive link between financial development and economic growth in 35 countries, starting modern theories of financial development. Robert King and Ross Levine[31] also proved a positive link between initial status of financial development and subsequent increase in Total Factor Productivity and individual

[30] Raymond W. Goldsmith, *Financial Structure and Development* (New Haven: Yale University Press, 1969), 33.
[31] Robert G. King and Ross Levine, "Finance and Growth: Schumpeter Might Be Right," *Quarterly Journal of Economics* 108 (1993): 717–37.

income in 80 countries. The McKinnon-Shaw[32] School, too, proved the case but from the opposite point of standing: they demonstrated how financial depression policies inhibited the economic development in developing countries after World War II. It is now hardly questionable that financial development contributes to growth, hence the research significance of financial markets.

Secondly, financial integration can be more revealing about price information transmitting across markets, hence more revealing on market integration. This is because transport cost affects capital flow less than commodity circulation. The former featured more standardized and valuable goods (for example, coins) and frequent innovation in credit tools (paper notes); whereas the latter relied much more heavily on transport conditions of the time. "Most of the factors responsible for financial integration can be expected to influence the integration of other markets for goods with favourable weight-value ratios".[33] This makes capital flow a better indicator of price transmission, and a more suitable benchmark for integration research than other markets. It follows that policy makers all over the world have become increasingly concerned about both the benefits and risks of financial integration.[34] At the very least, an understanding of capital market integration can help policy makers predict and prepare for financial shocks from adjacent or connected markets; it may also enlighten economic historians who seek to learn from past financial crises.

The next question is: why are interest rates the object of study?

Early research on European financial market integration focused on such tradable financial devices as stock or bonds since the 17th century. For instance, Larry Neal[35]

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[32] Ronald I. McKinnon, *Money and Capital in Economic Development* (Washington D.C.: The Brookings Institution Press, 1973).
Edward S. Shaw, *Financial Deepening in Economic Development* (Oxford University, 1973).

[33] David Chilosi and Oliver Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520," *Journal of Economic History* 71, no. 3 (2011): 762–91.

[34] Risks in financial integration can be found in financial crisis that spread quickly among countries. For example, typically, there were the 1998 financial crisis among South-east Asian countries, and the 2008 American financial crisis out of secondary mortgage securities.

[35] Neal Larry, "Integration of International Financial Markets: Quantitative Evidence from the Eighteenth to Twentieth Century," *The Journal of Economic History* 45, no. 2 (1985): 219–26.

produced a short paper on stock price difference between Amsterdam and London during crisis years from the 18th to 20th century. Toniolo, Conte, and Vecchi [36] investigated debt of the Italian state across several Stock Exchanges from 1862 to 1905, finding that the prices of the Rendita Italiana failed to fully converge until 1887 (at 5%) due to institutional failure to check rent-seeking behaviour of local vested interests. Also, the spread of information and communication technology, trade volumes and the diffusion of the "single currency" were not driving forces strong enough to push that course of financial integration.

Nonetheless, to trace back further into history, we have to deal with the fact that such modern financial instruments were not available. Then, money markets[37] and exchange rates among metallic currencies become the object of interest for scholars in this field of research. Data of European exchange rates start to be available from the 13th century.[38] A representative paper of these was conducted by Chilosi and Volckart,[39] who studied currency market integration of central Europe from 1400 to 1520 based on exchange rates. The study found a cyclical fashion of financial integration under the influence of money supply, and that long-distance integration was linked to political factors like the emergence of territorial states. Other related works include Boerner and Volckart,[40] Kugler,[41] Canjels, Prakash-Canjels and Taylor,[42] and Schubert.[43]

Still, if going further back to where there were neither advanced financial tools such as bonds and equities, nor sufficient data of exchange rates, we have to consider a primary

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[36] G. Toniolo, L. Conte, and G. Vecchi, "Monetary Union, Institutions and Financial Market Integration: Italy, 1862–1905," *Explorations in Economic History* 40 (2003): 443–61.

[37] Here the concept of "money market" is not in the sense of short-run credit tools, as opposed to the "capital market" of long-term credit tools in the modern framework of financial economics. Rather, it simply means exchange markets for metallic moneys like gold coins or silver coins in the ancient times.

[38] Peter Spufford and S. Wilkinson, W., *Handbook of Medieval Exchange* (London: Woodbridge for the Royal Historical Society, 1986).

[39] Chilosi and Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520."

[40] Lars Boerner and Oliver Volckart, "Currency Unions, Optimal Currency Areas and the Integration of Financial Markets: Central Europe from the Fourteenth to the Sixteenth Centuries," *EUI Working Papers, Florence: European University Institute* MWP 2008, no. 42 (2008).

[41] Peter Kugler, "Financial Market Integration in Late Medieval Europe: Results from a Threshold Error Correction Model for the Rhinegulden and Basle Pound 1365-1429," *Working Paper, University of Basel*, 2009.

[42] E. Canjels, G. Prakash-Canjels, and A. M. Taylor, "Measuring Market Integration: Foreign Exchange Arbitrage and the Gold Standard, 1879-1913," *Review of Economics and Statistics* 86 (2004): 868–82.

[43] E. S. Schubert, "Nnovations, Debts, and Bubbles: International Integration of Financial Markets in Western Europe,1688-1720," *Journal of Economic History* 48 (1988): 299–306.

and essential financial instrument. In this case, the debt instrument of loan appears to be an obvious candidate. Loans were the first and a most commonly seen financial device in China's financial history. The tool has played a significant role in financial markets for thousands of years, either in the form of consumption capital or reproduction capital. Many Chinese scholars have studied loans and credit behaviour in China, such as Yang Lien-sheng,[44] Xiong Zhengwen,[45] Li Jinzheng,[46] Liu Qiugen,[47] Qiao Youmei,[48] Qi Xia,[49] among others. Grounded on their works, we can go further to find more data, even to fill the gap of research in a very early period of history.

On top of historical availability, spatial availability is another factor to consider. Essentially, an integration study is a cross-sectional comparison of prices; thus, it needs to be based on homogeneous products across different markets in different regions. This is why wheat, rather than rice or tea, is often selected for occidental commodity market integration studies. Wheat spread across the continent of Europe for thousands of years and its core quality remained stable across regional markets. This makes it feasible to compare wheat prices on different markets across space. So is the case of rice in research of commodity market integration in East Asia; and that of loans and interest rates in financial market research. Loans were the first financial tool in Chinese financial history, and commonly seen all over the country,[50] which makes interest rates an appropriate object of research on China's financial integration.

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[44] Lien-sheng Yang, *Money and Credit in China: A Short History* (Cambridge: Harvard university press, 1971).

[45] Zhengwen Xiong 熊正文, "Zhongguo Lidai Lixi Wenti Kao 中国历代利息问题考 （A Study of Interest Rates in Chinese Dynasties）" (Thesis of Yan-jing (Peking) University, 1934).

[46] Jinzheng Li 李金铮, *Minguo Xiangcun Jiedai Guanxi Yanjiu 民国乡村借贷关系研究(A Study on Rural Credit Activities in Republican China）* (Beijing: People's Publishing House, 2003).

[47] Qiugen Liu 刘秋根, "元代官营高利贷资本论述 (A Study on Usury Capital in the Yuan Dynasty)," *文史哲 (Literature, History and Philosophy)*, no. 3 (1991).

Qiugen 刘秋根 Liu, *Ming Qing Gaolidai Ziben 明清高利贷资本(Usury Capital during the Ming-Qing Period)* (Beijing: 社会科学出版社 Social Sciences Documentation Publishing House, 2000).

[48] Youmei Qiao 乔幼梅,"宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)," *Zhongguo Shehui Kexue 中国社会科学* 3 (1988): 214.

[49] Xia Qi 漆侠, "宋代的商业资本和高利贷资本 (Commercial and Usury Capital in the Song Dynasty)," in *宋史研究论文集 (A Collection of Papers on the Song History)* (Henan Renmin Chuban She, 1984).

[50] For more details on the development of capital market tools, please refer to Xinwei Peng 彭信威, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*, 2nd ed. (Shanghai, 1957)., or any other financial annals of China.

Furthermore, data availability in time and space is subject to structural features of the data under study (prices, in the case here, interest rates). In this respect, loans have another competitive edge over equities or other financial products. Again, we conduct an analogy between the capital and the commodity market. Grain is a representative commodity. Although grain markets can be different from other commodity markets, key factors that significantly influence grain market integration are likely to influence market integration of other products; it is possible to extend findings from the context of grain to other commodity markets.[51] Similarly, loans as an essential credit device play a similar role on financial markets as grain does on commodity markets. Formal features may vary, such as object borrowed, maturity term, or financial channel (through financial intermediary or private networking); however, the intrinsic mechanism of credit stays the same: borrowers pay for the time value of capital. This mechanism of investment and return is also applicable to other financial tools. Thus, findings on loans may be enlightening on other sectors of the financial market.

Another factor to note is the mathematical structure of interest rates. "There is more continuity over the centuries in interest rates than there is in most prices. This is because the interest rate is a ratio of like to like. Like-rates produce the same mathematical result in any era, in any currency, and at any given price structure. … the rate of interest is one of our closest statistical links with our economic past."[52] "Like to like" means that no matter what kind of loans (paper notes, silver or copper coins), their interest rates are highly comparable. This is because unlike commodity prices (heavily dependent on a unit of count such as grams and kilograms in weight, or square metres and acreages in area), interest rates are in percentage terms, namely, a ratio of interest return to the principal (which do not involve any units, but in the form of %). In this sense, interest rates can to a great extent avoid the problem of comparing apples with pears; there is an intrinsic attribute of compatibility in the mathematical structure of interest rates.

[51] Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price."
[52] Sidney Homer and Richard Sylla, *A History of Interest Rates* (New Brunswick, N.J.: Rutgers University, 1996), 57.

Therefore, this thesis chooses loans as the target market, and interest rates as the target price. Here we clear up some definitions. Note these hereafter (unless otherwise specified):

- interest rates collected for and studied by the present thesis are simple rates only, and compound rates[53] are not of concern here;

- by "loan" the thesis refers to debt capital in general, which involves a borrower and a lender, including both short-term loans (such as consumption capital) and long-term debt (such as real capital going to production);

- by "capital" the thesis means money borrowed for consumption, commerce or production;

- by "capitalist", we mean professionals who made profit from credit activities (not used in the Marxist sense[54] or suggesting any value judgement on exploiting the working class);

- by "financial market" or "capital market", it covers both indirect finance through financial intermediaries (such as banks or money shops), and direct finance between households or individuals (through their personal networking). To avoid comparing apples with pears, I will separate individual and institutional transaction data when estimating integration.

0.3 Why China in a Secular Perspective?

Although there is much of integration literature on European markets, little work has been done on market integration in Asia. An Asian perspective, particularly an Asia-finance perspective, may fill the gap of research in this field. The next part explains this paper's scope of research in time and space.

There are indeed some papers on Asia's commodity market integration. An example on

[53] A compound rate counts the interest payment for the current payment period (day, week, month or year) into the principal of the next payment period (day, week, month or year), so that the total interest payment increase by an exponential rate. See
C G Lewin, "An Early Book on Compound Interest - Richard Witt's Arithmeticall Questions," *Journal of the Institute of Actuaries* 96, no. 1 (1981): 121–32.
C G Lewin, "Compound Interest in the Seventeenth Century," *Journal of the Institute of Actuaries* 108, no. 3 (1981): 423–42.
[54] Karl Marx, "Pre-Capitalist Relationships," in *Capital (Vol.3)* (New York: International Publishers, 1894).

India was conducted by Studer[55] in a comparative dimension between Asia and Europe. And there are also a few papers on China. Carol Shiue and Wolfgang Keller based their market integration analysis on China's grain prices. They held that market performance in China was comparable with that of Western Europe overall in the late 18th century, but that England was better than both continental Europe and the Lower Yangzi Delta area of China.[56] Their empirical study also found that the degree of market integration in the 1720s was a very good predictor of per capita income in the 1990s. The current pattern of interregional income in China is well connected with geographic factors that were already apparent several centuries ago, long before the initiation of modern reforms.[57] Se Yan and Cong Liu made similar observations about the impact of weather shocks and transport (especially waterways) on grain market integration from 1742 to 1795. They concluded that market integration in the north was poorer than in the south, because natural endowments dictated that northern rivers failed to facilitate transport and trade as well as southern rivers.[58] There were more discussions about rice prices,

[55] Roman Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900" PhD thesis (*faculty of Modern History,* Trinity Term, Nuffield College, Oxford University, 2008).
[56] Shiue and Keller, "Markets in China and Europe on the Eve of the Industrial Revolution."
[57] Wolfgang Keller and Carol H Shiue, "Market Integration and Economic Development: A Long-Run Comparison," *Review of Development Economics* 11, no. 1 (2007): 107–23.
Carol H. Shiue and Wolfgang Keller, "The Origins of Spatial Interaction-Evidence from Chinese Rice Markets, 1742-1795," *Journal of Econometrics* 140, no. 1 (2007): 304–32.
[58] Se Yan and Cong Liu, "A Comparative Study of Market Integration between Northern China and South China Based on Grain Prices of Qing Dynasty,"*Journal of Economic Research* 经济研究 Dec (2011): 124–37.

made by Qaun,[59] Wang,[60] Chen,[61] Hou,[62] Lu and Peng,[63] Wu,[64] Cheung.[65]

An even starker contrast in the amount of studies is found on financial market integration of Asia and Europe. There is one representative study[66] on Japan's capital markets (1884-1925) by Mitchener and Ohnuki. They attributed improvement of financial market integration to technological diffusion, growth in commercial branches or institutional changes of banking networks.

However, financial market integration in modern China, to the best knowledge of the present author, remains largely a virgin field of research. This is especially the case when the time span under investigation extends further back into history than the early modern period. Most Chinese literature on traditional finance focused on institutions rather than markets, using qualitative rather than quantitative methods. Only a few touched on

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[59] Han-shang Chuan and Richard A. Kraus, *Mid-Ch'ing Rice Markets and Trade: An Essay in Price History* (East Asian Research Center, Harvard University: East Asian Research Center, Harvard University, 1975).

[60] Yeh chien Wang, Renyi Chen, and Shaohong Zhou, "Shiba Shiji Dongnan Yanhai Mijia Shichang de Zhenghexing Fenxi 十八世纪东南沿海米价市场的整合性分析 (Integration Analysis on Coastal Rice Markets in the 18th Century)," *Jingji Lunwen Congkan 经济论文丛刊* 30, no. 2 (2002): 151–73.

Yeh chien Wang, "Secular Trends of Rice Prices in the Yangzi Delta, 1638-1935," in *Chinese History in Economic Perspective*, ed. Thomas G. Rawski, Uian Li, and M. Li (Berkeley: University of California Press, 1992), 35–68.

[61] Chunsheng Chen 陈春声, *Shichang Jizhi Yu Shehui Bianqian-Shiba Shiji Guangdong Mijia Fenxi 市场机制与社会变迁-18 世纪广东米价分析* (Zhongshan University Press, 1992).

Chunsheng Chen 陈春声, "Lun Qingdai Zhongye Guangdong Miliang de Jijie Chajia 论清代中叶广东米粮的季节差价," *Zhongshan Daxue Xuebao*, no. 1 (1989): 67.

Chunsheng Chen 陈春声, "Qingdai Qianqi Liangguang Shichang Zhenghe 清代前期两广市场整合," *Zhongguo Jingjishi Yanjiu 中国经济史研究*, no. 2 (1993).

[62] Yangfang Hou 侯杨方, "Changjiang Zhongxiayou Diqu Migu Changtu Maoyi 1612-1937 长江中下游地区米谷长途贸易：1612—1937," *Zhongguo Jingjishi Yanjiu 中国经济史研究 (Research on Chinese Economic History)*, no. 2 (1996).

[63] Feng Lu 卢锋 and Kaixiang Peng 彭凯翔, "Woguo Changqi Mijia Yanjiu 1644-2000 我国长期米价研究 1644—2000," *Jingjixue Jikan 经济学季刊*, no. 1 (2005).

Kaixiang Peng 彭凯翔, *Qingdai Yilai de Liangjia: Lishixue de Jieshi Yu Zaijieshi 清代以来的粮价：历史学的解释与再解释* (Shanghai Renmin Publishing House, 2006).

[64] Chengming Wu 吴承明, "Liyong Liangjia Biandong Yanjiu Qingdai de Shichang Zhenghe 利用粮价变动研究清代的市场整合," *Zhongguo Jingjishi Yanjiu 中国经济史研究 (Research on Chinese Economic History)*, no. 2 (1996): 90–96.

[65] Sui-wai Cheung, "The Price of Rice: Market Integration in Eighteenth-Century China," *Studies on East Asia* 29 (2008).

[66] J. Mitchener and M. Ohnuki, "Institutions, Competition and Capital Market Integration in Japan," *Journal of Economic History* 69 (2009): 138–71.

financial markets, and there have been no systematic, let alone empirical studies on this subject.

Some Chinese scholars such as Peng[67] have discussed the interest level itself, rather than convergence or divergence of interest rates among different regions in China.[68] Others have treated capital market merely as facilities of trade and commodity circulation. For example, Ma Junya[69] described how a traditional hierarchical network of finance helped collect and allocate huge sums of capital throughout rural markets all over the country. Such trade circuits of commodity and the ensuing capital flow formed an asymmetric monetary system.[70] Given the huge size of the agricultural sector, such capital transfer across regions could take place on a very large scale, leading to seasonal market integration. However, according to Ma, financial networks only served to facilitate seasonal goods transactions, rather than treating it as an independent system. Neither was the degree of integration examined with statistical methods.

Peng is probably the first Chinese scholar to address the subject of financial integration. His dataset focuses on the period of 1910s-30s, from which more than half of the data come. He finds that rural interest rates were lower than that of intermediary interests in urban areas.[71] He explains interest rates with factors such as the length of highway or that of telegraph lines relative to the size of population. However, the study is not systematically focused on integration, nor does it gauge nor explain financial integration with econometric methods in this field of research. There are still many integration questions left to be answered, such as those listed at the beginning of this thesis.

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[67] Zhiwu Chen, Kaixiang Peng, and Weipeng Yuan, "Robbery , Social Order and Interest Rates in Modern China," *Asian Historical Economics Conference* 2010, no. 1971 (2010): 1–20.

[68] Such as Liu Qiugen, Li Jinzheng, Wen Rui, Rosenthal & Wang, Peng Kaixiang, etc. More literature is given in Chapter 1, Part I.

[69] According to Ma, based on the huge size of her agriculture department, such cross-regional capital transfer could take place on a very large scale, not only in line with grain harvest, but also with other rural product, such as cocoon of silk industry and export commodities out of handicraft industry among peasantry families, etc. Please refer to Junya Ma, "Traditional Finance and China's Agricultural Trade, 1920-1933," *Modern China* 34, no. 3 (2008): 344–71.

[70] Akinobu Kuroda, *World History in Monetary Systems: An. Analysis of Asymmetry* (Tokyo: Iwanami Press, 2002).

[71] Kaixiang Peng 彭凯翔, "Jinxiandai Lilvshi Yanjiu Baogao 近现代利率史研究报告 (Report on Modern Interest History of China)," in *History of China's Finance and Market*, 2006, 16.

Why has there been little work, especially empirical work, done on financial integration of early modern China? As mentioned in the introduction, there are largely three reasons for geographical and temporal biases in this field of research. The last is on data availability, which is particularly important for us to understand in this situation. Data availability is restrained by two conditions: the need to record price information, and the possibility to do so.[72] The former depends on the development of commerce, and the latter on that of education. However, those factors cannot explain the lack of systematic financial records in China. It was not that China's commercial activities were not strong enough to create demand for price information records, or that the country's literacy or numeracy levels were not good enough to support a documentation system. It was probably the lack of tradition to preserve physical evidence, or the lack of physical evidence due to discretional preservation. There has been financial press and regularly reported financial-market price quotes in the Netherlands and Britain since the 17th and 18th century.[73] However, the situation was quite different in China. Despite the fact that paper was first invented in China as early as in the Han dynasty, followed by printing technologies in the Song dynasty, there were no systematic data records of the financial industry until around the late 19th or early 20th century. The central government only recorded a few key economic data of its concern, such as grain prices. Some noble families or clans did keep their financial journals, but few of these archives have been preserved or yet discovered.

Besides, the traditional Chinese book-keeping system based on Chinese characters rather than Arabic numbers was less efficient and precise. Traditional Chinese characters are different from their modern version; the traditional Chinese syntax also differs significantly from its modern version; and there is no punctuation in the traditional language system, which makes it even more difficult and inefficient to process the

[72] Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900.", 16.
[73] James R. Lothian, "The Internationalization of Money and Finance and the Globalization of Financial Markets," *Journal of International Money and Finance*, 2002, http://ssrn.com/abstract=613694., 8.

materials. Even though some data were extracted, they were in Chinese descriptions (short sentences) instead of pure Arabic numbers ready to be processed. So far there has been no systematic machine-readable dataset. This may explain the lack of empirical studies on Chinese financial history, where the present thesis intends to fill a gap.

The research on China's market development is important not only in complementing existing economic literature regarding geographical coverage, but also in its contribution to unresolved historical questions.

One of the questions is: when did the traditional Chinese economy transform from its medieval times to modern times?[74] There is on-going debate about this topic between two schools: the school of Tang-Song transition and the school of Ming-Qing transition.

[74] Note that the expression of "medieval times" and "modern times" in the Chinese context does not refer to the same time period as that in a European context. How to define them in China is in the debate of the Tang-Song transition and Ming-Qing transition, as discussed below. But in brief, the medieval times in Chinese history means pre-modern period, referring to the times when aristocratic clans dominated the society; whereas the modern times refer to the period when civil classes (represented by merchants and intellectuals) arose and grew. Accordingly, cultural, economic and many other aspects of the society changed from the medieval to the modern times. Further discussion is laid below.

The school of Tang-Song transition [75] (the 8th-12th century) [76] argues that the

[75] It is well acknowledged that Japanese scholar Naito Konan was the first to notice the substantial changes in between the Tang and the Song dynasty, stating that the Tang dynasty marked the end of medieval times and the Song dynasty the beginning of modern times in China. His student Miyazaki Ichisada then developed this statement into a full-fledged theory. More Japanese researchers later followed their path and joined the Kyoto historians. Many Chinese scholars also contemplated on the modernity of the Song society. Actually, this theory covers not only the economic sector, but a wide range of subjects and aspects of the society. Scholars believe that in the northern Song dynasty, only economy but also political, social and cultural structure of China experienced substantive changes from the Tang dynasty and before, which made the Song society similar to a modern one (近世) in many aspects. A representative opinion was made by Qian Mu, who stated that: "The most significant social changes happened in the Song dynasty. China before the Song dynasty can be deemed ancient; after, modern. From the first dynasty of Qin all the way to the Tang dynasty, the Chinese society was dominant by the noble and aristocratic clans; since the Song dynasty (except in the Yuan period), the civil elite took over the place of the aristocratic in the ruling class. From then on, everything (ranging from politics, economy to social and daily life) changed." See Mu Qian 钱穆,"Lixue Yu Yishu 理学与艺术,"in *Songshi Yanjiu (A Collection of Papers on the Song History) 宋史研究*, vol. 6 (Taiwan shuju, 1974), 2.

Similar discussions have been going on among western scholars too. For more details, please see:

Konan Naito 内藤湖南, "Gaikuo de Tang-Song Shidai Guan 概括的唐宋时代观 (A General View on the Tang-Song Period)," *Lishi Yu Dili 历史与地理 (History and Geography)* 9, no. 5 (1922).

———— *Naito Konan Zenshu 内藤湖南全集 (Collected Works of Naito Konan)* (Tokyo:筑摩书房, 1970).

Miyazaki Ichisada 宫崎市定, "Cong Buqu Zouxiang Dianhu 从部曲走向佃户," in *Miyazaki Ichisada Zenshu 宫崎市定全集* (Tokyo: 岩波书店, 1992).

————, *Jiupin Guanren Fa Yanjiu—Keju Qianshi 九品官人法研究—科举前史* (Beijing: Zhonghua Shuju, 2008).

Guangming Deng 邓广铭, *Self-Selected Academic Works of Deng Guangming 邓广铭学术论著自选集* (Beijing: Shoudu Shifan Daxue Chubanshe, 1994).

——— "Tantan Youguan Songshi Yanjiu de Jige Wenti (Discussions on A Few Issues of the Song History),"*Shehui Kexue Zhanxian* 2 (1986).

Zengyu Wang 王曾瑜, *Song Chao Jieji Jiegou 宋朝阶级结构 (Social Structure of the Song Dynasty)* (Shi Jia Zhuang: Hebei Jiaoyu Chubanshe, 1996).

Xia Qi 漆侠, "Tang-Song Zhiji Shehui Jingji Guanxi de Biange Jiqi Dui Wenhua Sixiang Lingyu Suo Chansheng de Yingxiang 唐宋之际社会经济关系的变革及其对文化思想领域所产生的影响," *Research on Chinese Economic History 中国经济史研究* 1 (2000).

——Xia Qi 漆侠, "Songdai Shehui Shengchanli de Fazhan Jiqizai Zhongguo Gudai Jingji Fazhan Guocheng Zhong Suochu de Diwei 宋代社会生产力的发展及其在中国古代经济发展过程中所处的地位,"*Research on Chinese Economic History 中国经济史研究中国经济史研究* 1 (1986).

Ruixi Zhu 朱瑞熙, *Songdai Shehui Yanjiu 宋代社会研究 (Research on the Song Society)* (Zhengzhou, 1983).

Rulei Hu 胡如雷, "Taong-Song Zhiji Zhongguo Fengjian SHehui de Juda Biange 唐宋之际中国封建社会的巨大变革 (Enormous Social Changes during the Tang-Song Period)," *Shi Xue Yue Kan 史学月刊* 7 (1960).

Bangwei Zhang 张邦炜, *Huyin Yu Shehui 婚姻与社会: 宋代 (Marriage and Society)* (Chengdu: Sichuan Renmin Publishing House, 1989).

Lecheng Fu 傅乐成, "Tangxing Wenhua Yu Songxing Wenhua 唐型文化与宋型文化 (the Tang Culture and the Song Culture)," in *Zhongguo Tongshi Jiaoxue Yantaohui 中国通史教学研讨会*, ed. (Taibei: Taibei Huashi Publishing House, 1979), 314–50.

Wailu Hou 侯外庐, ed., "Zhongguo Sixiang Tongshi 中国思想通史" (Renmin Publishing House, 1992), 1.

Peter Kees Bol, "Reconsidering Tang-Song Transition: With Particular Attention to Intellectual Change," in *Zhongguo Jingjishi Yanjiu 中国经济史研究 Xue Shu 中国学术*, vol. 3 (Beijing: Shangwu Yinshu Guan 商务印书馆, 2000).

_____ *斯文-唐宋思想转型 ("This Culture of Ours": Intellectual Transitions in T'ang and Sung China)* (Nanjing: Jiangsu Renmin Publishing House, 2001).

Vilfredo Pareto, *Jingying de Xingshuai 精英的兴衰 (The Rise and Decline of the Elite Class)* (Shanghai: Shanghai Renmin Publishing House, 2003).

Robert M. Hartwell, "750-1550 年中国的人口、政治及社会转型（Demographic, Political, and Social Transformations of China, 750-1550）,"*Harvard Journal of Asiatic Studies* 42, no. 2 (1982): 365–442.

Eric Lionel Jones, *Growth Recurring: Economic Change in World History* (Oxford: Oxford University Press, 1988).

Qinan 罗祎楠 Luo, "Moshi Jiqi Bianqian Shixue Shiye Zhongde Tang-Song Biange Wenti 模式及其变迁-史学史视野中的唐宋变革问题 (Paradigm and Transformation-the Tang-Song Transition Debate in a Historical Perspective)," *Zhongguo Wenhua Yanjiu 中国文化研究 (Research on Chinese Culture)* 2 (2003).

Guanglin William Liu, "Wrestling for Power: The State and the Economy in Later Imperial China, 1000- 1770 (竞逐权力:晚期中华帝国的国家与市场经济)" (PhD Thesis, Department of East Asian Languages and

transformation process started in the mid-Tang dynasty, that the critical turning point appeared towards the closing years of the Tang dynasty, and that the modern times of the society (or at least some modern elements) initiated in the Northern Song dynasty. In economic history, this suggests that the Northern Song dynasty was unprecedented in the market economy, marking a peak of the traditional Chinese economy; and it remained the peak for a very long time until the eve of industrialisation. The school of Ming-Qing transition, on the other hand, stresses economic progress in the 16th-18th century China, in which sense they took the late Ming and early Qing period as the heyday of the traditional Chinese economy and the turning point to a modern path.[77] Many scholars take a market-centred paradigm in analysing this question, focusing on the role played by markets in economic development and transformation.[78] However, to

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Civilization,Harvard University, 2005).

[76] The specific starting and ending time for the period is also not settled. Some define it as the 8th -11th century (as Richard Von Glahn does), others take it as the 8th -12th century (as Smith J. Paul does). But it is generally acknowledged that the period covers the latter Tang dynasty and the Northern Song dynasty. For example, please see Paul Jakov Smith and Richard von Glahn, *The Song-Yuan-Ming Transition in Chinese History* (Cambridge MA: Harvard University Asia Centre, 2003).

[77] In this sense, the California school agrees with the Ming-Qing Transition. The school contends that living standards of handicraft workers in urban centers like Lower Yangzi region of the 18th century was about the same level as that of Europe. However, their viewpoint is now challenged by Allen et al. ("Wages, prices, and living standards in China, 1738-1925: in comparison with Europe, Japan, and India", *Economic History Review,* 2010), who find new evidence to show that the 18th century Chinese workers' living standard was only about the same as that in Central and Southern Europe, and that it was no rival to that in leading European regions like North-western Europe. But all in all, their debate mainly focuses on handicraft industry and commodity market development in rural areas. No evidence from financial markets was provided yet.

For more details and references on the debate, please see:

Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton, 2000).

Prasannan Parthasarathi, "Rethinking Wages and Competitiveness in the Eighteenth Century: Britain and South India," *Past and Present* 158 (1998): 79–109.

Roy bin Wang, *China Transformed: Historical Change and the Limits of European Experience* (Ithaca: Cornell University Press, 1997).

James Z. Lee and Wang Feng, *One Quarter of Humanity: Malthusian Mythology and Chinese Realities, 1700–2000* (Cambridge, Mass., 1999).

Bozhong Li 李伯重, *Agricultural Development in Jiangnan, 1620-1850* (New York: St. Martin's Press, 1998).

_____ *Jiangnan de Zaoqi Gongyehua 1550-1850 江南的早期工业化 1550-1850* (Beijing: Shehui Kexue Chuban She, 2000).

_____ "Zhongguo Quanguo Shichang de Xingcheng 1500-1840 中国全国市场的形成 1500-1840," *Qinghua Daxu Xuebao* 14, no. 4 (1999): 48–54.

_____ "Was There a'fourteenth-Century Turning Point'? Population, Land, Technology, and Farm Management," in *The Song-Yuan-Ming Transition in Chinese History*, ed. Paul Jakov Smith and Richard von Glahn (Cambridge, Mass.: Harvard University Asia Centre, 2003), 175.

Robert C. Allen, Tommy Bengtsson, and Martin Dribe, eds., *Living Standards in the Past: New Perspectives on Well-Being in Asia and Europe* (Oxford: Oxford University Press, 2005).

[78] For details, please see:

Sigeru Kato, *Shina Keizaishi Kosho 支那经济史考证(Research on Economic History of China)* (Tokyo: Toyo bunku 东洋文库, 1953).

Kato Sigeru 加藤繁, *Shina Keizaishi kosho 支那经济考证,* Tokyo, 1953, translated by Wu Jie 吴杰,Beijing: Zhonghua shuju, 1959.

Yoshinobu Shiba 斯波義信, *Sodai Shoyoshi Kenkyu 宋代商業史研究* (Kyoto, 1968).

date, there has been little evidence from financial markets provided for the debate, hence the present thesis. Research on financial markets may shed some light on the debate with some new evidence.

Furthermore, China can make a good object of study on how a large financial market came into being. In comparing market performance, one needs to consider not only market size or local economy, but also if these markets share a common background of social political regime, so that there is a benchmark of comparison. Europe has never been a unified country. When studying the integration process across European countries, one may find it difficult to control for social political differences in different countries, such as language, culture, religion and political regime (republic or monarch). By contrast, the U.S.A is a united country consisting of sub-states whereby most markets share a common background of social political institutions, which provides a benchmark for comparison. Also, there are indeed some papers on American national financial market formation during the 19th century.[79]

In this sense, China can also make a good case for integration research. China was an empire first united in 221 BC. After that, unification and fragmentation took turn till the end of dynasties in the 20th century. But during this process, there were at least some 950 years when the core part of the country was united under the reign of one royal

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Yiling Fu 傅衣凌, *Mingqing Shidai Shangren Ji Shangye Ziben 明清时代商人及商业资本* (Beijing, 1956).
_____*Mingdai Jiangnan Shimin Jingji Shitan 明代江南市民经济试探* (Shanghai, 1956).
_____*Mingqing Shehui Jingji Bianqian Lun 明清社会经济变迁论* (Beijing, 1989).
Shiji Liu 刘石吉, *Mingqing Jiangnan Shizhen Yanjiu 明清时代江南市镇研究* (Beijing, 1987).
Zongwen Fu 傅宗文, *Songdai Caoshizhen Yanjiu 宋代草市镇研究* (Fuzhou, 1989).
Shuzhi Fan 樊树志, *Mingqing Jiangnan Shizhen Taiwei 明清江南市镇探微* (Shanghai, 1990).
Xuewen Chen 陈学文, *Mingqing Shiqi Hangjiahu Shizhenshi Yanjiu 明清时期杭嘉湖市镇史研究* (Beijing, 1993).
Denis C Twitchett, "Merchant, Trade and Government in Late Tang," *Asia Major* 14, no. 1 (1968).

[79] Lance Davis, "The Investment Market, 1870-1914: The Evolution of A National Market," *The Journal of Economic History* 25 (1965): 355–99.
Richard Sylla, "Federal Policy, Banking Market Structure, and Capital Mobilization in the United States, 1863-1913," *The Journal of Economic History* 29 (1969): 657–86.
Larry Neal, "Trust Companies and Financial Innovation, 1897-1914," *Business History of Review* 45 (1971): 35–51.
John James, "The Development of the National Money Market, 1893-1911," *The Journal of Economic History* 36 (1976): 878–97.
Richard Keehn, "Federal Bank Policy, Bank Market Structure, and Bank Performance: Wisconsin, 1863-1914," *Business History Review* 15 (1980).
Marie Elizabeth Sushka and W. Brian Barrett, "Banking Structure and the National Capital Market, 1869-1914," *The Journal of Economic History* 44 (1984): 463–77.

court.[80] The Ming-Qing period (1368-1911), in particular, witnessed the longest period of unification (about 429 years out of 543 years). During such a long period, different areas of China probably came to share a common background in core parts of their culture, religion and politics.[81] Moreover, geographical boundaries of the 15 core provinces[82] (which also provide the majority of interest rate data under study here) were settled in the Ming dynasty. This further enhances the benchmark for integration analysis across time and space.

Finally, given the nature of the market integration process, a long-run perspective is a natural choice. Particularly, financial integration itself is a gradual course rather than a new phenomenon. Many scholars studying European markets have taken a long-term perspective, for it is "part of an evolutionary process that began much earlier and that has continued, albeit with periodic interruptions and reversals, for many centuries," and "what we see today is simply the latest and most advanced manifestation of this process".[83] Specifically, the paper of Findlay and O'Rourke[84] provided the historical background before 1500 AD. Also, although an observable trend of financial integration is detected in Europe only after the 17th century (based on empirical data), Lothian still found an institutional history of financial systems very helpful in providing integration-related information, even for centuries as early as the 4th century AD.[85] Similarly, to work on an eastern counterpart of western market integration, it is reasonable for this

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[80] Jianxiong Ge and 葛剑雄, *Tongyi Yu Fenlie Zhongguo Lishi de Qishi 统一与分裂 中国历史的启示 (Unification and Fragmentation: Insights from the Chinese History)* (Sanlian Shudian 三联书店, 1994).

[81] The major cultural aspect commonly shared by the Chinese includes family/clan culture (宗族). Major religious content shared by the Chinese includes Confucianism, Buddhism, Daoism (儒释道). And the major political institution dominant on the land is the monarchy system. But of course, there are other aspects to consider. Moreover, each of these aspects above is already too extensive a topic for this limited thesis to further discuss. But given the historical evidence on unification, it is reasonable to assume that the common background shared by China's regions and markets is greater than that shared by European countries, and probably also greater than that by the states of U.S.A (which became united only after 1776).

[82] The 15 provinces included: Zhejiang, Jiangxi, Nanzhili (southern capital area), Huguang (Hunan and Hubei), Sichuan, Fujian (including Taiwan), Guangdong (Canton), Guangxi, Yunnan, Guizhou, Hebei (northern capital area), Henan, Shandong, Shanxi, Shannxi (including Gansu).

[83] Lothian, "The Internationalization of Money and Finance and the Globalization of Financial Markets.", 0 (abstract page).

[84] Ronald Findlay, Kevin H. O'Rourke, and Centre for Economic Policy Research (Great Britain), *Commodity Market Integration, 1500-2000* (London: Centre for Economic Policy Research, 2002).

[85] Lothian, "The Internationalization of Money and Finance and the Globalization of Financial Markets."

thesis to take a secular perspective.

0.4 Contribution and Outline

This paper complements existing literature in such dimensions as explained below.

Firstly, in the analytical framework of financial integration, most studies focus on advanced tradable instruments such as bonds or stocks; while this study means to analyse the most essential tool on the financial market, namely, the loan and interest rates. Moreover, regarding geographical coverage, this thesis supplies more evidence from the east as a complement to mainstream literature on the west. There have been many works on financial integration regarding leading western economy of the times, such as Italy, the Netherlands, Britain, as well as Europe as a whole. By contrast, there is little integration works on Asia, and barely any on China. This is where this thesis means to fill the gap—to enrich the eastern and Chinese side of the story.

A major reason for the geographical and temporal biases mentioned above is the difficulty in data collection, especially in China. Thus, secondly, the present research means to enrich the financial dataset with new evidence of interest rate data, which in itself may be constructive to the field of research. Current Chinese research on financial and commercial activities is limited by the scope of time and space, covering fragmented areas and periods. Most focus on a certain province/region (especially Northeast China and the lower Yangtzi River area) of late Qing or the Republican era, because data sources cluster in these periods and places. For example, Huang[86] specialized in banking and remittance business of Shanxi bankers in late Qing. Xu[87] examined private debit and credit behaviour of the countryside of Jiangsu, Zhejiang and Anhui during the 1920s

[86] Jianhui Huang 黄鉴晖, eds., *山西票号史料 (Historical Materials of Shanxi Bill Houses)* (Taiyuan: Shanxi Jingji Chuban She, 2002).

[87] Chang Xu 徐畅, "高利贷与农村经济和农民生活关系新论:以 20 世纪二三十年代苏浙皖三省农村为中心 (Review on the Relation between Usury and Rural Economy and Peasantry Life: Provinces of Jiangsu, Zhejiang and Anhui in the 1920s and 30s)," *Jianghai Xuekan 江海学刊* 4 (2004).

and 30s. Han and Lu[88] focused on financial activities in the rural areas of Zhejiang and Hunan provinces in the Republican era. There has been little work on China's financial market, which spans a long time and covers a large area of China.

However, a larger scope of research can reduce the debate by applying a consistent method on data across time and space. This is where the present research comes in. The research complements existing Chinese financial datasets with interest rates dated from the 6th to 20th century and covering 24 Chinese provinces/regions[89] (as of the 1820 map). Some of the data were hand-copied from an original archive and some were from collections of historical documents, which form a largest dataset of interest rates so far that have never been systematically used in any empirical research yet.

Thirdly, regarding statistical methodology, the present research adopts time series models and spatial integration methods (as explained below), combining a micro and macro-perspective. On one hand, this thesis seeks to examine the degree of overall integration of all the markets available on a time-section for different times. On the other, though grounded on a large scope in time and space, the thesis also zooms in for a higher scale of resolution, measuring regional integration based on pair-wise analyses within a certain period.

Conventional literature has focused on time-series methods. These methods compose the mainstream approach used in studying regional market integration. Based on time-series data, they estimate integration degree between a pair of markets over a period of time, as well as the adjustment speed of one market towards the other. With all the values and convenience of research, however, those methods cannot work on more than two

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[88] Dezhang Han 韩德章, "浙西农村之借贷制度 (Credit Institutions in the Rural Area of Western Zhejiang)," *Shehui Kexue Zazhi 社会科学杂志 (Journal of Social Science)* 3, no. 2 (1932).
Guoxiang Lu 陆国香, "Hunan Nongcun Jiedai Zhi Yanjiu 湖南农村借贷之研究 (A Study on Rural Credit in Hunan)," 国民政府实业部国际贸易局 (International Trade Bureau, Industrial Department of the Nanjing Government), 1935.

[89] These provinces/regions are based on the 1820 map, covering Jiangsu, Hunan, Hubei, Sichuan, Hebei, Zhejiang, Suiyuan/Inner Mongolia, Dongbei (Northeast China area, including Heilongjiang, Jilin, Liaoning), Ningxia, Gansu, Shaanxi, Shanxi, Shandong, Anhui, Henan, Yunnan, Guizhou, Jiangxi, Fujian, Canton, Guangxi, Qinghai, Taiwan, and Xinjiang.

markets in a given cross-section. To create a larger picture, researchers have to conduct an integration estimation pair by pair first, and then aggregate the results of pair-wise performance. In other words, these methods cannot estimate overall integration.

On the other hand, spatial integration models[90] are based on testing of spatial correlation, as opposed to autocorrelation within a time-series. They study how one region's price is influenced by related conditions of many other regions. Put it simply: time-series models estimate the integration between a pair of markets through a period of time, thus hereafter referred to as "regional integration"; spatial integration models estimate the simultaneous interaction among more than two markets on a cross-section, thus named "overall integration". This thesis employs a hybrid strategy with both approaches used where applicable. Spatial methods are taken as complement to time-series models, applied to a group of markets (more than just a pair). And outcomes of these two approaches can be used as benchmarks to check against each other.

Lastly, the thesis may help understand the economic cycle reflected in the Tang-Song transition from a new perspective of financial markets (instead of commodity markets). It may also help us to further understand the Great Divergence with evidence on the financial sector of the national economy. However, it is not feasible or possible for this limited PhD thesis to settle such a huge question as the nexus between finance and growth; but slightly more evidence in support is aimed towards.

The layout of the thesis is as follows. The introduction above lays a contextual base and literature review for the whole thesis. Part I covers only Chapter 1, focusing on interest

[90] The spatial integration models are based on test of spatial correlation, as opposed to autocorrelation in time-series. To put it simply, it studies how one region's price is influenced by related conditions of another, or many other regions. For details please see the following references:
Luc Anselin, *Spatial Econometrics: Methods and Models* (Dordrecht: Kluwer Academic, 1988).
Luc Anselin, "Space and Applied Econometrics," *Special Issue, Regional Science and Urban Economics* 22 (1992).
Andrew D. Cliff and J.K Ord, *Spatial Autocorrelation* (London: Pion, 1973).
Michael F. Goodchild, "Spatial Autocorrelation," *Concepts and Techniques in Modern Geography (CATMOG)* 47 (1986): 1–56.
Paul Krugman, "Space: The Final Frontier," *Journal of Economic Perspectives* 12 (1998): 161–74.

rates; Part II covers Chapter 2 and Chapter 3, focusing on financial market integration. Part I (Chapter 1) supports Part II (Chapter 2 and 3) with a background in both data (sources and quality) and historical financial development (in tools, institutions and markets).

Specifically, Chapter 1 studies structural determinants and temporal trends of the present dataset under study (scattered over 6th-20th century China). It starts with a brief introduction of currencies under study and of literature on interest rates, then discusses the data sources, quality and descriptive statistics of the entire dataset. Moreover, preliminary observations are made on time coefficients of the raw data, and checked against their historical backgrounds to see if qualitative evidence corresponds with them. Next, interest rates are regressed against loan features, which result in interest structures to show how the intrinsic features affected the interest rates. At last, coefficient trends of time dummies are analysed against the historical background of financial development. Qualitative evidence provided here concerns financial instruments, markets and institutions, which also work as a historical background for integration analyses in Part II.

Chapter 2 gauges financial integration by market pair. It starts by presenting the time-series methods (the Error Correction Model and Threshold Autoregressive Model); then applies them to the markets of Ningbo and Shanghai as a pilot study. Then it presents the data distribution and discusses their quality. Next, the methods are used on 125 data series out of 91 markets scattered over 18th-20th century China. The empirical results are firstly given by cross-sectional analysis (across distance groups) on the Early Qing period (1709-1840), then by historical analysis over five periods (Early Qing, Late Qing, Warlord Era, Nanjing Era, and Last Wars).

Chapter 3 examines overall financial integration at a macro level, namely, among multiple provincial markets. Again it starts by introducing the statistical approach, but this time it is the spatial integration method. This is followed by a data description on provincial aggregates of interest rates scattered over 23 provinces and 57 years during the Ming-Qing period (1368-1910). Then it runs a causal-effect regression on several

specifications of the model. The purpose is to see whether and to what extent the following variables could explain the interest rate gap between the local provincial aggregate and all other markets:

- interest rates on other markets (spatial correlation);
- warfare involvement (proxy of political stability);
- size of provincial population (proxy of commercial development);
- acreage of provincial arable land (proxy of the agricultural development);
- education level (proxy of innovation and technology).

Part I. Interest Rates

Part I below lays a foundation for the subsequent analysis of financial integration in Part II with a historical background in both data (sources, quality and patterns) and financial development (instruments, markets and institutions). The dataset comes from more than 600 localities across 24 provinces/regions of the 6th to 20th century China. The section addresses questions such as: What intrinsic attributes of loans influenced the interest rates under study? What social-economic factors or events also affected them? How was their temporal trend? The empirical outputs below are also supported with historical evidence in the corresponding periods.

Chapter 1 Context, Determinants and Trend

1.1 Monetary and Literature Background

A monetary system sets the stage for credit behaviour and financial integration. First of all, the type of money defined the form of loans, namely, whether it was a grain loan, silver loan or coin loan. Different types of loans might feature different interest rate levels; moreover, different types of currency (for example, comparing paper notes and copper coins) could feature different levels of transport cost, thus affect financial integration. One cannot fully understand Chinese credit behaviour and capital markets without knowledge of the complexity of Chinese currencies. Secondly, monetary diversification and unification could both affect interest rates and market integration. More than one currency circulating side by side with no fixed exchange rates would increase transaction cost, both on commodity and on the capital market. This in turn would increase credit cost and impede financial integration, and vice versa. Therefore, here we briefly introduce the Chinese currencies in circulation during the periods under study (6^{th}-20^{th} century).

In the interest rate entries collected by this thesis, there are four major types of currency involved: grain, silver ingot, copper coins and paper notes. Copper coin was a most popular and long-lasting form of currency, seen as early as in the Spring-and-Autumn era (770 BC-476 BC). Commodity loans were often seen in rural areas. In the Sui-Tang period (581-959 AD),[91] many loans were based on grain or fabric, and there were also loans of copper coins. The copper coin was the most long-lasting and a major currency involved in our dataset. Loans of the Song (960-1279 AD) and the Yuan (1279-1368

[91] The official reign of the Tang dynasty covered 618-907 AD However, data from the short gap after the Tang and before the Song dynasty (907 AD-960 AD) are also labeled here as the Sui-Tang period (581-960). Data found for the Sui dynasty (581-618) are from the same archives discovered in Tulufan and Dunhuang area as data for the Tang dynasty, and they were coherent in time. Besides, since the focus of Part I is structural analysis of interest rates in general, but not whichever individual dynasty or region and it is not time-series or regional analysis, we tend to make full use of all the raw data available, instead of tailoring them to suit the dynasties.

AD) dynasty were mainly based on silver ingot,[92] copper coins, and paper notes.[93] The unit of account for silver ingot was tael,[94] which was originally a measure of weight. Finally, loans of the Ming (1368-1644 AD) and the Qing (1644-1911 AD) dynasty were mainly based on silver ingot, silver dollars, and copper coins. Paper notes and copper dollars joined the system too in the Qing dynasty. During this period, "In China, the currency is at the top a weight pure and simple, in the middle a combination of weight and token currency, and at the bottom a coin which stands on its own feet, and neither receives support from, nor absolutely gives it to any other unit in the series."[95] There were no fixed exchange rates between any two currencies.

Next, we briefly assess Chinese literatures on interest rates and credit activities. The first research on interest rates was done by Master Guan (管子, 723-645 BC).[96] His observations on credit activities found both benefit and harm from the business. On the one hand, he noticed that credit behaviour could help the poor make ends meet, even enhance re-production if the interest rate was acceptable given the weather and rural

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[92] Silver became currency in Western Jin (265-316 AD); but it did not become an official currency until the Southern Song (1127-1279 AD) (See Xinwei 彭信威 Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*, 2nd ed. (Shanghai, 1957), 274.

[93] This includes the flying money as bill of exchange that first appeared in the Tang dynasty (618-907 AD) and official paper notes that emerged in the Song dynasty (960-1279 AD).

[94] 1 tael in Qin and Han dynasties equaled about 16.14 grams. But it varied in time and across space.

For example, in the Ming-Qing period, 1 tael in Sichuan (Chuan-ping 川平) equaled c. 35.88 grams, whereas 1 tael in Hunan (Xiang-ping 湘平) equaled some 36.13 grams. By the end of the 19th century, there had developed more than 100 types of weight-scaling criteria. In large cities like Beijing or Shanghai, usually more than one weights were employed.

In the Qing dynasty, virtual units of account in silver were also created for the purpose of transaction and book-keeping. National taxation used Ku Ping (库平,1 tael=37.301 grams); grain tax transported through canals applied Cao Ping (漕平, 1 tael=36.6527 grams); for customs tariff, Guan Ping (关平, 1 tael=37.7993 grams) was exercised. For more details, please refer to:

Jiaxiang Zhang 张家骧, Chapter 4 in *Zhong Hua Bi Zhi Shi 中华币制史* (Zhishi Chanquan Chubanshe, 2013).

Cunren Chen 陈存仁, *Yin Yuan Shi Dai Sheng Huo Shi 银元时代生活史* (Shanghai: Shanghai People's Publishing House, 2000).

[95] Hosea Ballou Morse, *The Trade and Administration of the Chinese Empire* (Shanghai: Kelly and Whalsh, 1907), 166.

[96] zhong Guan, *Guanzi 管子·轻重丁 (Master Guan)* (Beijing: Zhonghua Publishing House, 1979).

This is a book complied during the Warring States Period (475-221 B.C.) to record the economic thoughts and policies of Master Guan (723-645 B.C.), Prime Minister of Kingdom Qi and a pioneering economist of the time. He introduced many economic and monetary thoughts. For instance, he suggested that the state should supply seed or money loans to peasants in spring and collect them back in autumn. He also pointed out that the state could interfere commodity prices and control the ratio of money to commodity by adjusting money supply (which might be compared with the modern "quantity theory of money" that emerged in the 15th-16th century Europe).

The survey mentioned above was based on a question guideline, and it produced a report on interest rates in all four regions of the Kingdom Qi, located about the Shandong Province today.

output of the year. On the other hand, he also noticed that usurious credit[97] could impoverish individual people and the nation as a whole. In a national survey for the Kingdom of Qi (located in modern Shandong province, existing from the 11th century BC to 221 AD), he found that the annual interest rate in the east was 50%, that in the west 100%, that in the south 50%, and that in the north 20%. Throughout the whole kingdom there were some 3,000 households in debt.[98] He suggested that the state should regulate financial markets with state capital and limit the interest rate level. Master Guan laid a foundation for financial policies and research on interest rates.

In the following years, many others have studied China's interest rates through different dynasties,[99] but they mostly followed the traditional method of qualitative description, observing interest rate levels of certain times and summarising loan features. There formed a tradition to criticise "usury"[100] on moral grounds, which continued into the

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[97] By usury he mainly referred to loans in the private sector with interest return being ten times (or even more) of the principal. He compared these private loans with state loans, and suggested that the king should regulate interest rate levels of private loans. For details, see Ibid.

[98] The record does not tell whether these interest rates were annual or monthly. But judging from the level of these interest averages, we might assume they were annual rates, or the total amount of interest return per year. Of course, such data are not solid hence are excluded from the empirical analysis of this thesis.

[99] Regarding the Song dynasty, Qi Xia and Jiang Xidong studied commercial loans, Liu Qiugen studied state loans, and Wang Wenshu's research covered the whole loan business of the time. Regarding the Yuan dynasty, Qiao Youmei and Liu Qiugen looked at loans and interest rate levels, whereas Yang Shuhong studied loan contracts of the time. There are also studies on credit market of the Ming-Qing period. See:

Xia Qi 漆侠, "宋代的商业资本和高利贷资本 (Commercial and Usury Capital in the Song Dynasty)," in *宋史研究论文集 (A Collection of Papers on the Song History)* (Henan Renmin Chuban She, 1984).

Xidong Jiang 姜锡东, *Songdai Shangye Xinyong Yanjiu 宋代商业信用研究 (A Study on Commercial Credit in the Song Dynasty)* (Hebei Jiaoyu Chuban She, 1993).

Qiugen Liu 刘秋根, "Shilun Songdai Guanying Gaolidai Ziben 试论宋代官营高利贷资本," *Hebei Xuekan 河北学刊* 2 (1989).

Wenshu Wang 王文书, "Songdai Jiedaiye Yanjiu 宋代借贷业研究 (A Study on the Song Credit Business)" (Hebei University, 2011).

Youmei Qiao 乔幼梅, "宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)," *Zhongguo Shehui Kexue 中国社会科学* 3 (1988): 214.

Qiugen Liu 刘秋根, "元代官营高利贷资本论述 (A Study on Usury Capital in the Yuan Dynasty)," *文史哲 (Literature, History and Philosophy)*, no. 3 (1991).

Shuhong Yang 杨淑红, "Yuandai Minjian Qiyue Guanxi Yanjiu 元代民间契约关系研究" (Hebei University, 2008).

Qiugen Liu 刘秋根, *Ming Qing Gaolidai Ziben 明清高利贷资本(Usury Capital during the Ming-Qing Period)* (Beijing: 社会科学出版社 Social Sciences Documentation Publishing House, 2000).

[100] The term "usury" may imply a value judgement in traditional historical contexts. For example, see

Hefa Feng 冯和法, *Zhongguo Nongcun Jingji Ziliao 中国农村经济资料 及续编 (Research Materials on Chinese Rural Economy)* (Liming Shuju 黎明书局, 1933).

Dajun Liu 刘大均, *Woguo Diannong Jingji Qingkuagn 我国佃农经济情况 (Economic Situation of Tenant Farmers in China)* (Shanghai: Shanghai Taipingyang Shudian, 1929).

Zigang Feng 冯紫岗, *Lanxi Nongcun Diaocha 兰溪农村调查 (Survey in the Rural Area of Lanxi)* (Zhejiang University Press, 1935).

Yu Yue Wan Gan Sisheng Zhi Diandangye 豫鄂皖赣四省之典当业 (The Pawn Industry in the Four Provinces of Henan, Hubei, Anhui, Jiangxi) (a survey report by the Department of Rural Economy, Nanking University, 1936).

20th century. For example, interest research in the 1930s found that major credit activities in the 19th and 20th centuries featured "unreasonably" high interest rates. They tended to attribute the high interest rate level to the greed of the lender (landowners, merchants and so on) who exploited the fruits of the labour of the poor borrowers (peasants and city commoners). This view stayed for decades, possibly because it fitted in with the Marxist framework of class conflict and surplus value.[101] However, there came different voices after the 1980s. The contention mainly comes from the following two aspects.

To start with, some academic opinions[102] held that the recorded interest rate levels may be biased, or not as high as people thought. A legal perspective may help understand such opinions. Making a loan contract was on many occasions not compulsory. Particularly, transactions between close relatives or involving small amounts of capital often operated on an oral agreement.[103] Many of these informal oral contracts featured a low, even close-to-zero interest rate because their risk of default was relatively low. However, in the absence of written documents, loan features and interest rates cannot be captured. Hence exclusive reliance on written sources may have unavoidably biased the results of the analyses, particularly so if based on a small sample. While a larger sample and dataset does not avoid this fundamental problem, it is still likely to be more representative, and thus helps minimising such bias.

Secondly, others believed that, considering external circumstances such as productivity,

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Hecheng 林和成 Lin, *Zhongguo Nongye Jinrong 中国农业金融 (Finance in Rural Areas of China)* (Zhonghua Shuju 中华书局, 1936).

Jinzheng Li 李金铮, *Minguo Xiangcun Jiedai Guanxi Yanjiu 民国乡村借贷关系研究(A Study on Rural Credit Activities in Republican China*） (Beijing: People's Publishing House, 2003).

But hereafter, unless explained otherwise or quoted from a reference, this term is defined as credit activities based on an interest rate higher than the legal ceilings set up by the state of the time, with no value judgement implied by the author of the present study.

[101] Pierre-Joseph Proudhon first used this concept and then developed by Karl Marx (Karl Marx, Chapter 8 in *Capital (Vol.1)* (New York: International Publishers, 1894). Basically it means the value created by the working class and in excess of their labor-cost, which allows for profit and capital accumulation.

[102] For example, there was such an opinion as that the interest rate level of China's pawnshops was no higher than that of Europe or America, and indeed lower than that of Japan. For details, please see:

Gonggan 宓公干 Mi, *Diandang Lun 典当论 (Pawn)* (Shanghai: Shangwu Yinshu Guan 商务印书馆, 1992).

[103] Kaixiang Peng, Zhiwu Chen, and Weipeng Yuan, "Jindai Zhongguo Nongcun Jiedai Shichang de Jizhi 近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)," *Jingji Yanjiu 经济研究* 5 (2008): 147–59.

grain price or transaction costs, the interest rate level may not be as usurious as people thought. In other words, high interest rates may not be simply a consequence of human greed. For example, Xiong[104] divided the Chinese history of interest rates into two periods. From the Eastern Zhou dynasty (around 685 BC) to the mid Qing dynasty (1814 AD) was stage one, when interest rates in the private sector were all the same high level of about 100% per year. From the mid-Qing period to the 1930s was stage two, when annual interest rates dropped to a range of 24%-48%. His observation simplified interest movements, overlooking historical fluctuation of interest rates. Meanwhile, it also proposed a new perspective to explain the high interest rate level in Chinese history: low economic productivity left little capital surplus, thus little financial supply.

Wen Rui also stated that it was not reasonable to deem many grain loans in rural China usurious, if considering demand and supply on grain markets. Grain prices featured seasonal fluctuation, with a remarkable gap between the spring and the autumn price. This was understandable considering demand and supply: grain supply increased in autumn following harvest, and the price decreased; while peasants were running short of grain stock after the whole winter, thus the price increased. Usually the poor borrowed grain in spring (when grain stock was low and the price was high) and return it in autumn (when grain stock was high and the price was low). To the lender, his opportunity cost to lend out grain in spring was high. The interest payment that he demanded when entering a contract would reflect not only time value, but also market value of the grain.[105] Furthermore, to the borrower, if the transaction involved an exchange of money and grain (as in the case where money was borrowed and grain returned, or grain borrowed and money returned), the interest ratio calculated in grain probably appeared to be higher.

Another opinion comes from Peng.[106] He maintained that because of information

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[104] Zhengwen Xiong 熊正文, "Zhongguo Lidai Lixi Wenti Kao 中国历代利息问题考 （A Study of Interest Rates in Chinese Dynasties）" (Yan-jing (Peking) University, 1934), 157-159.

[105] Rui Wen 温锐, "Minjian Chuantong Jiedai Yu Nongcun Shehui Jingji Yi Ershishijichu Ganmin Bianqu Weili 民间传统借贷与农村社会经济－以２０世纪初（１９００－１９３０）赣闽边区为例," *Jindaishi Yanjiu 近代史研究* 3 (2004).

[106] Peng Kaixiang, Chen Zhiwu, Yuan Weipeng, "The Mechanisms of Rural Credit Market in Modern China", *Economic*

asymmetry or the lack of efficiency in information transmission, the hidden cost in contract entrance (such as land measuring and collateral management) and enforcement (such as networking or legal administration) was often high. The real cost deduced the profit margin for the lender, thus the nominal interest rate did not equal his real interest return.

In short, it remains a controversial issue whether China's interest rate levels in general were as high as people once believed. Also, most of them focus on a qualitative discussion, covering a short period in a small region. Given current evidence, it would be assertive to jump to a conclusion on whether usurious credit was the mainstream phenomenon on China's financial markets. Based on a large dataset collected from 24 provinces/regions in the 6th-20th century, Chapter 1 discusses interest rate levels in markets and years under study.

1.2 Data Description

1.2.1 Data Sources

Information on credit activities and interest rates in China's history are scattered among all sorts of historical material, ranging from household documents to memorials to the throne. This makes it difficult to do systematic research on a large scale, which is why most related studies focus on a limited period and a small region. This thesis examines unexplored archives to create a historical dataset of China's interest rates, which in itself may be constructive to the field of research.

Specifically, two major types of sources are employed by this study and their data tested separately.

Type One, sources of private transactions and [107]individual data:

Studies, (2008),Vol.5. 近代中国农村借贷市场的机制, 《经济研究》2008 年第 5 期. Originally quoted from Stiglitz and Weiss, 1981.

[107] As in Category I above, each entry of interest rate stands for a single and direct transaction, usually between two individuals in the private sector, without involving a third party.

- Collections or copies of land or credit contracts in historical documents,[108] such as:
  - The Tulufan and Dunhuang documents contain credit contracts and interest rate data from the 6th to the 10th century, mainly from the Tang period
  - Documents from the province of Anhui (particularly from the Huizhou area)[109] contain data from 1425 to 1955
  - Documents from the province of Fujian give access to interest rate data during the period of 1665-1931
  - Documents from Ba hsien (Ba county in the province of Sichuan)[110] give access to data from 1749 to 1850
  - Journals of a local business clan in the county of Xinzhu (Taiwan)[111] records interest information from 1816 to 1895
- Original family documents of influential local clans and ledgers of family businesses. These sources contain business contracts, letters, and transcripts of court proceedings, accounts and ledgers, to public regulations, tax information and awards from the state.[112] For instance, those of the Confucius Clan, Qufu (Shandong) provide access to data from 1660 to 1842.

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[108] Historical documents (including contracts) in assorted areas of China, for examples:
For Anhui: Juexin Wang 王鈺欣 and Shaoquan Zhou 周紹泉, eds., *Huizhou Qiannian Qiyue Wenshu 徽州千年契约文书* (Huashan Wenyi Chuban She 花山文艺出版社, 1993).
For Guangxi: Yingqiang Zhang 张应强 et al., ed., *清水江文书 (Qingshuijiang Manuscripts of Indigenous Agroforestry Contracts)* (Guangxi Shifan University, 2007).
国立台湾大学特藏资源, "Taiwan Gu Qi Shu 台湾古契书 (Historical Manuscripts of Contract Documents in Taiwan)," n.d., http://ci6.lib.ntu.edu.tw:8080/db/list.jsp.
For Guangdong: Dihua 谭棣华 Tan and Jianmin 冼剑民 Xian, eds., *Guangdong Tudi Qiyue Wenshu 广东土地契约文书 (Collection of Land Contract Documents in Guangdong)* (暨南大学出版社, 2000).
For Zhejiang: Wanying 王万盈 Wang, ed., *Qingdai Ningbo Qiyue Wenshu Jijiao 清代宁波契约文书辑校 (Collection of Contract Documents in Ningbo, Zhejiang)* (Tianjin Guji Chuban She 天津古籍出版社, 2008).
For Fujian: Guozhen 杨国桢 Yang, ed., "Minnan Qiyue Wenshu Zonglu 闽南契约文书综录 (Collection of Contract Documents in the South of Fujian)," in *Research on Chinese Social Economic History 中国社会经济史研究 增刊*, 1999.
For Guizhou: Zhaoxia 孙兆霞 Sun, ed., *Jichang Qiyue Wenshu Huibian 吉昌契约文书汇编 (Collection of Contract Documents in Jichang, Guizhou)* (Shehui Kexue Wenxian Chubanshe 社会科学文献出版社, 2010).
For Gansu: Zhi 沙知 Sha, ed., *Dunhuang Qiyue Wenshu Jijiao 敦煌契约文书辑校 (Collection of Contract Documents in Dunhuang, Gansu)* (Jiangsu Guji Chuban She 江苏古籍出版社, 1998).
[109] *There is* a greatly diversified range of files from contracts of businesses, land and grain transaction, tax receipts, litigation, to systematic journals of influential local clans, letters.
[110] The Provincial Archives of Sichuan, ed., *Qingdai Baxian Dangan Huibian 清代巴县档案汇编 (Collection of Ba Hsien Documents)* (Dang'an Chuban She 档案出版社, 1991).
[111] 国立台湾大学特藏资源, Vol. of Xinzhu Zhengliyuan Hao 新竹郑利源号 in"Taiwan Gu Qi Shu 台湾古契书 (Historical Manuscripts of Contracts in Taiwan)."
[112] Zhixiang 蔡志祥 Cai, ed., *Qian Tai Long Shangye Wenshu 乾泰隆商业文书* (Huannan Yanjiu Chubanshe 华南研究出版社, 2003).
Zhiwei 刘志伟 Liu, ed., *Zhang Shenghe Jiazu Wenshu 张声和家族文书* (Huanan Yanjiu Chubanshe 华南研究出版社, 1999).
Fanyin 孔繁银 Kong, ed., *Qufu Kongfu Dang'an 曲阜孔府档案* (Qi Lu Shu She 齐鲁书社, n.d.).

- Local cultural and historical material, where we can find diaries of the local gentry or scholars, regional news, even public announcement of tablet inscriptions,[113] etc.

The sources above contain spot rates of specific loans, often with detailed information such as the date of transaction, name of the borrower and lender, the amount of principal, status of collateral, expected maturity, etc. Apart from money loans, these sources also contain information on commodity loan contracts, mainly grain loans in rural areas. Some peasants borrowed money (to buy grain for food, maybe also buy seed and tools for sowing) in spring, and returned grain in autumn. Some borrowed grain in spring, and returned money after selling the harvest in autumn. Others borrowed grain and returned grain too. In a contract where the borrowed and the returned were different, the interest rate is unknown to us, namely, there is not a clearly written ratio of interest return. To calculate it, we need to know the exchange rate between the borrowed and the returned: the grain price. We have two problems in obtaining accurate grain prices. First, regarding the random coverage of the data in time and space, it is difficult to find grain prices to match interest rate data at the exact time and locality when and where the contract was executed. Besides, there were seasonal fluctuations in grain prices.[114] Second, it is difficult to find accurate or real grain prices because there were seasonal fluctuations in grain prices and grain transactions alone were quite complicated, involving assorted weights, measures and currencies as defined by local customs and conventions. To find accurate grain prices, one has to first thoroughly understand the grain trade at different times and places of the country; a topic that can populate a thesis alone. Thus, apart from money loans, this paper only adopts the grain-grain type of

[113] For example,
Yuanxiang 詹元相 Zhan, "Wei Zhai Ri Ji 畏斋日记 (Diary of Mr. Zhan)," in *Qing Shi Ziliao 清史資料 (Historical Materials from the Qing Dynasty)*, ed. 中國社會科學院歷史研究所清史研究室 (Beijing: Zhonghua Shuju 中华书局, n.d.), 184–274.
Gang Zhang 张橿, *Zhang Gang Ri Ji 张橿日记* (Diary of Mr. Zhang) (上海社会科学院出版社, 2003).
Suzhou Museum, ed., *Ming Qing Suzhou Gongshangye Beikeji 明清蘇州工商業碑刻集 (Collection of Tablet Inscriptions in Suzhou during the Ming-Qing Period)* (Jiangsu Renmin Chubanshe, 1981).
[114] In seasons of grain shortage, grain prices would surge and largely increase the grain-converted amount of money and interest return; vice versa. This not only makes it difficult for us to find accurate grain prices to match the interest rate data, but may also twist the real interest rate level. (At the moment this paper does not concern the relationship between prices and real interest rates, though).

commodity loans, but not grain-money or money-grain loans.

An example of such historical documents is given below:

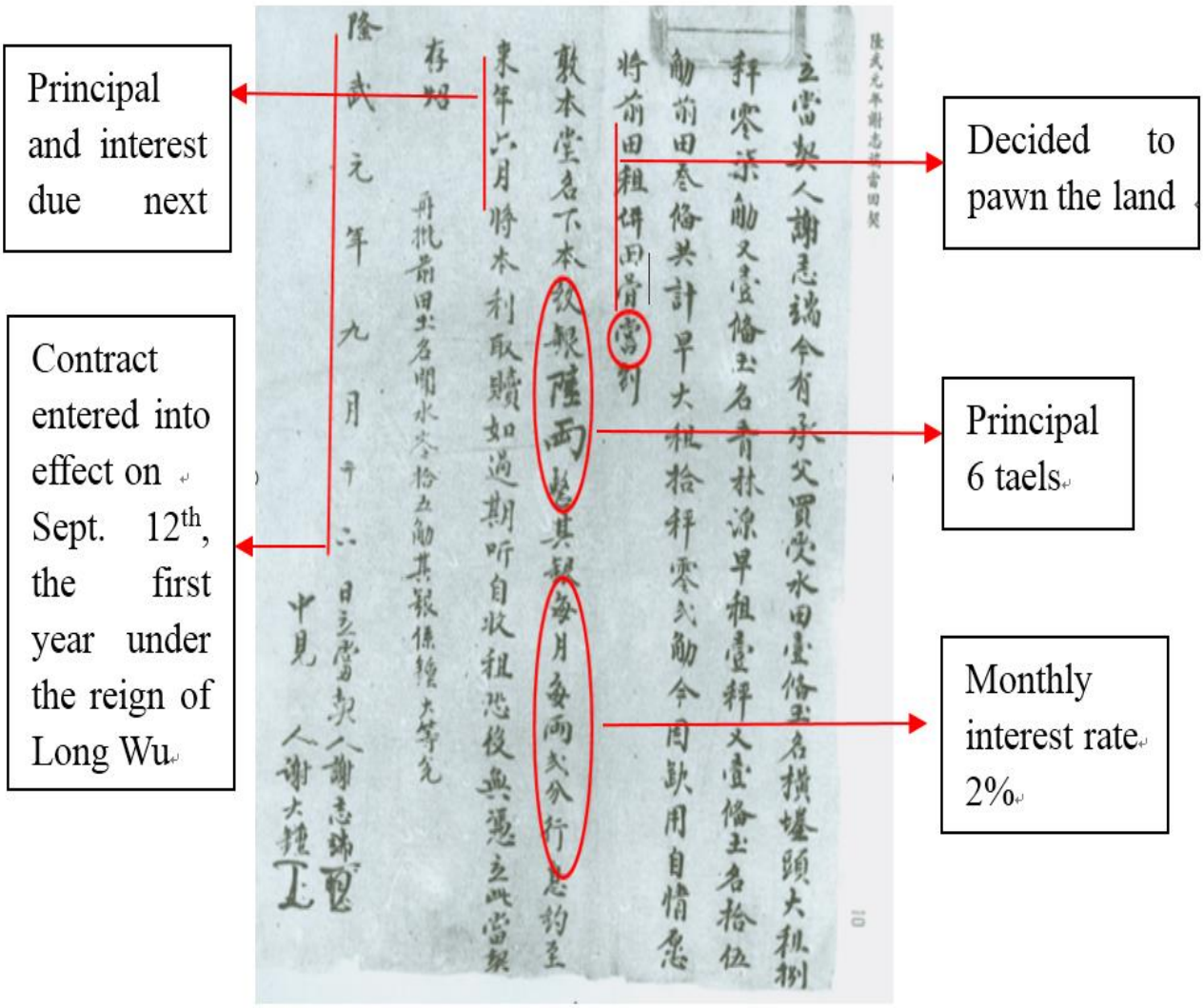

Figure 1 Pawn Contract [115]

The figure above shows a pawn contract dated 12 Sept. 1646. The contract reads: Mr. Xie pawned his land and its yield in return for a loan of 9 months, with a principal of 6 silver taels at the cost of a monthly interest rate 2% per tael.

- Traditional historical books (such as annals) that recorded some financial

[115] Wang and Zhou, Vol. of the *Qing and Republican China in Huizhou Qiannian Qiyue Wenshu* 徽州千年契约文书 *(Historical Mannuscripts in Huizhou in a Millenium)*.

transactions in certain times. For example, there are Annals of the Han Dynasty, Collections of Legal Documents in the Song Dynasty, Outline of the Qing History, etc.[116] This source include summary or generalisation of interest rates for certain times.

Type Two, sources of intermediary[117] transactions or institutional data:

- Transcripts of the Royal Court including memorials to the throne, as well as the government's legal files of lawsuits involving debt or financial disputes (archival case records by the Board of Punishment)[118]
- Industrial or institutional journals, such as:
    - The Bankers' Weekly[119] records a smooth time-series of inter-bank offered rates from 1872 to 1952 in Shanghai, which by then was the financial centre of China
    - The Central Bank's Quarterly supplies interest rate information during the period between the 1900s and the 1930s in major commercial port cities, such as Chongqing, Hankou, Tianjin, Ningbo, Hangzhou, Changsha, Nanjing, Wuhu, Jiujiang, Qingdao, Zhengzhou, Fuzhou, Guangzhou, Guiyang, Chengdu, Xian, Lanzhou, and Kunming
    - The Banking Quarterly, for the provinces of Guangdong during the Republican era
    - The Economic Quarterly by the Provincial Bank of Hunan Province (Republican)
    - The Monthly Statistics, Jiangxi province (Republican)
    - The Historical Materials of Shannxi Money Shop, Supplemented

[116] Historical books such as:
Gu 班固 Ban, *Han Shu 汉书 (History of the Former Han Dynasty)* (Zhonghua Shuju 中华书局, 1962).
Yi 窦仪 Dou, *Song Xing Tong 宋刑统 (Uniform Penal Code of the Song Dynasty)* (Wenhai Chuban She 文海出版社, 1963).
Miantang 黄冕堂 Huang, *Qing Shi Zhi Yao 清史治要 (A Brief History of the Qing)* (Qi Lu Shu She 齐鲁书社, 1990).
[117] Financial intermediary is a collective term for financial institutions, organizations and firms that provide financing services.
[118] Related works on such records include, for example, Philip C. C. Huang and Kathryn Bernhardt, *Research from Archival Case Records: Law, Society and Culture in China* (Brill, 2014).
[119] "Yin Hang Zhou Bao 銀行週報 （Banker's Weekly）," *Association of Banks and Financial Institutions in Shanghai 上海銀行公會*, n.d., doi:SOAS Lib: C per 153558,153559.
Financial Research Centre of Shanghai Branch of The People's Bank of China, ed., *Shanghai Qianzhuang Shiliao 上海钱庄史料 (Historical Materials of the Financial Industry in Shanghai)* (Shanghai: Shanghai People's Publishing House, 1978).

Version, Shannxi province (Republican)

- The Historical Materials of Jin Cheng Bank[120] dating from 1892 to 1937
- The Financial section of the State Gazetteers of Taiwan[121] contains interest rate data of both private and banking finance dating from 1898 to the 1970s.

These sources provide banking data from the cities of Guangzhou, Changsha, Nanchang, Pingyao(county), Tianjin and several places in Taiwan (including Taipei), etc.

- Yearbooks or statistical summaries of regional or national financial market or economy, such as Statistics Monthly of the Republican China, National Yearbook of Banks (1934) and Chorography of China's Industries[122]
- A financial feature in a local gazetteer, such as those of Taiwan, Fujian, Dongbei, and of cities such as Wuhan, Beijing, and Tianjin. Some gazetteers and historical documents were compiled by local authority such as a government or influential clan in the old times; others have just being collected and edited since recent years.
- Regional or national surveys of rural and urban economy during the Republican era, carried out by universities or by the State. For example, Crop Report[123] gives an entire picture of rural interest rate in 1934 covering 22 provinces of China based on a national survey carried out by Ministry of Industry, Nanking Government. And Land Utilisation[124] is the fruit of an academic research led by John Buck, which covers 15,112 farms, 150 localities, 142 hsien (县), 22 provinces of China from the

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[120]Financial Research Centre of Shanghai Branch of The People's Bank of China, ed., *金城银行史料(Historical Materials of Jin Cheng Banks)* (Shanhai: Shanghai People's Publishing House, 1983).

[121] Shaoyuan 薛紹元 Xue and Guorui 王國瑞 Wang, eds., "Finance," in *Taiwan Sheng Tongzhi 台湾省通志 (Taiwan Gazetteers)* (Zong Qing Tushu Chuban youxian gongsi 宗青圖書出版有限公司, 1983).

[122] Bureau of Statistics of the Nationalist 國民政府主計處統計局 Government, ed., "Zhonghua Minguo Tongji Tiyao 中华民国统计提要 (Statistical Yearbook of the Republic of China)," in *民国史料丛刊 (Collections of Historical Materials from the Republic of China)* (Da Xiang Chuban she 大象出版社, 2009).

中国银行总管理处经济研究室 Economic Research Centre of Administration Department Bank of China, ed., *Quanguo Yinhang Nianjian 全国银行年鉴 (Statistical Yearbook of Banks)* (汉文正楷印书局, n.d.),1937.

Department of Industry 實業部國際貿易局, Bureau of International Trade, ed., *Zhongguo Shiye Zhi 中国实业志（Reports on Industrial Development in China, by Province)* (Department of Industry, 1933).

[123] Department of Agricultural Economics Ministry of Industry The National Agricultural Research Bureau, ed., "农情报告 （Crop Report）" (Nanking: The National Agricultural Research Bureau, Ministry of Industry, n.d.).

[124] John Buck, *Land Utilization in China : A Study of 16,786 Farms in 168 Localities, and 38,256 Farm Families in Twenty-Two Provinces in China, 1929-1933* (Nanking: University of Nanking, 1937).

year 1929 to 1933. (For more sources, please see Bibliography.)

1.2.2 Data Quality

This section discusses data quality. The first question arising here is, how reliable are these sources regarding data quality? In this respect, interest rate data can be grouped in four categories.

In the first category, each entry of data stands for one single transaction of capital or a specific loan contract. Usually there is attached information, such as the name(s) of the borrower and lender, time, place, amount, purpose of loan, security form, etc., as shown in the pawn contract (Figure 1) above. This makes it a solid ground of research.

However, is it an adequate representative of the market prices? Or is it a unique rate particular to a specific deal? As mentioned earlier, the samples here cannot capture those transactions based on oral agreements rather than written contracts. Moreover, many contracts were lost over time. It was common practice to preserve a contract if enforcement proved problematic, and to destroy those that had been carried out successfully. This is bound to bias the sample to an unknown extent. However, loan contracts were usually defined by local conventions and traditions. Moreover, this study is based on a large sample. If more than one entry is found from the same market and year, the average of the interest rates is taken. Together, the large number of entries can reflect local factors and customs that influenced the interest rate level and thus can probably explain differences between regional levels. Finally, the concept of "market price" means "a set of similar prices agreed within the market".[125] Therefore, interest rates from specific contracts are more than just "a group of rates particular to any given" family or individual; rather, they can be taken as an indicator of market force.[126]

In the second category, a data entry represents many transactions of a certain time period

[125] Lingfan Li, "Bullion,bills and Arbitrage: Exchange Markets in Fourteenth- to Seventeenth Century Europe" (the London School of Economics and Political Science, 2012), 106.
[126] Ibid.

and locality. Usually, these are systematic records of the financial industry, thus may be called “institutional sources”. They provide quite trust-worthy and complete time series data. For example, every daily inter-bank rate of the Shanghai financial market is the average of all inter-bank transactions on a specific trading day in Shanghai. Similar data are found in the form of monthly or annual rates. In this sense, they are the best representation of market price.

In the third category, an entry stands for a general level of interest based on interviews or personal memories, such as those found in social surveys in Republican China, local literature, gazetteers, tablet inscriptions, and so on. These records of data may be blurry, however, with generalised descriptions or averaged estimations of the situation for that specific time and locality. Their credibility is not as high as the first two categories.

In the last category, an entry is just a planned or legal interest ceiling for a certain period and in a certain area. Some interest rates of banks, state-owned pawnshops, or related laws are of this type. Because there was no evidence to show how perfectly this policy was implemented, this source of data is doubtful.

Admittedly, this is not a perfect sample, and bias may come from drawing on such a wide array of sources. However, the majority of the data used here are from the first and second category of sources, and both of these contain representative market rates. There are only limited data of the third and the fourth type (no more than 1%), so their influence is small. Besides, since most markets present data of mixed sources and features, similar biases are likely to offset one another when comparing interest levels across time in the historical trend of the dataset. This is particularly the case when a large sample is employed. Moreover, in the structural analysis of Section 1.3, we will limit their influence by dropping some data without proper attribute description, or control for source differences through attribute dummies (such as the type of creditor).

The next question concerns the compatibility of the raw data regarding unit of count. Because the integration level among two or more localities is tested based on the same

specification, prices need to be standardised in this field of research regardless of whether it concerns commodity (grain)[127] or financial markets. On financial markets, interest rates were often recorded as payment for a month (monthly rate), or as payment for a year (annual rate). For instance, daily interest rates were applied on intra-bank credit and overnight transaction, whereas loan transactions among commoners often recorded monthly rates, and commercial loans often noted annual rates. To compare and analyse them, we need a benchmark, which induces the problem of conversion. However, the case of financial prices is more complex than that of grain, for there are different options: either simple or compound interest rates can be computed.[128]

Regarding this, a common practice among financial researchers is the method based on simple interest rates: a daily rate times 30 makes a monthly rate; and a monthly rate times 12 makes an annual rate.[129] The present paper adopts this method too. This conversion is only a switch in the measure of interest payment, or a shift in the unit of account. Instead of telling us how much the borrower paid for one month's occupation of the capital, it tells us how much was paid for one year. Note that converting a monthly rate into an annual rate does not change its maturity from a month to a year. In regression analysis on interest rate determinants, we can still control for maturity.

Neither does the conversion touch on any other contract terms recorded from the past. It is true that interest charges varied in line with the term, as with many other influential factors. However, this is fixed and engraved in history; all the influences on, thoughts

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[127] For example, in grain market research, one can compare grain prices of different weights (grams, kilograms) by unit-converting (the price per gram converted into kilogram by timing 1000, or vice versa). For example, "As each city's prices are quoted in a different monetary and physical unit, it was necessary to convert the original series into a single unit" (Victoria N. Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price," *Discussion Paper Series, Department of Economics,University of Oxford* 350 (2007), 10-11.) "Drawn from a wide array of sources that report local prices in different weight (or volume) and currency units, all annual prices used here are standardized in grams silver per hectoliter" (Max-Stephan Schulze and Oliver Volckart, "The Long-term Impact of the Thirty Years War", *Working Papers* of the Economic History Department, London School of Economics, p7-8).

[128] The term "usury" implies a value judgement in many historical contexts. But hereafter, unless explained otherwise, this term is defined as credit activities based on an interest rate higher than the legal ceilings set up by the state of the time, with no value judgement implied by the author of the present study.

[129] "Most ancient rates, like modern small-loan rates, were quoted by the month, and these are simply multiplied by twelve without compounding, and without allowing for variation in the calendar, to give an annual rate" in Sidney Homer and Richard Sylla, *A History of Interest Rates* (New Brunswick, N.J.: Rutgers University, 1996), 9. Also see Peng, Chen, and Yuan, "近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)."

of and negotiations between the lender and borrower have already been imprinted, thus are denoted by the existing interest rate in hand. If the lender and the borrower agreed that the loan of a longer-term should cost more interest, they would already realize that agreement by putting down a higher rate in the contract, such as a monthly rate of 9%. Hence, such data are hard evidence, and they remain intact after the conversion. However, of course, for any converting process we expect a slight side-effect or bias from rounding numbers. However, to make data comparable over time and in the cross-section, it is a necessary risk.

An alternative way to standardize interest rates is by compounding. Compounding is a means of exponential increase by counting interest payment of the first period into the principal of the second period.[130] Based on the same monthly rate, the result of an annual rate calculated by compounding can be much higher that of simply multiplying by 12.[131] Then, why do we choose the first method of simple rate rather than compounding? The method adopted here shall match the history under study. If most Chinese people in the times under study tended to consider compounding when they negotiated a loan, we might as well consider compounding when processing data (even though the data were not compound rates). Regarding this, below we briefly go through some historical

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[130] A compound rate counts the interest payment for the current payment period (day, week, month or year) into the principal of the next payment period (day, week, month or year), so that the total interest payment increase by an exponential rate. See
Lewin, "An Early Book on Compound Interest - Richard Witt's Arithmeticall Questions."
Lewin, "Compound Interest in the Seventeenth Century."

[131] Below is an example to compare the difference between the simple method and compound method in converting monthly rates into annul rates. Suppose the principal of a loan is 1 dollar, and the monthly interest rate is 6%. If the interest rate is a simple rate:

- in the first month,

the total of principal + (interest payment) = 1+(1*6%)=1.06;

- in the second month,

principal + (interest payment of two months)= 1+(1*6%+1*6%)=1+(1*6%)*2=1.12;

- in the twelfth month,

principal+ (interest payment of 12 months)= 1+(1*6%)*12= 1.72

If the interest rate is a compound rate:

- in the first month, the total of principal + interest payment = 1+1*2%=1.06;
- in the second month, (principal + interest payment) of two months $=1*(1+6\%)^2=1.124$
- in the twelfth month, (principal + interest payment) of twelve months $=1*(1+6\%)^{12}=2.01$

The more frequent conversion is, the larger difference between the result of simple-rate payment and compound-rate payment, which may bias the historical analysis here if the monthly rates and annual rates are distributed extremely unevenly over time (say, more than 80% of interest rates collected for a century is monthly rates; while more than 80% of that for the next century is annual rates).

But given the range which most monthly rates fall into (1%-6%, see Figure 6), the difference between converting monthly rates into annual rates by multiplying 12 and that by compounding is not as much as to reverse a historical trend (a difference of 14%= (2.01-1.72)/1.72, as calculated above).

aspects about compound rates.

Firstly, the legal system of the Tang dynasty (618-907 AD) first produced written laws to forbid compound rates, which then continued to the last dynasty.[132] State loans tended to abide by the law, hence there is probably no need to convert state loan rates by compounding. Although these legal maximums were often violated in the private sector, at least they made a warning line for financial institutions and commoners. It is true that some creditors might demand compound interest return off the record, namely, hidden interest payment from the loan contract. However, if a compound loan was off the record, it left no written document (legal contracts) to be traced. Therefore, it is out of reach and not of concern by the present study.

Secondly, according to common practice in this trade, only if the debtor still could not make the payment when the last loan contract was terminated on the day of maturity, would the compounding process be initiated and a new contract entered into effect.[133] In other words, even if the compound practice had left written documents for us to find, we would face at least two contracts. There would be no individual contract which defined such a compound rate as this: Before the termination of the contract and at the end of each day (month/year), the interest payment for the last day (month/year) would be automatically turned into the principal of the next period. Instead, there would be two (or more) separate loans (the principal of the succeeding loan just "happened to be" the principal plus interest payment of the precedent). Of course, that was a disguised compound practice, probably to avoid the legal regulation on interest ceiling. However,

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[132] Pu 王溥 Wang, "Chapter 88 Miscellanious Codes," in *Tang Hui Yao 唐会要 (Institutional History of the Tang Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1955).

Dou, *Song Xing Tong 宋刑统 (Uniform Penal Code of the Song Dynasty), 414*.

Juzheng 薛居正 et al. Xue, "Chapter 10 The Last Emperor, Liang Shu (History of the Liang Dynasty)," in *旧五代史 (Old History of the Five Dynasties)*, 1976, 3.

Lian 宋濂 et al. Song, "Xing Fa 刑法 (Penal Codes), Vol.105 of Section Zhi," in *Yuan Shi 元史 (History of the Yuan Dynasty)* (Zhonghua Shuju 中华书局, 1976).

Shanchang 李善长 Li and Weiqian 刘惟谦 et al. Liu, "Vol.9, Book 3 户律之钱债 (Money and Debt Related Articles, Civil Laws)," in *Da Ming Lv Li 大明律例 (Laws and Precedents of the Ming Dynasty)*, ed. Xiaofeng 懷效鋒 Huai (Beijing: Falv Chuban She 法律出版社, 1999), 28.

Ben 徐本等 et al. Xu, *Daqinglv Jijie Fuli 大清律集解附例 (Statutes of the Great Qing with Collected Commentaries and Appended Precedents)* (Beijing: Kexue Chuban She 科学出版社, 1994).

[133] Kaixiang 彭凯翔 Peng, "Jinxiandai Lilvshi Yanjiu Baogao 近现代利率史研究报告 (Report on Interest Rates of Modern China)," in *History of China's Finance and Market*, 2006.

in this case, there would be at least two simple interest rates, two amounts of principal, thus two entries for the dataset. Accordingly, the conversion step for simple rates is applicable.

In addition, traditional Chinese creditors seemed to be insensitive to maturity (or the term structure of the loan).[134] In case of payment default on maturity, the term would be extended provided that the borrower continued to pay the interest instalment. Two hypotheses may be drawn from this observation. First, since extending maturity was not a problem, there was no need to avoid or punish it by defining within the contract a higher interest rate for the following periods. This is probably why progressive-rate loans barely existed in China (which, for example, defined both a lower interest rate for the first year, and a higher interest rate for the second year in one contract). To the best knowledge of the author, there was no written record found of such progressive-rate contracts.[135] Hence, we do not need to consider how to calculate annual rates from monthly rates in a progressive way.

Second, even if the contract set up an increased rate to punish for a delayed interest payment, this was done at the termination of the current loan contract, namely, it was meant for a second/succeeding contract.[136] Thus, we can still treat them as two separate entries of simple rates. Suppose the lender and borrower decided to set up progressive interest rates by term, for example:

- for the first 12 months, a monthly rate of 3%

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[134] see Peng, Chen, and Yuan, "Jindai Zhongguo Nongcun Jiedai Shichang de Jizhi 近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)", 153. And also
Ping 欧阳苹 Ouyang, "Sichuansheng Nongye Jinrong 四川省农业金融," in *Sichuan Nongcun Jinji Diaocha Baogao 四川农村经济调查报告 （Survey Report of Sichuan Rural Economy）* (Zhongguo Nongmin Yinhang 中国农民银行, 1941).
Regression analyses support this observation with estimated regression coefficients of various maturity terms (See Section 1.3.2.)

[135] In researching on China's interest rates, the only time I encountered related literature is when I read about the laws of credit behavior in the ancient times, which was imprinted on a copper tripod (times of oracle bone inscriptions). It recorded a lawsuit in which, a person was punished and fined, and if he could not make the payment in the first year after sentence, he must double his payment as a sort of penal interest. See (Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*, 62.)
But in the dataset under study here, there are no such progressive rate included at all.

[136] For reference, see Xuncheng 杜恂诚 Du, *Jin Dai Zhong Guo Qian Ye Xi Guan Fa 近代中国钱业习惯法：以上海钱业为视角 (Conventioinal Laws of Contemporary Chinese Financial Industry -Based on Shanghai Financial Industry)* (Shanghai Caida Chubanshe 上海财大出版社, 2002), 54.

- a monthly rate of 4% for the next 12 months if the borrower fails to return the principal and pay all the interest at the end of the first 12 months.

In this case, the loan contract may be taken as two entries for the dataset of the thesis:

- a monthly rate of 3% recorded with a maturity of 1 year (short-term); and
- a monthly rate of 4% recorded with a maturity of 2 years or more (long-term).

Then each of these two rates can be converted into simple rates.[137]

In short, compound rates are not collected for or studied by this paper, hence the standardizing method of compounding is not suitable; the method of simple rates fit the present study the best.

The rest of Chapter 1 presents descriptive statistics of the overall dataset (all the 26,222 raw data known by a specific year), and then analyses data patterns in time, space and other structural features (maturity, collateral, currency, principal, creditor, etc.). It does not mean to conclude on how interest rates developed in any particular market, or to determine a representative trend for specific regions or the country as a whole. This is because the data are very scattered with their distribution unbalanced in time and space, and we cannot rule out the possibility of discovering new data evidence (after all, an empirical study can only go as far as its data availability allow). Rather, it means to introduce the new discovery of financial data in Chinese history, speaking for the present dataset (a large one, with data scattered over more than 600 localities during the 6th to the 20th century). Also, it lays a quantitative foundation for further discussions on financial integration in Part II. Since data examined in Part II come from the raw data set here, the dataset's structural features and patterns will influence financial integration analysis later.

[137] Taking two entries out of them may cause slight bias on the term structure. The second rate was higher because it was the second year/stage of a 2-year loan, but it was recorded as a one-year loan here. But now we record them as two loans of 1-year maturity, this feature of the contract would be covered or disguised. If to analyze the term structure and see how much influence a longer maturity can have on interest rates, this might bias the analysis a bit. But again, the author of the paper has not encountered such a progressive-rate based loan contract. Thus this is not a problem for this paper.

1.2.3 Descriptive Statistics

First of all, the sample spans a long history from the Sui dynasty to the beginning of the financial re-marketization reform in the 1980s; however, this by no means suggests the study has found an entry for every year in between. But this is not a problem for this chapter, since this chapter contains no time-series analysis on any particular dynasty or period, but only statistic descriptions and a structural analysis. Time distribution of the raw dataset is given below. The 20th century accounts for the largest proportion of data, followed by the Qing and the Tang dynasty.

Table 1 Descriptive Statistics by Time and Type
(Whole Sample of Raw Data)[138]

		Sui-Tang (581-959)	Song (960-1279)	Yuan (1279-1368)	Ming (1368-1644)	
private	Number of Obs.	562	36	24	112	
	Mean (unit:%)	50.5	120.8	87.1	72.6	
	Std.	28.7	146.3	66.8	75.7	
	Min (unit:%)	0.0	6.0	0.0	10.0	
	Max (unit:%)	240.0	900.0	240.0	500.0	
institutional	Number of Obs.	40	52	14	37	
	Mean (unit:%)	82.2	37.5	51.5	23.9	
	Std.	72.6	34.2	34.0	12.1	
	Min (unit:%)	20.0	0.0	18.0	10.0	
	Max (unit:%)	500.0	200.0	120.0	48.0	
		Qing (1644-1911)		Republican (1911-1949)		R.R.C. (1949-1985)
private	Number of Obs.	3,519		8,488		223
	Mean (unit:%)	36.1		39.8	39.8	7.5
	Std.	118.3		431.1	431.1	4.6
	Min (unit:%)	0.0		0.0	0.0	1.8
	Max (unit:%)	3789.5		36000.0	36000.0	25.2
			modern banks		modern banks	modern banks
institutional	Number of Obs.	2,542	1,388	1,623	7,474	89
	Mean (unit:%)	39.7	10.5	37.1	37.9	9.3
	Std.	31.0	10.5	37.9	203.2	4.7
	Min (unit:%)	0.0	0.0	1.2	0.0	3.6
	Max (unit:%)	442.1	147.6	360.0	10800.0	23.4

Source: own dataset, 26,222 raw data entries containing records of transaction year.

[138] The official reign of the Tang dynasty covered 618-907 AD However, data from the short gap after the Tang and before the Song dynasty (907 AD-960 AD) are also labeled here as the Sui-Tang period (581-960). Data found for the Sui dynasty (581-618) are from the same archives discovered in Tulufan and Dunhuang area as data for the Tang dynasty, and they were coherent in time. Besides, since the focus of Part I is structural analysis of interest rates in general, but not whichever individual dynasty or region and it is not time-series or regional analysis, we tend to make full use of all the raw data available, instead of tailoring them to suit the dynasties.

Table 2 Summarized Statistics by Dynasty
(Whole Sample of Raw Data)

Dynasty/Times	Sui-Tang	Song	Yuan	Ming	Qing	Republican	R.R.C.
Number of Obs.	602	88	38	149	7449	17585	312
Mean (unit:%)	52.6	71.5	74.0	60.5	32.6	38.8	8.0
Std.	34.2	104.8	59.0	69.1	84.1	327.7	4.7
Min (unit:%)	0	0	0	10	0	0	1.8
Max (unit:%)	500	900	240	500	3789.5	36000	25.2

Source: the same as above.

The minimum level recorded in most of the times is zero, reflecting the long-existence of low-interest and beneficial loans. It is interesting to make a comparison with European interest rates. From times before the Christ to the 20th century, the lowest reported rate in each half-century in Europe ranged from about 2% to 40%.[139] This comparison in a sense suggests China's interest rates might not be as high as once thought; however, there might be hidden interest rates about zero-interest capital transactions in China. On average, however, China's interest rates were much higher than in Europe.[140]

The mean of interest rates after the establishment of PRC was the lowest among all periods. This may be because the data in the PRC period covers only some years between 1949 and 1985, ending in the early years of the Reform and Opening-up. In the era of planned economy, the government set up interest rates for the nationalized banks, and labelled any credit transactions based on an interest rate higher than the legal ceiling as "usury",[141] which was strictly forbidden at the time, hence the low interest rate level.

Apart from the pre-Tang period, the Yuan dynasty topped all regarding the average of annual interest rates. Usury was the major practice during the time, with bureaucrat

[139] Homer and Sylla, *A History of Interest Rates,* 61-63, 136-139.
[140] For references on European interest rates in history, see Ibid.
[141] In the planned economy era when Marxism was dominant in China, the term "usury" was used in the context of Marxist economy (for more references, please see Marx, "Pre-Capitalist Relationships."

capital[142] prevailing all over the country in various economic sectors.[143] However, throughout the times from the Yuan to the Qing dynasty (the 13th-19th century), the average annual interest decreased from 74% to 32%.

Second, the data distribution is also quite uneven in space, as shown in the table below.[144] This may bias historical observations on interest rate trends. For example, data for the Tang dynasty were mostly collected from a region near the capital. Maybe the interest rate level of this period appeared to be high only because this region featured a very high interest rate, while interest rates in the rest of the empire could be much lower? Indeed, this is possible. However, this chapter does not aim to determine a representative trend for specific regions or the country as a whole, thus, geographic representativeness is not a critical issue in the present context. Still, we can take a closer look at the spatial distribution.

[142] This refers to state loans, capital from assorted sources such as royal families, government loans, officials and bureaucrats, or a hybrid of them.

[143] Qiao, "宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)."
Dujian 翁独健 Weng, "Hantuo Zakao 翰脱杂考," *Yanjing Xuebao 燕京学报* 29 (1941).
Qi, "宋代的商业资本和高利贷资本 (Commercial and Usury Capital in the Song Dynasty)."

[144] Note that these data are described according to the 1820 provincial division, which works purely as geographic reference. It does not mean that the administrative division of provinces stayed the same through centuries; neither does it mean that the empire covered the same size of area all the time.
We just need a time-invariant geographical base to tell where these transactions happened. If we do not use a provincial code based on the 1820 map, we can use a map as of today or of another time, or we can always use the coordinates of the location. It does not matter to us whether a market switched from Province A to Province B or C across time. We only need to know that the transaction happened on a time-invariant map.
We choose the 1820 Qing map as the geographical framework because: one, the Qing dynasty connects the Ming dynasty and the Republican era in history, a natural common ground in territory division of both periods; and two, the 19th and 20th century provide a major proportion of the interest rate data --- fitting them in the geographic framework of their corresponding time would be more convenient.

Table 3 Detailed Descriptive Statistics by Time and Location

Period	Province/Region											
Sui-Tang (581-959)	**all**	**Jiang su**	**Hu nan**	**Hu bei**	**Si chuan**	**He bei**	**Zhe jiang**	**Inner Mongolia**	**Liao dong**	**Canton**	**Tai wan**	**Xin jiang**
Number of Obs.	301											500
Mean (unit:%)	26.3											48.7
Std.	17.1											27.6
Min (unit:%)	0											0
Max (unit:%)	250											240
Song (960-1279)	0											
Number of Obs.	78.5		5	2			7					
Mean (unit:%)	73.1		30.0	30.0			73.4					
Std.	109.4		10.0	14.1			74.1					
Min (unit:%)	0		20	20			20					
Max (unit:%)	900		40	40			200					
Yuan (1279-1368)	0											
Number of Obs.	30.5	1				1	1					
Mean (unit:%)	74.2	36.0				24.0	36.0					
Std.	55.8	.				.	.					
Min (unit:%)	0	36				24	36					
Max (unit:%)	220	36				24	36					
Ming (1368-1644)	0											
Number of Obs.	77	42	3	4	2	7	18		1	7	1	
Mean (unit:%)	45.3	51.1	46.7	60.0	150.0	67.1	43.5		100.0	102.3	66.0	
Std.	37.6	33.1	47.3	46.9	70.7	41.7	37.7		.	135.5	.	
Min (unit:%)	17	10	10	10	100	10	10		100	20	66	
Max (unit:%)	268	100	100	100	200	100	130		100	400	66	
Qing (1644-1911)	0											
Number of Obs.	3729	929	180	155	398	487	107	77	135	114	1,542	
Mean (unit:%)	31.8	13.7	15.5	22.7	44.0	26.5	36.2	24.0	19.6	27.8	28.3	
Std.	46.9	55.6	17.0	14.1	164.0	59.7	48.4	0.0	12.5	33.9	50.9	
Min (unit:%)	8	0	0	6	0	0	1	24	0	1	0	
Max (unit:%)	1919	1200	144	120	3200	1200	240	24	120	300	1800	
Republican (1911-1949)	0											
Number of Obs.	8802	1,696	1,139	1,055	129	1,270	1,177	8	2,731	294	4,614	
Mean (unit:%)	24.0	46.2	21.7	75.1	103.9	50.1	99.6	113.8	27.4	41.8	10.6	
Std.	167.0	152.1	40.9	478.0	479.0	205.3	201.4	121.4	43.6	212.5	16.5	
Min (unit:%)	1	0	1	0	5	0	0	24	0	0	0	
Max (unit:%)	18012	3600	732	10800	3600	7200	6280	360	1200	3600	198	
R.R.C. (1949-1985)	0											
Number of Obs.	156								312			
Mean (unit:%)	4.0								8.0			
Std.	2.4								4.7			
Min (unit:%)	1								2			
Max (unit:%)	13								25			

(to be continued)

(continued)

Period	Province/Region											
Sui-Tang (581-959)	Gui zhou	Gan su	Shann xi	Shan xi	Shan dong	An hui	He nan	Yun nan	Jiang xi	Fu jian	Guang xi	Qing hai
Number of Obs.		50	6									
Mean (unit:%)		53.5	56.9									
Std.		23.8	36.4									
Min (unit:%)		30	20									
Max (unit:%)		170	120									
Song (960-1279)												
Number of Obs.		1					2		2			
Mean (unit:%)		200.0					12.0		100.0			
Std.		.					0.0		0.0			
Min (unit:%)		200					12		100			
Max (unit:%)		200					12		100			
Yuan (1279-1368)												
Number of Obs.		9					1		2			
Mean (unit:%)		93.3					120.0		21.0			
Std.		80.0					.		12.7			
Min (unit:%)		0					120		12			
Max (unit:%)		240					120		30			
Ming (1368-1644)												
Number of Obs.			9	1	2	23	5	1	7	9	1	
Mean (unit:%)			197.8	100.0	100.0	22.6	76.0	100.0	49.7	50.0	10.0	
Std.			166.3	.	0.0	10.1	33.6	.	29.7	31.2	.	
Min (unit:%)			30	100	100	10	30	100	10	20	10	
Max (unit:%)			500	100	100	60	100	100	100	100	10	
Qing (1644-1911)												
Number of Obs.	980	79	380	283	84	843	50	11	36	519	38	13
Mean (unit:%)	54.7	47.6	46.2	39.5	65.8	23.2	59.8	97.1	135.0	29.3	49.3	36.0
Std.	33.3	41.7	194.1	59.1	117.6	23.2	60.9	129.2	594.7	22.4	49.4	0.0
Min (unit:%)	24	10	12	0	10	0	10	36	10	0	12	36
Max (unit:%)	300	360	3789	840	1059	450	400	450	3600	327	300	36
Republican (1911-1949)												
Number of Obs.	10	47	26	672	1,008	110	277	14	399	836	14	40
Mean (unit:%)	41.5	78.3	1444.6	27.6	25.2	54.0	40.9	38.7	24.5	60.8	114.1	55.6
Std.	23.5	82.1	7048.3	24.3	42.1	128.2	72.8	19.3	65.5	412.9	211.7	60.4
Min (unit:%)	12	4	8	0	1	0	0	12	3	1	13	24
Max (unit:%)	89	360	36000	500	612	1116	720	86	696	7200	800	360
R.R.C. (1949-1985)												
Number of Obs.												
Mean (unit:%)												
Std.												
Min (unit:%)												
Max (unit:%)												

Source: the same as Table 1 and Table 2.

Except for the Tang dynasty and the PRC period, all other periods have data from at least 7 provinces/regions (see Table 3 above), which in turn consist of multiple markets of counties and cities. Given a large number of data entries for every time-point (year) on the historical line, problems in distribution are likely to offset one another to an extent, hence limit the bias from clustered data groups or outliers on the trend of the dataset. This is particularly the case in a kernel-smoothing process of the trend line.[145]

Regarding the Tang period (618-907 AD), data are from the three provinces of Gansu, Shannxi and Xinjiang. Most of these data come from archives uncovered in Dunhuang in the province of Gansu and in Tulufan of the province of Xinjiang, which may seem out of the way, located in the remote north-west of China. However, actually, the data area was not as remote a hinterland as it seems today, because the political and economic centre during the Sui-Tang period, namely, the capital city of Chang'an was located in Shannxi. Hence, this area was not far from the core of the empire at the time. Besides, Dunhuang and Tulufan were right on the Silk-road.[146] Given the prosperity of domestic and long-distance trade at the time, this area probably saw the exchange of commodities and capital among diverse people from all over the country and abroad. Combining these two aspects, it is reasonable to assume the capital market here may represent other markets to an extent.[147] Lastly, this is the only area where archives from the Sui-Tang

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[145] Considering the possibility that interest behaviour follows a non-linear pattern, the paper employs a Kernel trend line, a non-parametric technique using OLS to make polynomial approximations. (For more examples of kernel trends in this field of research, please see:
Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy."
Federico and Persson, "Market Integration and Convergence in the World Wheat Market, 1800-2000."
David Chilosi and Oliver Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520," *Journal of Economic History* 71, no. 3 (2011): 762–91.
Moreover, the kernel-smooth method also helps reduce the bias resulting from non-identical data distribution. With a re-weighing function to smooth fluctuations brought by extreme data and outliers, it fits the data distribution and reaches a non-parametric mean at a time point.

[146] "The routes all started from the capital in Chang'an, headed up the Gansu corridor, and reached Dunhuang on the edge of the Taklimakan." For more details on the routes, please refer to
Bohong Jin, *In the Footsteps of Marco Polo* (Beijing: New World Press, 1989).
Brian Hook, ed., *The Cambridge Encyclopedia of China*, 2nd ed. (Cambridge University Press, 1991).

[147] However, this by no means suggests national integration already happened at this time. Integration requires many more conditions (such as narrow interest gaps, frequent or regular interplay between or among fixed markets in a continuous period of time or on the same time-section) than occasionally a few interest rates similar to that on some other markets. In short, "spatial coverage to make a trend line" and "integration among/between fixed markets" have different criteria for data representativeness.

period are discovered. Admittedly, these data are not as representative as a perfectly even distribution sample with the same number of entries for every province of the huge empire. But since this chapter does not mean to conclude on how interest rates developed in any particular region, limited spatial coverage does not worry us here. It is better to have few data than nothing at all for us to have any clue about the interest level at the time. Hence we cannot overlook the data series discovered here.

Still, considering the potential bias from temporal and spatial distribution and to modify the historical trend observed below, we will check the trends against their corresponding historical background, to see if qualitative evidence tends to support the empirical findings. Moreover, Section 1.3 later will control for location variables to exclude geographic influences on interest rates and have a closer look at temporal dummies' coefficients.[148]

Below are some preliminary observations on historical trends of the dataset. Overall, it is clear that the interest rate level was declining (see Figure 2). To explore in more detail what was going on, we split the overall sample into two sub-samples according to data density or frequency by period. The first period concerns the millennium between the rise of the Tang and the end of the Ming dynasty (618-1644 AD). Comparing Figure 3 and Figure 4, we can see that data frequency in this period is obviously lower than that in the Qing dynasty and thereafter (1644-1985). Thus, descriptive approaches such as the moving average may not be suitable here. However, a kernel trend suggests that interest rates fell in a non-linear way during this period: two cycles stand out (see Figure 3 below). The two downward paths of the interest rates are found about the 8th to the 12th century and the 15th to the 17th century. The second period concerns the Qing dynasty until the eve of the Reform and Opening-up in the PRC era. Four major waves of interest, climbing-and-descending, are detected for this period, as illustrated in Figure

[148] So is the case for the P.R.C period, which gives only the 3 north-east provinces of Liaoning, Jilin, Heilongjiang. In future research, this part of the dataset should be further developed and enriched to verify our observations here.

4. Because of higher data density, Figure 4 can employ the tool of ten-year moving averages[149] to show more detailed interest rate fluctuations.

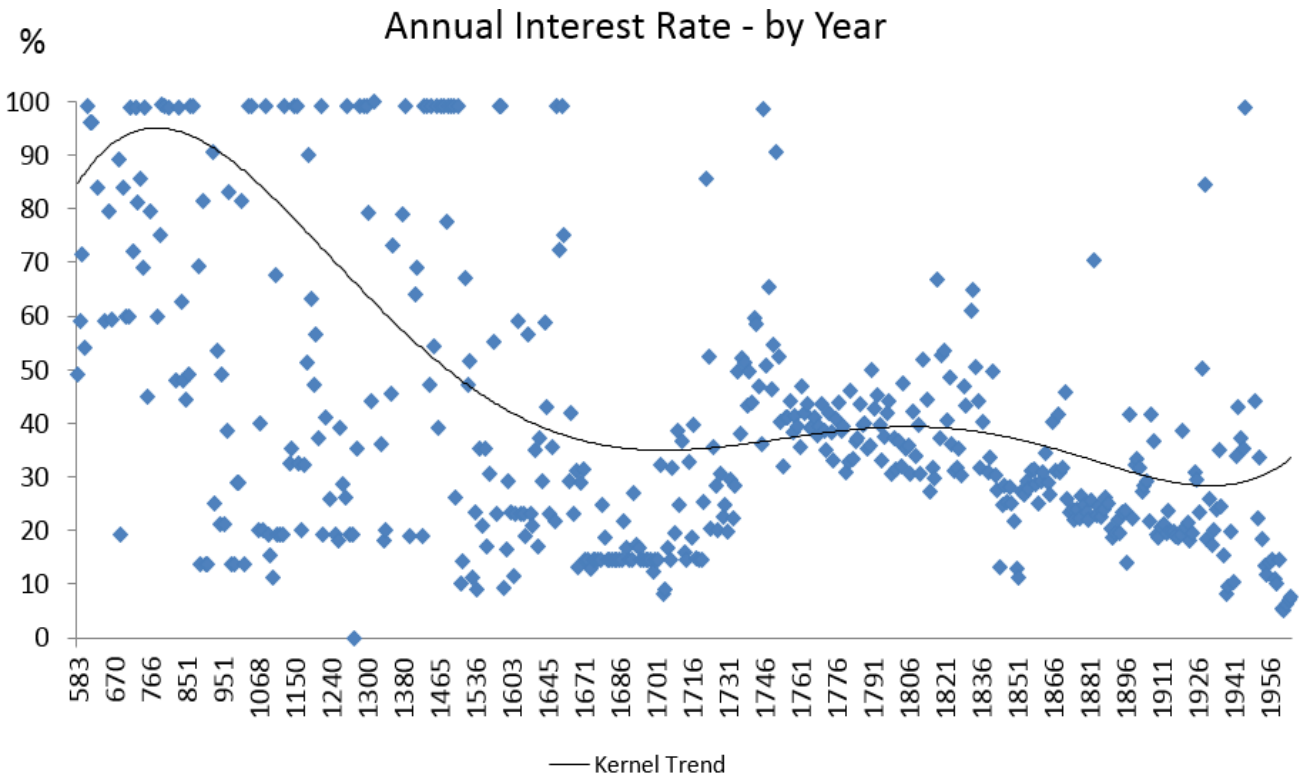

Figure 2 Annual Interest Rates

Each point represents an average of all interest rates available for the year on the X-axis. Calculation based on own dataset of 26,222 raw data entries containing information of transaction year. Outliers are not shown in the figure, with the vertical axis topped at an annual interest rate level of 120%.

[149] Note that moving averages feature a delaying effect. Namely, a point on the trend line stands for average performances of interest rates in the previous nine years and that in the current year. This effect applies to all the following analyses of the interest rate trend line.

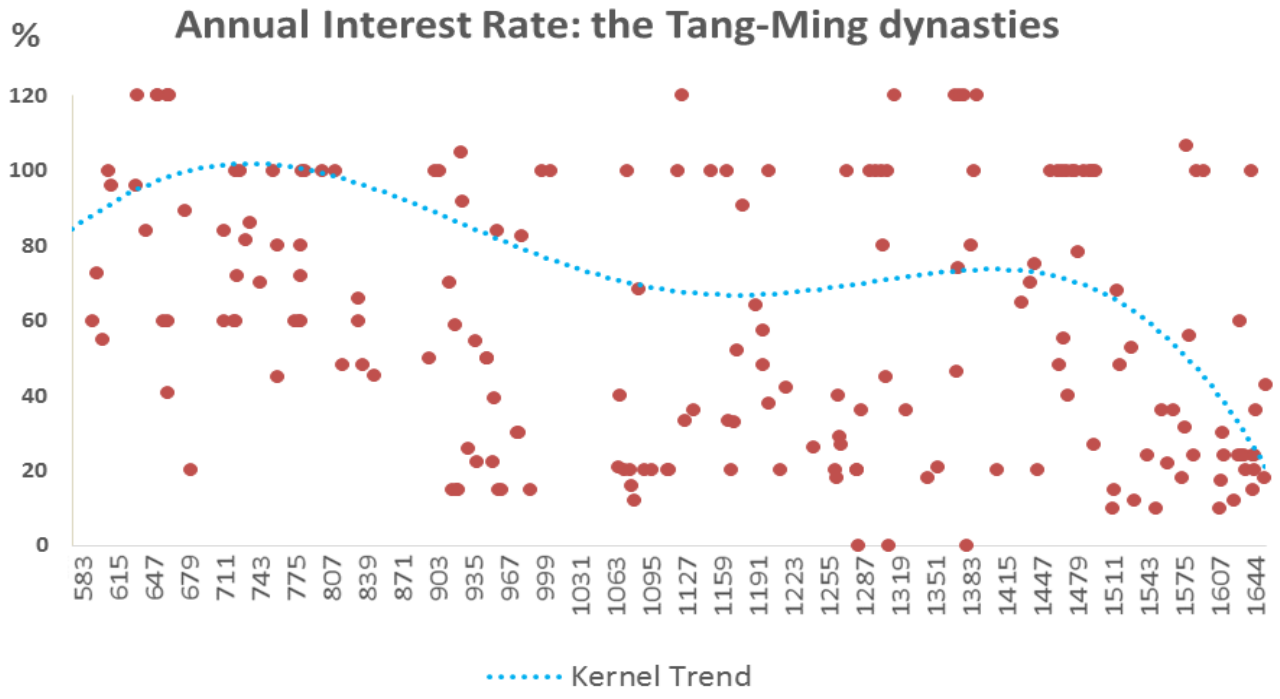

Figure 3 Annual Interest Rate: sub-period 1

Source: the same as Figure 2.

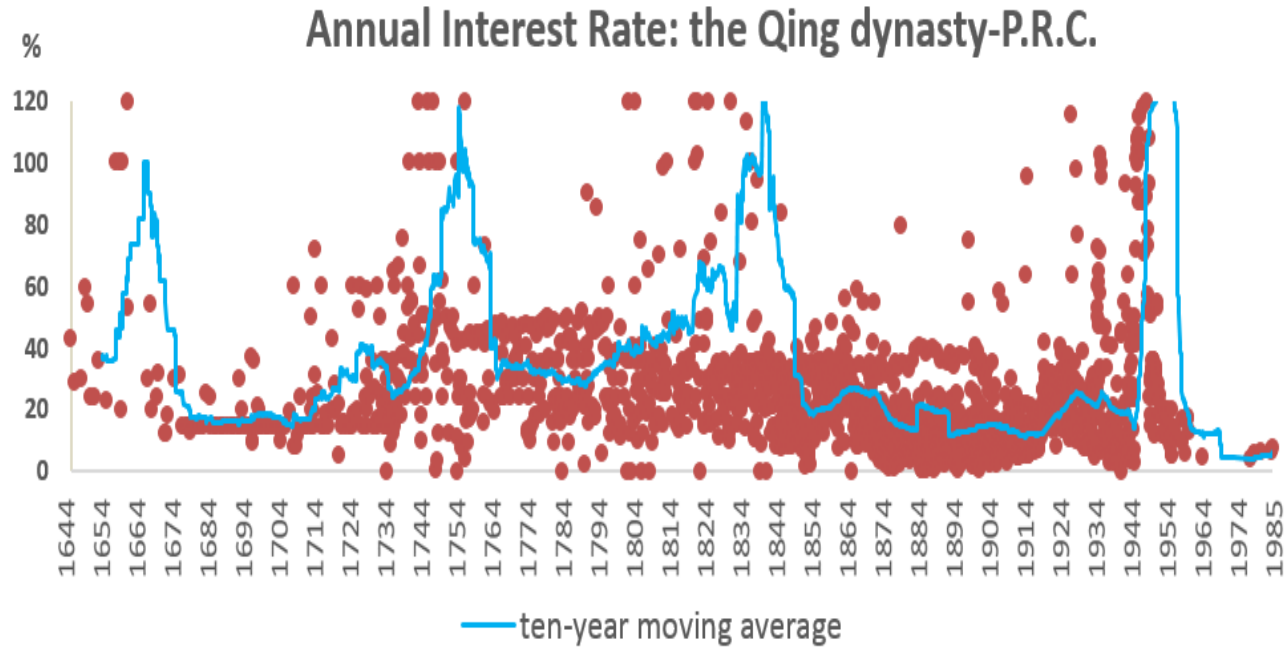

Figure 4 Annual Interest Rate: sub-period 2[150]

Source: the same as Figure 2

[150] This figure uses moving averages instead of the kernel smoothing method earlier. Because data in this period is of higher density and of less fluctuation, moving-averages can show more details of the raw data than the kernel trend.

As discussed above, we may ask: Can we find qualitative evidence in history to support the quantitative descriptions above? Can the trend line fit with the corresponding historical background? As an example, we walk through the peaks and troughs in Figure 4 of the second period to see if history tends to support the data trend.

The first peak was at the beginning of a new dynasty, around the year 1660. In the first few decades of the Qing dynasty, despite small-scale conflicts in the south against the rest of the Ming court, large-scaled re-construction was underway in most areas of the country, spurring capital demand. However, the financial market was already drained by wars and in times of uncertainty. Naturally, the interest rate level would upsurge. Nonetheless, it took less than two decades for the re-establishment of a national economy, and for the emergence of another prosperous period, the so-called "Kang-Qian Era" (the time spanning the reign of three emperors from Kangxi to Qianlong, 1662-1795).[151] As political stability and economic development continued, from around 1660 to 1704 interest rates decreased and stabilized at an annual rate of 20%.

The second wave arose about the time 1704. Towards the end of Emperor Kangxi's reign (康熙), who reigned during 1662-1722, continuous land-expanding wars on the frontier, though barely affecting mainland of the empire, had shown its financial effect. The national treasury was exhausted by large military expenditure. Furthermore, political conflicts, not only among the princes but also between the Han and the Manchu bureaucrats, came to be white-hot. The princes running for the throne were busy seeking support and making factions, of course, with political arrangements that involved large capital. These conditions largely increased capital demand. On the other hand, warfare impacted economic production; and political corruption encroached product surplus and capital in the public sector, undermining capital supply in the private sector. Combining

[151] This time spanned the reign of three emperors. The reign of Emperor Kangxi was from 1662-1722, that of Yongzheng from 1723-1735, and that of Emperor Qianlong from 1736-1795.

increased demand and shortened supply, one could expect the interest rate level to surge.

This up-going trend of interest rates halted under the reign of Emperor Yongzheng (雍正, who reigned during 1723-1735), probably because of the emperor's hard work in financial reform. Right after he took the throne, he set up an independent auditing team, and initiated an anti-corruption campaign sweeping the whole bureaucratic system. Any official who "borrowed" from the state (be they working at the level of central departments or local counties, or even members of the royal family) were ordered to pay back the debt within a time limit. If they could not make it, all their properties would be confiscated. Moreover, to prevent local officials from collecting more tax from the people in the name of "Taxation-Cost Fee (耗羡,火耗)" than they should, he ordered the tax to be collected by a fixed rate and managed by the provincial instead of the county or city government.[152] These policies protected local capital pools in the private sector, and also improved central finance. This laid down a solid ground for further economy-enhancing policies by his successor, Emperor Qianlong (乾隆, who reigned during 1736-1795).

However, the turning point for interest rates to go down did not come until around 1753 AD, when further economic policies enhanced the agricultural and commercial sector. Emperor Qianlong initiated land-reclaiming and irrigation works to deal with the increasing pressure of a rising population. He also encouraged farmers to grow cash crops and improve the marginal product of the land (though he surely was not aware of

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[152] This was an unwritten rule in the bureaucratic circle. When handing in local taxes to the central treasury, because the tax was collected in silver of all shapes and various weight, the local governments would melt the silver into sycee or ingots for the convenience of counting, storage and transport. However, re-mintage meant losing a small percentage of silver to wear and tear, or to the transaction cost of tax. To make sure the amount after re-mintage was as much as the tax should be, local governments usually collected more tax by the percentage of loss.

Before the financial reform, the central government had acquiesced to the common practice that local officials kept that percentage of additional tax as local fund for local officials' expenditure. This was meant to save the trouble of double transport: sending all the money in to the center first, and then deploying fund of expenditures later. But this institution soon became a means of exploiting local wealth, the loss rate determined at the discretion of local officials since local affairs were often out of reach for the central state. And eventually both the central treasury and local people suffered, leaving only officials in the middle richer. See：

Qingshizong Shilu 清世宗实录 (Veritable Records of Shizong Emperor of the Qing Dynasty), vol. 21 (Beijing: Zhonghua Shuju 中华书局, 1986).

Shouyi 白寿彝 Bai, ed., "Chapter 10 The Qing Dynasty," in *中国通史 (Chinese History)* (Shanghai: Shanghai People's Publishing House, 2004).

Jianzhong 董建中 Dong, "Qingdai Haoxian Guigong Qishi Kao 清代耗羡归公起始考 (A Study on the Initiation of the Tax-Cost Fee Reform in the Qing Dynasty)," *清史研究 (Research on the Qing Dynasty)* 1 (1999).

the concept) and income per household. Besides, there were tax policies in favour of merchants, allowing a tax discount if they covered business encouraged by the state.[153] Soon national production and the financial situation started to improve. The revenue increased from some 47,063,610 taels of silver in the year 1763 to some 81,824,044 taels in the year 1777.[154] Presumably, with economic development financial capacity of the market would also improve.

A third up-surging wave of interest rates took shape around the period 1790-1840, making a third peak on the eve of the Opium War.[155] This could be related to the unprecedented Malthusian crisis facing China at the time. By the end of the reign of Emperor Qianlong, the empire's population had doubled that of the beginning year, reaching some 300 million;[156] the population density increased from 55.49 people per square kilometre during the 1786-91, to the 80.69 people per square kilometre.[157] The national economy was pressing on to the Malthusian edge of marginal product – despite the introduction of higher-productivity food from North America, there was no sufficient land to feed the ever-increasing population. Less product-surplus meant less capital surplus. It also led to frequent peasantry uprising and social disorder, making for a worse investment environment. These population-induced problems would probably push interest rates high.

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[153] Bai, "Chapter 10 The Qing Dynasty."

[154] This is based on *Qing Shilu 清实录 (Veritabe Records of the Qing Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1986).and *Daqing Huidian 大清会典 (The Canon Collection of Statutes and Regulations of the Qing Dynasty)* (Taibei: Xinwenfeng Chuban 新文丰出版公司, 1979). Quoted from Zhongwen 史仲文 Shi and Xiaolin 胡晓林 Hu, eds., "Qingdai Jingji Shi 清代经济史 (Economic History of the Qing Dynasty)," in *中国通史 (Chinese History)* (Renmin Publishing House 人民出版社, 2002).

[155] The First Opium War happened from 1839 to 1842. It was between U.K. and China mainly because of their conflicts in trade. As a result, the Treaty of Nanking in 1842 was signed, five treaty ports were opened in China, and Hong Kong was ceded to U.K. This event is generally considered the starting point of Chinese contemporary history and western impact.

[156] The population in the year 1736 was some 133,220,000; and that in 1794 was some 313,280,000. For reference, please see

Tao 姜涛 Jiang, "清代人口统计制度与 1741—1851 年间的中国人口 (The Census System of the Qing Dynasty and Chinese Population from 1741-1851)," *近代史研究 (Research on Modern Chinese History)* 5 (1990).

Fuxian 易富贤 Yi, "就清朝初年人口与葛剑雄先生商榷 (Discussion on Population of Early Qing China with Mr. Ge Jianxiong)," *社会科学论坛 (Forum of Social Science)* 1 (2010).

[157] Jianxiong 葛剑雄 Ge, *Zhong Guo Ren Kou Fa Zhan Shi 中国人口发展史 (A History of Population Development in China)* (Fujian Renmin Chubanshe 福建人民出版社, 1991), 355.

After 1840, despite minor fluctuation, the interest rate trend decreased and stayed on a relatively low level for a few decades. A possible lens to view this is the western impact since the Opium War. Based on the five treaty ports of Guangzhou, Fuzhou, Ningbo, Xiamen, and Shanghai, not only western products but also capital entered the market and gradually penetrated the economy. Traditional financial intermediaries, such as some money shops in southern China, could have access to foreign sources for funds. Some of them even went further from capital pooling and transformed into modern banks by learning from their western partners.[158]

Another dimension to understand this is again Malthusian. There was a jump in population in the following two decades, which happened to be a period of man-made catastrophes plus natural disasters. The Taiping Rebellion[159] from 1850-1864 consumed some 20-30 million lives. Also the Yellow River flooded frequently during this time, with recorded floods in 1841-43 and 1851-55. As did the Yangtzi River in 1860 on a very large scale. Meanwhile, drought and locust plague appeared in the north.[160] We are not sure how such unfortunate relief of the labour/land pressure worked on the financial market. However, we do know it largely destroyed regional economies, thus decreased capital demand. It is no wonder that the timing of de-population coincided with that of decreasing interest rates.

The last peak of interest rates again toned in with warfare and financial policies, soaring around the time 1944-1956 and jumping from about 1956. Since the Fiat Money Reform[161] in 1935, deflation policy became the main financial tool of the nationalist

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[158] Jiaguan 洪葭管 Hong, *20 世纪的上海金融 （Financial Industry in 20th Century Shanghai）* (Shanghai: Shanghai Renmin Publishing House, 2004), 42-43.

[159] The Taiping Rebellion lasted from 1850 to 1864. It was a civil war between the Qing state and the military force of peasants in the south of China. At least twenty to thirty million soldiers and civilians died during this course.

[160] Wenlin 赵文林 Zhao and Shujun 谢淑君 Xie, *Zhongguo Renkou Shi 中国人口史 (Population History of China)* (Beijing: Renmin Publishing House 人民出版社, 1988), 385-386.

Tao 姜涛 Jiang, 中国近代人口史 (Zhejiang Renmin Chubanshe 浙江人民出版社, 1993).

Shuji 曹树基 Cao, *Qing Shiqi (Vol.5) 清时期卷 (Qing Dyansty)*, *Zhongguo Renkou Shi 中国人口史 (Population History of China)* (Fudan Daxue Chuban She 复旦大学出版社, 2003).

[161] This is a financial reform that switched the Chinese economy from silver currency to in-convertible paper notes. In November 3rd 1935, the nationalist government in Nanjing ordered: Paper notes issued by Central Bank, Bank of China and Bank of Communication shall be the only legal tender of the country, all payments shall be made

government to fund military expenditures. The second Anti-Japanese war (1937-1945) saw that the amount of paper notes issued by August 1945 increased to about 400 times more than that by June 1937.[162] What is more, the Second Chinese Civil War (1946-1949) worsened the financial situation of the nationalist government. For example, the deficit in 1948 reached 90 billion (paper dollars). The amount of paper notes issued by August 1948 reached some 663,690 billion, which was about 470,000 times more than that by June 1937 and more than 1,000 times more than that by 1945.

Under such circumstances, not only consumption prices but also interest rates would increase. On the one hand, currency value decreased rapidly, accordingly, the opportunity cost of lending money and holding expenditures was every high. . It was possible that that even on the day of maturity, the interest payment and principal would depreciate for several times before the lender could spend it. Expecting that future money was much less valuable than today, he would ask for larger return in the future. Also, considering the extremely high risk of contract violation in times of war, the lender would certainly want a higher risk premium. On the other hand, with factories shutting down and merchants going bankrupt, national output was shrinking and the capital pool was drying up. In 1948, only 20% of some 3000 factories in Shanghai were still running.[163] Less production led to less output and capital surplus, namely, less capital supply hence higher interest rates.

The interest rates jumped from about 1956 as rapidly as it soared. This was mostly because of the strict regulation on credit behaviour. Since the establishment of the PRC in 1949, usury was forbidden and state loan interest rates were strictly controlled by the economic committee of the state. But the country was not fully settled yet and there was large demand for credit during the recovery period, thus capital markets were not fully

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with the money; silver taels and dollars shall be converted into paper notes at authorized locations, no longer used in circulation and kept in stock by the government only; to guarantee a fixed exchange rate, the three banks are entitled to all necessary exchange transactions. See

Feiping 郭飞平 Guo, *Zhonghua Minguo Jingjishi 中华民國經濟史 (Economic History of Republican China)* (Beijing: Renmin Publishing House, 1994).

[162] Dixin 许涤新 Xu and Chengming 吴承明 Wu, *Zhongguo Ziben Zhuyi Fazhan Shi 中国资本主义发展史 (Capitalism Development in China)* (Beijing: Renmin Publishing House 人民出版社, 1990), 473.

[163] Shouyi 白寿彝 Bai, Section 1, Chapter 18, Vol. 12 in *中国通史 (Chinese History)* (Shanghai: Shanghai Renmin Publishing House, 2004).

regulated. From December 1951 to the end of 1956, the Socialist Transformation on agriculture, handicraft industry, and the commercial and industrial enterprises[164] took place. All means of production and the ensuing product surplus were collectivized, which means there was hardly any private source of capital. Besides, credit activity involving interest return was severely condemned and barely seen. All these social economic policies ensured the drop of interest rate levels.

In brief, this section depicts a historical trend of the interest rates under study. The overall trend line declined when it approached contemporary times, suggesting qualitative advancement in an institutional framework. Fluctuations of the interest rate trend largely echoed cyclic boom-and-busts of the economy, with peaks and troughs mirroring dynastic alteration. Significant events of political economy (such as wars and recovery) brought external shocks to the interest rate level, which were often temporary or in line with dynastic alteration or economic cycles.

The previous section describes the raw data, checking their trends against the corresponding historical background. However, the dataset is a hybrid sample, with unbalanced data ranging from personal rates, bank rates, to state loan rates. Different types of interest rate data might feature different interest rate levels, hence, the historical trends of the dataset are subject to the sample structure. If a type of loan features a particularly high interest rate level, and it dominates the sample for a specific year, a simple average of all interest rates in that year would overlook the structural difference and distort the interest rate level by pushing it higher.[165] Nonetheless, due to data

[164] The Three Great Transformations campaign was a reform during the period 1951-1956. It aimed at transforming China into a socialist country in 10 to 15 years' time. The reform in the agricultural sector set up socialist communes as essential productive unit in rural areas. Peasants worked together on collectively owned land and with collectively owned tools, and they ate together in a communal hall. In the reform of the industrial sector, the state bought over all private handicraft factories and businesses, turning them into state-owned enterprises. Similar work was done on the commercial sector. As a result, public and collective ownership of property became dominant economic institution.

[165] Different proportions of assorted loans in the sample may lead to skewed distribution in interest rate levels, because different types of loans may feature different interest rate levels. For example, if there are 70% of data entries in 1368 are from a loan contract with a short maturity (no more than 1 month) whereas 70% of data in 1400 are from a loan contract with a long maturity (more than 1 year), this difference might make the average interest rate level in 1368 higher than that in 1400, because generally the interest rate for long-run loans could be higher than those for short-run loans. Similarly, such differences might also cause bias in cross-sectional research

availability it is impossible to have a perfectly balanced sample with exactly the same ratio of loan types throughout history. If in a strict sense, actually "nothing resembling a modern time series of exactly comparable interest rates is available from antiquity".[166] Indeed, such a structural problem is commonly seen in historical research of market integration.[167] Although in a large sample, the bias may be limited and errors are likely to offset each other, one cannot be too cautious when making historical observations. Thus, the following structural models control for such feature variables and regress the interest rates on time dummies.

1.3 Interest Rate Determinants: Structural Regression

The following two sections study how intrinsic loan features and external social-economic contexts affected the level of interest rates. Hereafter, by internal structure, this paper means what intrinsic factors of loans (collateral, principal, and location, etc.) affected interest rates in a micro-perspective, and to what extent. By external structure, the paper means what social political and economic circumstances influenced interest rates in a macro-dimension. Again, this part does not mean to draw historical conclusions on any specific region or the country as a whole; rather, it speaks only for the data under study herein (scattered over 600 localities in 24 provinces during the 6th - 20th century).

in comparing interest rates of different regional markets.

[166] Homer and Sylla, *A History of Interest Rates, 57*.

[167] Similar discussions are found about grain market integration. Such factors as volume, currency, and quality of grain might also affect the price level of a specific deal. However, structural difference regarding these factors was often neglected in studying grain markets, and various units of measurement were standardized so as to be compared. For example, grain prices were closely related to quality. Grain of superior quality could sell at a much higher price than the inferior. If the data proportion of good-quality grain to poor-quality grain on Market A is largely different from that on Market B, integration analysis may be biased. But evidence on price structure of different quality's grain was scarce and difficult to find, so the problem is mostly unsolved (See Giovanni Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870," *Working Papers HEC, of Department of History and Civilization, European University Institute* 1 (2008), 27.) In short, measure-standardizing is necessary for market integration research and the bias is limited.

1.3.1 Statistic Description and Model Specifications

Detailed data distribution in time and space has been given in Section 1.2 above. Figures below illustrate some key features of loans and interest rates.

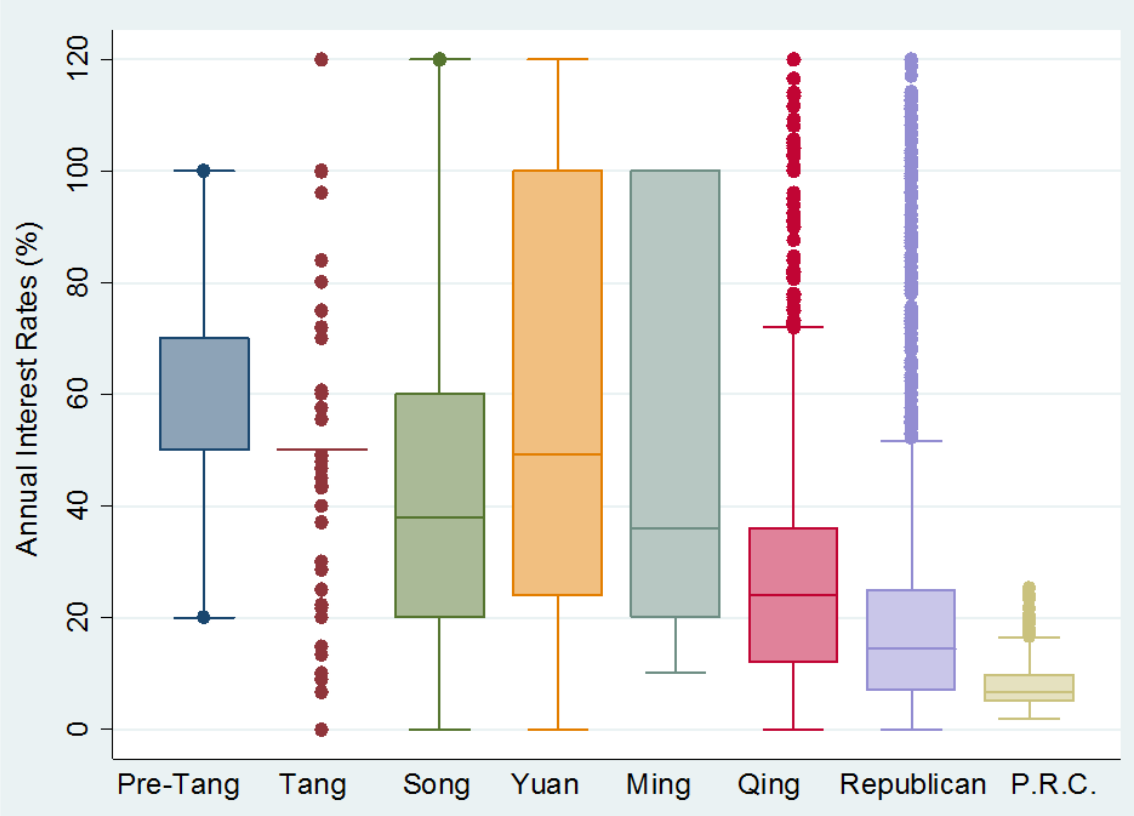

Figure 5 Box Plot of Interest Rates by Times[168]

Notes: The five lines of each box means from bottom to top: minimum, 25% quartile, median, 75% quartile, and maximum respectively. The height of the box stands for the level of variance.
Data source: own dataset of 26,222 raw data entries containing the information of transaction time, outliers higher than an annual rate of 120% or a monthly rate of 10% excluded. The data are scattered over the five periods above (however, it by no means indicates that we have entries for every year during these periods).

Figure 5 above depicts interest rate levels in different historical periods. Clearly, the annual interest rate level was decreasing throughout history, except for during the Yuan dynasty. The median value before the Tang dynasty was about 50%, which dropped to

[168] The historical periods above are: the Tang dynasty (618-907 AD); the Song dynasty (960-1279); the Yuan dynasty (1279-1368); the Ming dynasty (1368-1644); the Qing dynasty (1644-1911); the Republican China (1911-1949); the People's Republic of China (1949- 1985).

around 40% in the Song period, then all the way down to slightly above 20% in the Qing period. Regarding the level of variance, the Ming, the Yuan and the Song dynasty topped other periods, suggesting huge diversification in credit behaviour and transactional conditions. From the Qing to the PRC era, the level of variance kept shrinking as the financial industry became more standardized regarding business scope, procedures, etc. These changes represent a temporal pattern, reflecting social economic conditions of the times such as economic growth, financial development or policies in a dynasty. Similarly, political and economic conditions of a year or century could all impact capital markets and interest rates. To capture such temporal imprints on interest rates, we will define a group of time dummies to represent time-specific social and economic influences.

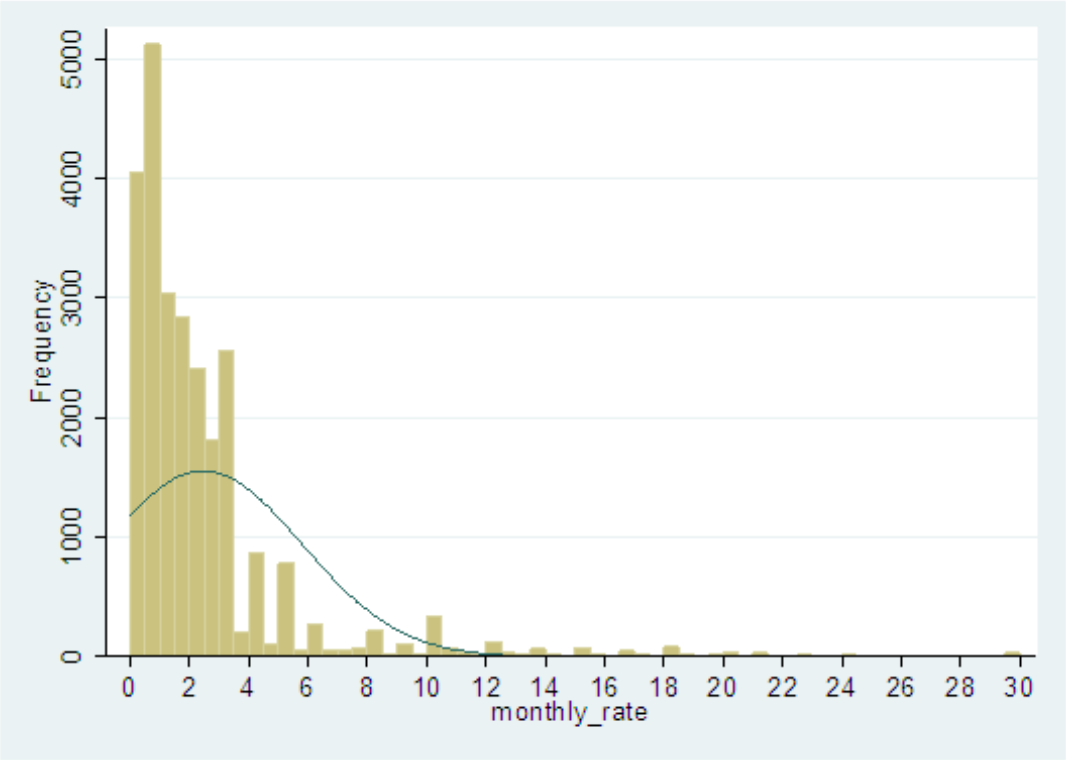

Figure 6 General Data Distribution of Monthly Rates (%)

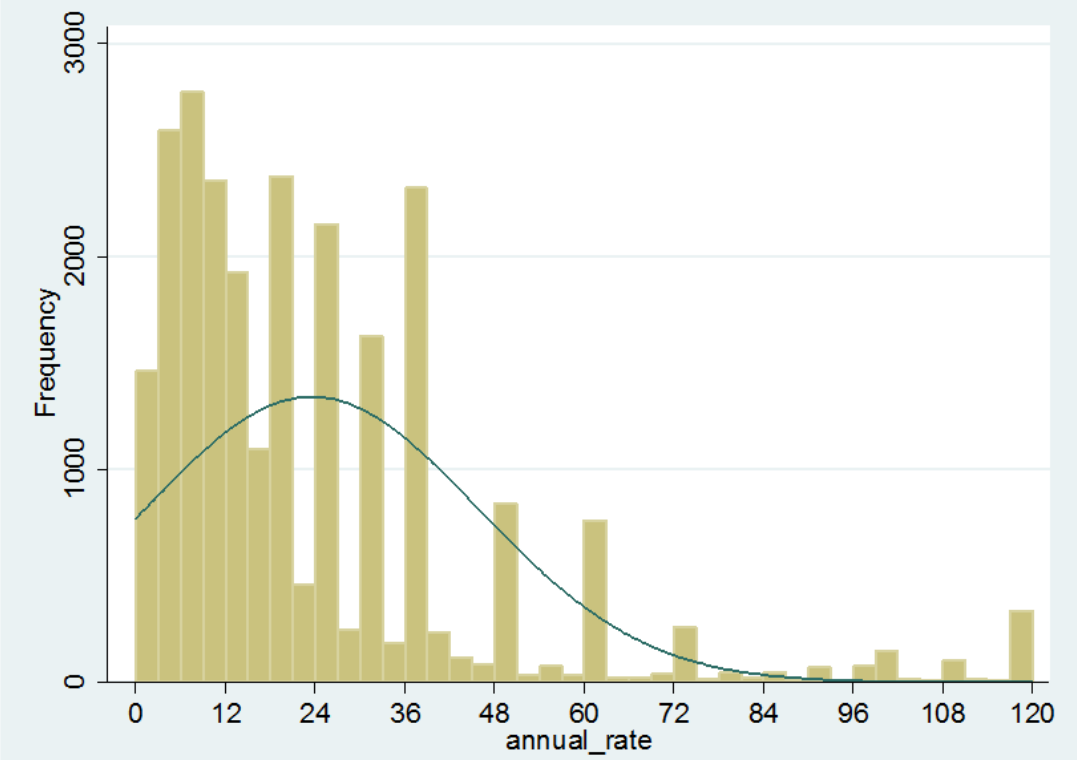

Figure 7 General Data Distribution of Annual Rates (%)

Sources of the two figures above: own dataset of 26,107 raw data entries containing transactional details or attributes of interest rates, with interest rates of both

institutional and individual transactions included, but outliers higher than 120% (annual) or 10% (monthly) excluded.

Figure 6 and Figure 7 above present the general distribution of raw data. In the form of an annual payment, most of the interest rates fall into the range from 0% to 60%, with the highest level at about 10%; in the form of a monthly payment, most of interest rates fall into the range from 0% to 10%, with the highest level at around 1%. Neither annual nor monthly rates follow a pattern of normal distribution, the reason of which may be the uneven sample structure, namely, the data are not perfectly randomly selected.

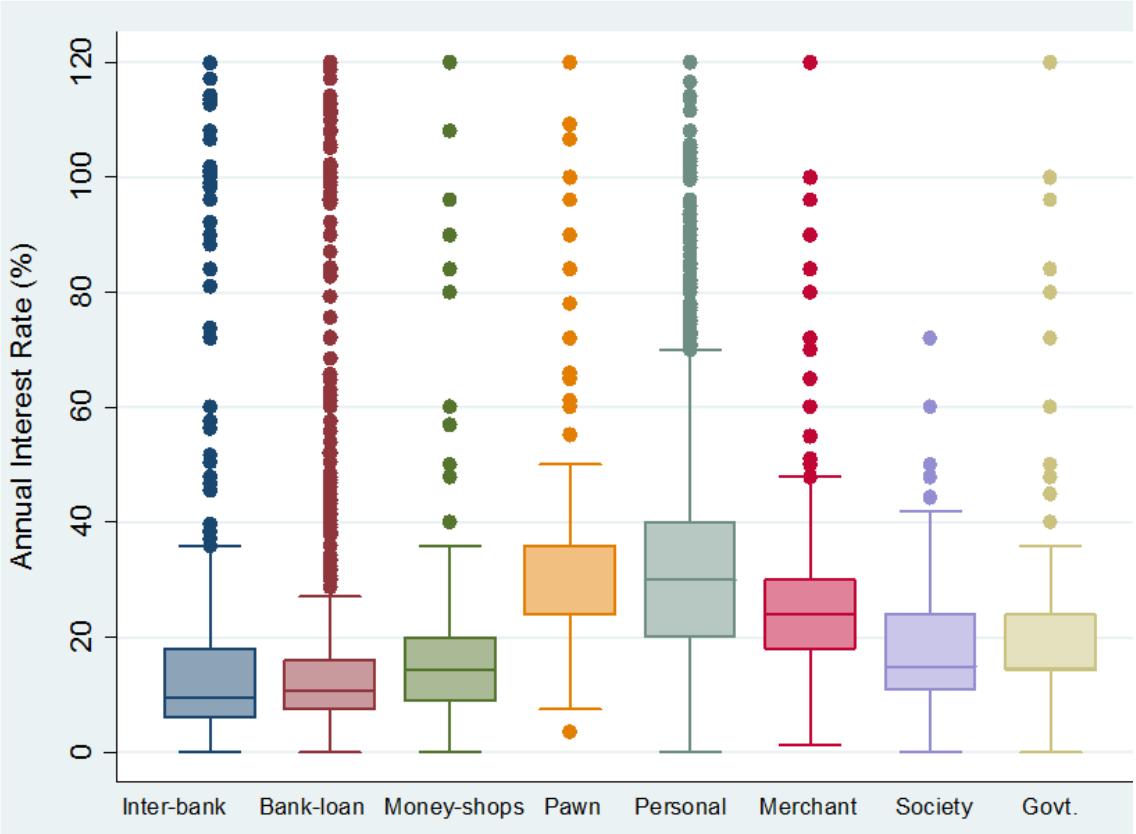

Figure 8 Box Plot of Interest Rates by Type of Creditor

Notes: The five lines of each box means from bottom to top: minimum, 25% quartile, median, 75% quartile, and maximum respectively. The dots outside of boxes are outliers. The height of the box stands for the level of variance.
Data source: the same as that of Figure 6 and Figure 7.

Figure 8 above gives descriptive statistics by the type of creditor. The median values of interest rates from all financial sources are scattered about the level of 20%. Three groups of capital sources are detectable regarding the interest rate level. First, interest rates of financial institutions (banks, money shops and Shanxi bankers, except pawnshops) are on the lowest level. Second, interest rates of personal and commercial sources plus pawnshops are on the highest level. Besides, personal loans feature a much higher box, suggesting larger variances. In other words, capital transactions between individuals and through personal network were more diversified, flexible or circumstantial than other types of loan. Third, government, mutual-help society and cooperatives stand in between the first two groups on the middle level. Grounded on the observation we may draw a hypothesis that the type of creditor does influence the interest rate level to a certain extent. We will test this hypothesis later in the regression and then explain it in its historical context.

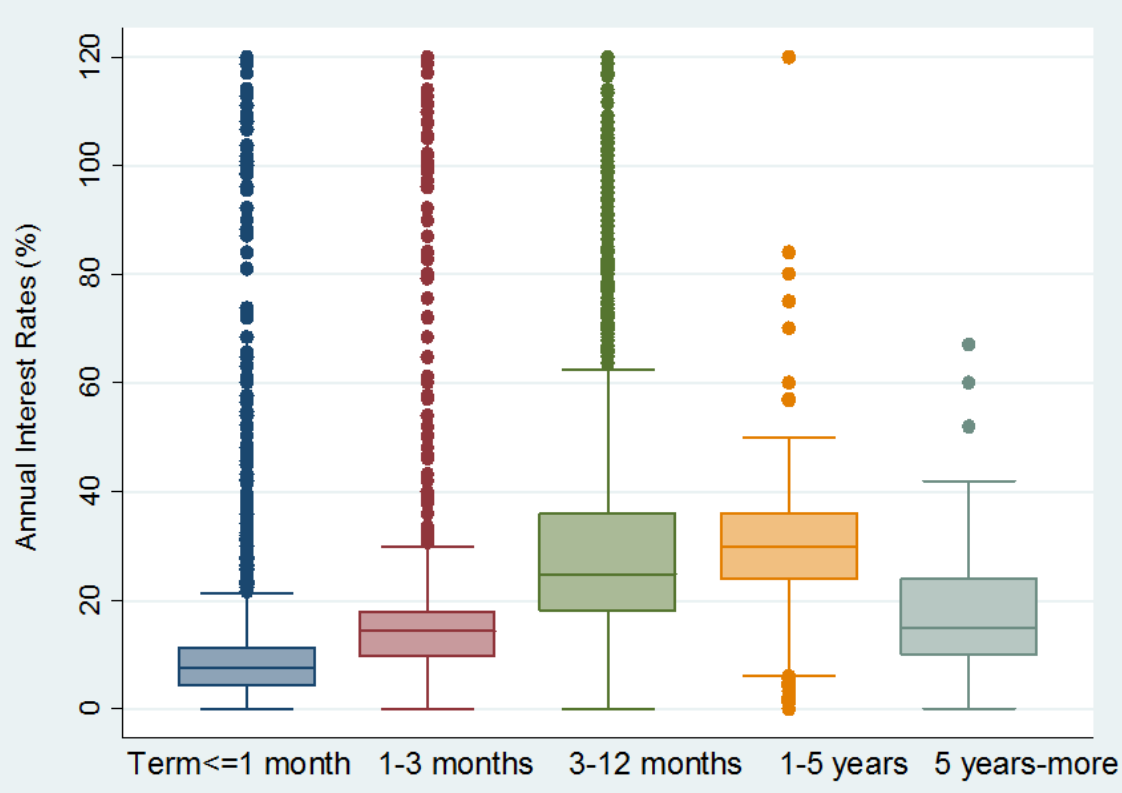

Figure 9 Box Plot of Interest Rates by Term Structure

Data source: the same as that of Figure 6, Figure 7 and Figure 8.

Figure 9 above illustrates the term structure of loans. Loans with a term shorter than 5 years show a positive relation between the term and the interest rate level. The interest rate level for loans with a longer term than 5 years, however, appears to be lower than that of 1-5 year loans. Apparently, there is also a maturity-related pattern of data distribution. Hence in the following regression, we also set up a group of dummies for different terms of maturity.

Now, we define variables by the attributes observed above.

(1) Interest rate

The interest rate is of course the dependent variable. The study uses some 26,107 entries of annual interest rates (scattered over the period of 583-1985 AD), which come with records of loan features as below.[169]

(2) Collateral

The dummy variable takes the value of 1 if there was collateral required of the debtor; otherwise, 0. In towns and cities, loans from pawnshops fell into the collateral-type of transactions, with the dummy value being 1. Such pawnshop loans often featured a relatively higher interest rate than other types of Chinese loans. In rural areas, land-based loans between peasants and villagers belonged to the collateral-type too. But land-based transactions were a bit complex. In some cases, the lender took over all or part of the yield of the land by the end of maturity, thus required less interest return. In others, he did not share the output of land, thus asked for more interest return. This transactional detail was not always clearly stated in the contract. Thus, we cannot further specify such land-based rural loans with more detailed attribute

[169] These data are nominal interest rates, not inflation-adjusted due to the lack of price index for all the years and localities for which we find interest rate data. In future research, price data (grain prices) are surely an interesting direction to complement the current study here.

categories.

(3) Urban:

It takes the value of 1if the transaction happened in cities or towns rather than rural areas or villages; if in villages and countryside, 0. Most bankers' interest rates or institutional rates fell into the urban category; whereas a large proportion of personal or private loans happened in rural areas.

(4) The dummy group of Principal

A principal larger than 1,000 taels is defined as *enormous;* that larger than 100 taels but smaller than 1,000, *huge*; that larger than 10 taels but smaller than 100, *large*; that larger than 1 tael but smaller than 10, *medium*. And a principal smaller than 1 tael is defined as small, which is the benchmark of comparison. These categories of amount are time-invariant because they are defined by numbers in relative terms to each other, rather than by a social or cultural concept.[170]

(5) The dummy group of Maturity (or Term)

The term of contract, or maturity, refers to the length of contract during which the borrower pays interest to the lender and by the end of which the former should return the total amount of principal to the lender. We define them by five categories below.

a= [daily rate, 1 month];
b= (1 month, 3 months];
c= (3 months, 1 year];

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[170] A principal larger than 1,000 taels, or 10,000 Yuan, or 1,000,000 copper coins, or 1,000 Shi (石) of grain, is *enormous*. The same ratio of convertibility among tael, dollar, copper coin, and grain weight applies to the other categories of principal (huge, large, medium and small principal).

The name of the dummy ("enormous" "large" "medium" or "small") is just a relative label for interest rates which fall into a certain range of number, set up as benchmarks for the convenience of statistical analysis. If we don't call it this way, we can simply label it as "a" "b" "c" or "d". Thus, it is an objective or time-invariant code (based on number comparison), rather than a social-economic concept defined in a social-economic context of any particularly dynasty or period

It does not rule out the possibility that a "small" amount of principal in the Song dynasty might considered "medium" or "large" in the Ming dynasty. It is also possible that the "large" amount here (larger than 10 taels and smaller than 100) might be deemed "small" in a particular period, maybe because of inflation or the state of mentality of people at the time. Regarding this, consumption price is worth of consideration for the model. Unfortunately it is impossible at the moment to find or compile a perfect price index: with not only perfect ratio of staple commodities in the basket for the corresponding time, but also differentiated prices in silver and in copper for loans in the corresponding currency. But this question is of course worthy of further exploration and future research.

d= (1 year, 5 years];
e= (5 years, ~)

(6) The dummy group of Form

The variable of *b_grain* equals 1 if the loan was in grain (borrowed or lent); otherwise, 0. Here we only examine grain loans with a clear interest rate stated, or those on a grain-in-and-grain-out basis.[171] The variable of *copper* equals 1 if copper cash was the object of credit. *dollar* equals 1 if standardized bullion dollars were borrowed or lent. And *silver* equals 1 if silver (either ingot or unspecified silver) was loaned; otherwise, 0. Transactions based on *paper notes* are the benchmark.

(7) The dummy group of Creditor and Debtor

This is the largest group of dummies. The variable of *centr_inter_bank* refers to interest rates set by the central bank or from the inter-bank market. *Bank* refers to loans from a modern bank. *Trad_m_b* refers to loans made by traditional financial institutions such as money shops or Shanxi bankers. *Pawn* refers to capital from pawnshops. *Commoner* refers to personal loans between individual citizens, farmers or urban commoners. And *merchant* refers to those of commercial capital flow in between merchants. *Governmental loan* is the benchmark in the Creditor group.

Regarding the debtor's features, this study only differentiates different types of deposit. This is because most debtors were commoners, not specified in the contract. But banking transactions further differentiated interest rates by the type of deposit. We can capture the following sub-attributes of loans: N1 means fixed term (one year) deposit; N2 means cheque-based current account deposit; N3 means deposit-book-based current account deposit; N4 means deposit with the principal and

[171] As discussed earlier, grain loans were popular in rural areas. Sometimes grain was borrowed but money was returned. Or vice-versa, money was borrowed but grain was returned. In such cases, calculation of the interest rate involves grain price in the exact year and at the exact place. This is too difficult a task to accomplish considering price availability in the wide range of time and localities. However, "Grain-in-and-grain-out" means that one borrowed grain and returned grain later. To calculate the interest rate in this case does not involve grain price. The interest rate is simply a ratio based on the amount of grain borrowed and returned. Thus, here we only consider this sort of grain loans.

interest in a lump sum on expiration; N5 means notice deposit; N6 means temporary deposit account. N7 means fixed (one year) deposit in traditional financial institution as opposed to that in a modern bank, which is the reference group here.

The dummy groups above represent the influences from the intrinsic attributes of loans on the interest rate level. The following dummy groups of time and space represent external influences from social economic background of the times and region on the interest rate.

(8) Time Dummy Group

T is a continuous variable of the trend term, showing how interest rate levels changed as years went by. C_i is a group of fourteen century dummies, spanning the 6^{th}-20^{th} century with each representing social economic influences during a century. D_i is a group of dynastic dummies.[172] As discussed in statistic description above, there are distribution patterns in time, particularly in dynasty. To capture such temporal patterns, accordingly, here we define seven[173] dynasty dummies: the Tang, the Song, the Yuan, the Ming, or the Qing dynasty, the Republican, or the PRC

[172] If we don't divide interest rates by century or dynasty, we can also divide them by decade, by year, even by month. All we need is just a benchmark for comparison. But too small a temporal unit is not necessary here: Given that the study is of a long-term perspective, it is not the purpose of the study to compare regression coefficients of March loans with that of April loans. What we mean to see is long-run fluctuation in interest rates. Besides, dynasty is a natural unit of division, resembling the turning of era and economic cycles. Every dynasty had quite different social economic features. This is why dynasty is an essential framework for historical analysis. Furthermore, preliminary observation based on raw data in the previous section already detected dynastic cycles and fluctuation. To capture or estimate such cyclical features, we also need to set up dynasty dummies.

[173] Setting seven dummies for seven periods in the regression is similar to Seasonal Adjustment or Seasonal Dummy (See Francis X. Diebold, *Chapter 6 in Elements of Forecasting*, 4th ed. (Ohio, US: Thomson, South-Western, 2007). Only here it is dynastic adjustment or periodical dummy. To avoid the problem of multicollinearity, we run a Pearson test on independent variables, the result of which is in Appendix 6; and we also drop the constant term in the specifications where C_i or D_i is used. Moreover, the large number of observations greatly reduces the risk of multicollinearity, hence the regression result turns out fine without dropping any explanatory variable by the program.

The reason we do not choose the specification with *n-1* time dummies for n time periods and a constant is that: we want to tell the influence of all time periods on the interest level. But in such a specification, the coefficient or influence of the omitted base period is included in the constant, together with those of other omitted base variables in other attribute categories (such as in maturity, principal, creditor, etc.). And we cannot tell their influences apart, hence, cannot identify the influence of base period or produce the trend index based on all periods' influences on the interest rate.

period. Each represents the unmeasured time-specific social and economic influences, such as financial policies, innovation, etc., in the corresponding dynasty or times. These options of time dummies help make different specifications of the model, so as to find the best fit of it. But to avoid overlapping their temporal influences (and the ensuing multicollinearity problem), when one group of them among the three (T, C_i or D_i) is chosen for regression at one time, the other two will be dropped.

（9） Geographical Dummy Group R_i

The locality could also affect interest rates. For instance, given the lower costs of waterborne transport, coastal areas might have better access to markets than inland areas, hence to capital supply and lower credit cost. The model below considers the geographical determination of interest rates by adding a group of province dummies P and regional dummies R. Again, to avoid overlapping their influences, they (P or R) will join the regression separately.

Note that the provincial division[174] below is based on the year 1820, which works purely as a geographic reference. It does not mean that the administrative division of provinces stayed the same throughout the centuries; neither does it mean that the empire covered the same size of area at all times. We just need a time-invariant geographical base to tell where the capital transactions occurred (relative to each other's location).[175] Besides, the regression does not concern any particular regions or the country as a whole, but structural analysis on individual interest rates; these geographic dummies are not the target variables, but benchmark variables to be controlled for. Thus, the provincial division is no critical issue in the context. Still, we choose the 1820 Qing map as the geographical framework because: one, the

[174] 24 dummies are used for 25 provinces/regions, which are: Jiangsu, Hunan, Hubei, Sichuan, Hebei, Zhejiang, Inner Mongolia, Dongbei (Jilin, Liaoning, Heilongjiang), Ningxia, Gansu, Shannxi, Shanxi, Shandong, Anhui, Henan, Yunnan, Guizhou, Jiangxi, Guangxi, Fujian, Taiwan, Canton, Qinghai, Xinjiang (the benchmark), plus a special area of HKMC(Hong Kong& Macau).

[175] If we do not use a provincial code based on the 1820 map, we can use a map as of today or of any other time. Or we can use the coordinates of the location, as Chapter 3 does in the spatial-integration regression. It does not matter to us whether a market switched from Province A to Province B or C across time. We only need to know that the transaction happened on a time-invariant map.

Qing dynasty connects the Ming dynasty and the Republican era in history, a natural common ground in territory division of both periods; and two, the 19th and 20th century provide a major proportion of the interest rate data — fitting them in the geographic framework of their corresponding time would be more convenient. Given this geographic base, when inputting data of interest rates and other variables, we stick to the provincial division of the base map.

Figure 10 Region 1: Coastal Area

The figure above and the two after are based on the 1820 map of China. This region covers the provinces of Shandong, Jiangsu, Zhejiang, Anhui, Fujian (including Taiwan), and Canton (including Hong Kong and Macao).

Figure 11 Region 2: Inland Area

This region covers the provinces of Qinghai, Xinjiang, Yunnan, Guizhou, Guangxi, Hubei, Hunan, Jiangxi, and Sichuan.

Figure 12 Region 3: Northern China

This region covers the provinces of Inner Mongolia, Jilin, Liaoning, Heilongjiang, Ningxia, Gansu, Shannxi, Shanxi, Hebei (Zhili), and Henan.

R includes two regional dummies to cover three regional groups as shown above. One of them stands for the coastal region, another for the inland region, and their benchmark of comparison is the region of Northern China (as shown in the figures below). The reason to put some provinces in the same group is that they shared similar geographical and economic features. For example, Shandong, Jiangsu, Zhejiang, Anhui, Fujian and Canton were all coastal provinces that had access to the sea and thus enjoyed convenience in long-distance trade home and abroad; whereas Qinghai, Xinjiang, Yunnan, Guizhou, Guangxi, Hubei, Hunan, Jiangxi and Sichuan were all inland provinces that relied more heavily on agriculture. However, of course, this is not the

only way to group geographically.

Some may consider other geographical features for criteria of grouping, such as rainfall volume, climate zones (temperate or tropical), or the distance to political economic centre (capital city). However, such factors as rainfall were more subject to ecological changes. They might experience extreme shocks in the short-run (such as droughts and floods) or change a lot over a long time (climate change). In that case, the corresponding groups of region might not hold. The same case goes to the market's distance to a political economic centre. It changes easily with the turn of dynasties and development of economies. Thus grouping by the distance may not hold for all the times under study here. Regarding the climate zones, most of China's areas belong to the temperate zone, which means that grouping by climate zone would be extremely uneven. Too few areas and data in the other region, namely the tropical zone, could not produce a statistically significant coefficient for the region. Other geographical factors might have similar problems too.

One may also divide the whole map by a grid of 300 (or other) kilometres' distance. This pure mathematical method is the most objective benchmark of geographical comparison, free from any human bias in the region division. However, it also probably overlooks some very important economic features attached to the provincial boundaries. These boundaries were not just administrative divisions set by emperors, but also natural output of social economic evolution over a long period. Thus, they probably denoted some homogeneity in local economies, and some differences between markets in and those out of the boundary. In this sense, a pure mathematical approach risks losing such social economic insights, hence may suffer an "objective bias".

The geographical location stayed relatively stable, less subject to ecological changes (except with earth crust movement). Also, generally speaking, adjacent economies tended to share similar geographical conditions, thus more homogeneous and suitable to form a group. Also, the number of provinces/markets in each region (as illustrated below) is not too large or too small for statistical analysis. Therefore, although the grouping method as illustrated below is not perfect, for the time being we adopt the three

regions. If a better way of geographical grouping arises, we may re-run the test for a comparison.

The following model means to quantify the influences of internal and external factors on the interest rate level.[176]

(1)

$$\log i = \alpha + \alpha_0 T + \sum_{i=1}^{14} \alpha_{1i} C_i + \sum_{i=1}^{7} \alpha_{2i} D_i + \sum_{i=1}^{2} \alpha_{3i} R_i + \sum_{n=1}^{7} \beta_n X_{ni}$$

where the last term of $\sum_{n=1}^{7} \beta_n X_{ni}$ is define as in (2)

$$\sum_{n=1}^{7} \beta_n X_{ni} =$$

$$\beta_1 Collateral + \beta_2 Urban + \beta_{3i} * Principal_i + \beta_{4i} Maturity_i + \beta_{5i} Form_i + \beta_{6i} Creditor_i + \beta_{7i} Debtor_i$$

C stands for the dummy group of centuries, *D* of dynasties, and *R* of location dummies. $\log i$ is the dependent variable, namely, logged interest rate. a is a term of constant, standing for the average level of $\log i$ when influences of all internal features are excluded. Each of the X-group variables, namely *Collateral, Urban, Principal, Maturity, Form, Creditor* and *Debtor,* represents a group of dummies that describe intrinsic features of loans and interest rates which may be found in a loan contract. The group of coefficients β stands for influences of these features. On the model above, we can do

[176] In constructing the model, the study also considered some social determinants of interest rate level, such as war, disaster, or population. But they are dropped because of the following reasons. The influence of war or disaster on capital markets are conveyed through its temporal and spatial coverage, namely, in which year it impacted which areas. But we already included both a trend term and a group of provincial dummies to enclose the temporal and geographical determination on interest rates in the model. Their explanation power might overlap the warfare or disaster variable, thus inducing a multicollinearity problem.
Regarding the factor of population: because our sample are drawn from more than 600 localities scattered over some 14 centuries' time, honestly, it is almost mission impossible to specify local population even provincial population for the exact markets in the exact years for which we have data. Meanwhile, data of provincial population were possible to get. But this was an aggregate indicator on a much larger scale, which was hardly determinant on an interest rate of a small locality like a city or a town.
But indeed these factors might be important and worthy of consideration. We will consider some of them in the cross-sectional analysis based on provincial interest aggregates in the last part of the thesis.

a robust regression[177] with White-adjusted standard errors and variance estimator.[178]

We will repeat the regression on different specifications and samples of the model to find the best fit and also as a robustness check. For example, from a purely statistic perspective, we will repeat the programme on the overall sample, a sample with the interest ceiling at 120% (annual), a sample with that at 50%, and a sample with that at 9%.

Finally, regarding a regression with data scattered over such a long period, one concern of historians may be that the explanatory power of the controlled variables might change over time. Indeed, in defining variables above we have carefully considered different loan types in different times, and distinguished them with different dummies.[179] Also, we have set up time dummies to control for temporal transformation in loan attributes,

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[177] In the process of market integration, common shocks among regional markets cause positive correlation in the cross-section; and different transaction costs introduce the problem of heteroscedasticity. This makes the ordinary least square (OLS) method inefficient in estimating regression coefficients. Its standard errors are likely to be biased. In this case, generalized least square (GLS) method is more efficient than OLS, especially in causal-effect analysis for integration degrees. For examples, please see: Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy." Chilosi and Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520.", 793. Max-Stephan Schulze and Oliver Volckart, "The Long-Term Impact of the Thirty Years War," n.d.

However, the regression here aims at only structural factors of interest rates (like principal and maturity, etc. instead of integration degree estimation), which are generally embedded in all interest rate data, regardless of temporal or spatial discrepancy. It does not involve cross-sectional spatial analysis or market co-movement yet (market integration to be discussed in the next part). So the risk of heteroscedasticity and positive correlation here is relatively low. We tested for the possibility of heteroscedasticity with the White method in STATA. The p-value of the test is 0.000, significantly smaller than the critical value of 0.05, which refuses the hypothesis of heteroscedasticity. Anyway, give the large sample size, we can do a robust regression on the semi-logged model in STATA 11, which allows for potential problems of auto-correlation and heteroscedasticity. For more references, please see:

R. Andersen, *Modern Methods for Robust Regression*, *Sage University Paper Series on Quantitative Applications in the Social Sciences* (CA: Sage: Thousand Oaks, 2008).

A. J. Stromberg, "Why Write Statistical Software? The Case of Robust Statistical Methods," *Journal of Statistical Software* 10 (2004): 1–8.

One more thing to notice is that, because there were interest ceilings and most interest return rates were positive, the data may follow non-normal distribution. Such a distribution pattern also may bias the result of OLS regression. However, such bias is quite limited, as proven by Peng with a bootstrap method. (See Peng, Chen, and Yuan, "Jindai Zhongguo Nongcun Jiedai Shichang de Jizhi 近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)."and Bradley Efron, "Bootstrap Methods: Another Look at the Jackknife," *Annals of Statistics* 7, no. 1 (1979): 1–26.

[178] The study uses STATA 11.0 to run the robust regression. STATA of version 11.0 and later treats standard errors of robust regression with both heteroscedasticity and correlation adjustment. The approaches involved in the program are respectively based on:

Halbert White, "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica* 48, no. 4 (1980): 871–838.

Whitney K. Newey and Kenneth K. West, "A Simple, Positive Semi-Definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica* 55, no. 3 (1987): 703–8.

Thus, maybe "White-Newey & West adjusted robust standard errors" is a more suitable name for the approach.

[179] If a new type of loan stemmed from the traditional financial business, the study sets up a new type dummy for it, instead of pooling their interest rates with the traditional ones. For instance, we separate modern banks' interest rates from those of traditional money shops or Shanxi bankers.

so that the regression coefficients for these attributes are time-invariant. Still, one cannot be too cautious regarding the risk. Therefore, we also repeat the regression on different samples by dynasty/period, and then compare the impact of attributes in different period samples.

1.3.2 Empirical Result

Again, the empirical findings below do not conclude on any specific regions or the country as a whole in any particular period; rather, they speak only for the data under study (a large dataset scattered over 600 localities in 24 provinces during the 6th-20th century). A negative coefficient means the variable helps reduce the interest rate; whereas a positive one means the variable increases the interest rate. The value to the right of the regression coefficient is the p-value. The higher the p-value is, the lower the possibility for the coefficient to be statistically different from zero is.

Table 4 Intrinsic Interest Determinants: Loan Attributes

Specification		1 (all periods)		2 (all periods)		3 (all periods)	
Location	urban	0.11	0.00	0.12	0.00	0.13	0.00
Maturity	a（0-1 month]	0.17	0.00	0.24	0.00	0.17	0.00
	b (1-3 months]	0.69	0.00	0.55	0.00	0.68	0.00
	c (3-12 months]	0.27	0.00	0.19	0.00	0.27	0.00
	d (1-5 years]	0.08	0.07	0.07	0.12	0.10	0.02
Creditor	centr_inter_bank	-0.05	0.50	-0.28	0.00	-0.06	0.34
	bank	-0.32	0.00	-0.30	0.00	-0.33	0.00
	trad_m_b	0.07	0.30	0.13	0.08	0.11	0.09
	pawn	0.94	0.00	0.74	0.00	0.91	0.00
	commoner	0.86	0.00	0.97	0.00	0.83	0.00
	merchant	0.77	0.00	0.84	0.00	0.76	0.00
Debtor	N1	-0.69	0.00	-0.64	0.00	-0.68	0.00
	N2	-1.65	0.00	-1.56	0.00	-1.66	0.00
	N3	-1.44	0.00	-1.33	0.00	-1.45	0.00
	N4	-1.27	0.00	-1.18	0.00	-1.07	0.00
	N5	-1.17	0.00	-0.98	0.00	-1.21	0.00
	N6	-1.30	0.00	-1.19	0.00	-1.32	0.00
Collateral	yes	0.08	0.00	0.11	0.00	0.06	0.01
Form	b_grain	0.13	0.04	0.11	0.06	0.12	0.06
	copper	-0.35	0.00	-0.34	0.00	-0.43	0.00
	dollar	-0.50	0.00	-0.48	0.00	-0.53	0.00
	silver	-0.71	0.00	-0.77	0.00	-0.82	0.00
Principal	enormous	-0.79	0.00	-0.65	0.00	-0.81	0.00
	huge	-0.63	0.00	-0.45	0.00	-0.57	0.00
	large	-0.54	0.00	-0.48	0.00	-0.52	0.00
	medium	-0.71	0.00	-0.65	0.00	-0.72	0.00
	constant	3.37	0.00	3.41	0.00		
no. of observations		25733		25733		25733	
Prob>F		0.000		0.000		0.000	
R-squared		0.4443		0.5040		0.9341	

(to be continued on the next page)

Specification		4 (all periods)		5 (all periods)		6 (all periods)		7 (Republican Era)	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Location	urban	0.10	0.00	0.18	0.00	0.19	0.00	-0.22	0.00
Maturity	a (0-1 month]	0.27	0.00	0.95	0.00	0.65	0.00	0.39	0.00
	b (1-3 months]	0.53	0.00	1.48	0.00	0.95	0.00	0.54	0.00
	c (3-12 months]	0.21	0.00	1.02	0.00	0.58	0.00	0.34	0.00
	d (1-5 years]	0.10	0.02	0.83	0.00	0.46	0.00	-0.05	0.48
Creditor	centr_inter_bank	-0.34	0.00	0.60	0.00	0.10	0.15	0.60	0.00
	bank	-0.29	0.00	0.35	0.00	0.11	0.06	0.61	0.00
	trad_m_b	0.25	0.00	0.95	0.00	0.63	0.00	1.43	0.00
	pawn	0.75	0.00	1.75	0.00	1.22	0.00	1.59	0.00
	commoner	0.93	0.00	1.96	0.00	1.66	0.00	1.46	0.00
	merchant	0.79	0.00	1.87	0.00	1.51	0.00	1.34	0.00
Debtor	N1	-0.63	0.00	0.24	0.00	-0.09	0.13	0.19	0.04
	N2	-1.59	0.00	-0.73	0.00	-1.02	0.00	-0.87	0.00
	N3	-1.32	0.00	-0.54	0.00	-0.80	0.00	-0.43	0.00
	N4	-0.97	0.00	-0.33	0.00	-0.64	0.00	-0.33	0.01
	N5	-1.00	0.00	-0.25	0.03	-0.43	0.00	-0.12	0.36
	N6	-1.20	0.00	-0.40	0.01	-0.66	0.00	-0.30	0.07
Collateral	yes	0.10	0.00	0.30	0.00	0.23	0.00	0.06	0.31
Form	b_grain	0.04	0.55	0.30	0.00	0.41	0.00	0.85	0.00
	copper	-0.48	0.00	-0.32	0.00	-0.29	0.00	-0.28	0.00
	dollar	-0.52	0.00	-0.49	0.00	-0.46	0.00	-0.54	0.00
	silver	-0.95	0.00	-0.70	0.00	-0.72	0.00	-1.18	0.00
Principal	enormous	-0.70	0.00	-0.18	0.00	-0.26	0.00	-1.12	0.00
	huge	-0.38	0.00	-0.24	0.00	-0.17	0.04	-0.50	0.00
	large	-0.45	0.00	-0.04	0.39	-0.16	0.00	-0.64	0.00
	medium	-0.68	0.00	-0.37	0.00	-0.43	0.00	-1.03	0.00
	constant							0.98	0.00
no. of observations		25733		25733		25733		17287	
Prob>F		0.000		0.000		0.000		0.000	
R-squared		0.9415		0.9326		0.9405		0.4953	

White-adjusted standard errors and covariances.

Data source: own dataset of 26,107 entries containing transactional details or attributes of interest rates. This is only part of the regression terms' coefficients. For regression output of the time and spatial dummies, please see the next table. For the full table please see Appendix 3.

Specifications 1-6 are different combinations of the terms in the model. Specification 1 stands for the regression output of a Trend term (T), Regional dummies (R) and Feature dummies of loans (F); Specification 2 for that of (T), Provincial dummies (P) and (F); Specification 3 for that of Dynastic dummies (D), (R) and (F); Specification 4 for that of (D), (P), (F); Specification 5 for that of Century dummies (C), (R), (F); Specification 6 for that of (C), (P), (F); Specification 7 for that of (P) and (F) with entries only for the Republican era (1911-49.Among all the sub-periods here presented

is only the Republican era, because the regression for this period produces the most significant output.

First of all, for a robustness check, the study presents regression output of several specifications and samples. Comparing the sub-sample of the Republican era[180] and the overall sample, although the coefficients of the same attribute are different, the comparative trend or ranking among the same group of attributes is very similar (see Appendix 4 and 5). For example, the figure below shows the loan attribute of currency form. The higher a feature point is, the more it contributed to the interest level. For both of the two samples, grain loans cost the most interest payment, followed by paper note (base), copper coin, dollar (standardized metallic) and silver tael. This pattern shows how loan forms influenced or determined interest rates; and it is found not only in the sub-sample of the Republican era, but also in the overall sample.

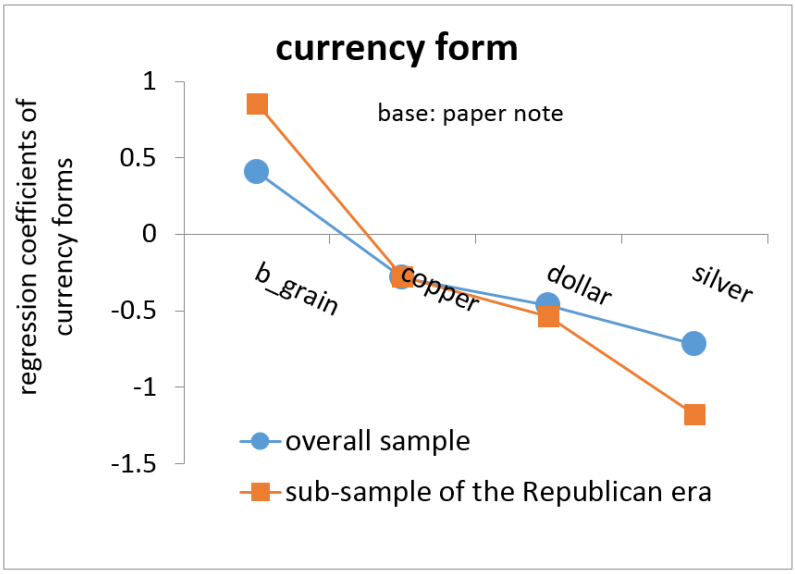


Figure 13 Robustness Check: Comparison by Period

Source: Regression coefficients in Column 6 and 7 of Table 4 above.
Notes: A higher coefficient point means the corresponding loan feature added more to the interest rate level.

[180] We repeat the regression on other periods too. But the Republican era has sufficient data entries to avoid variable dropping (due to multicollinearity), and provides more significant regression coefficients.

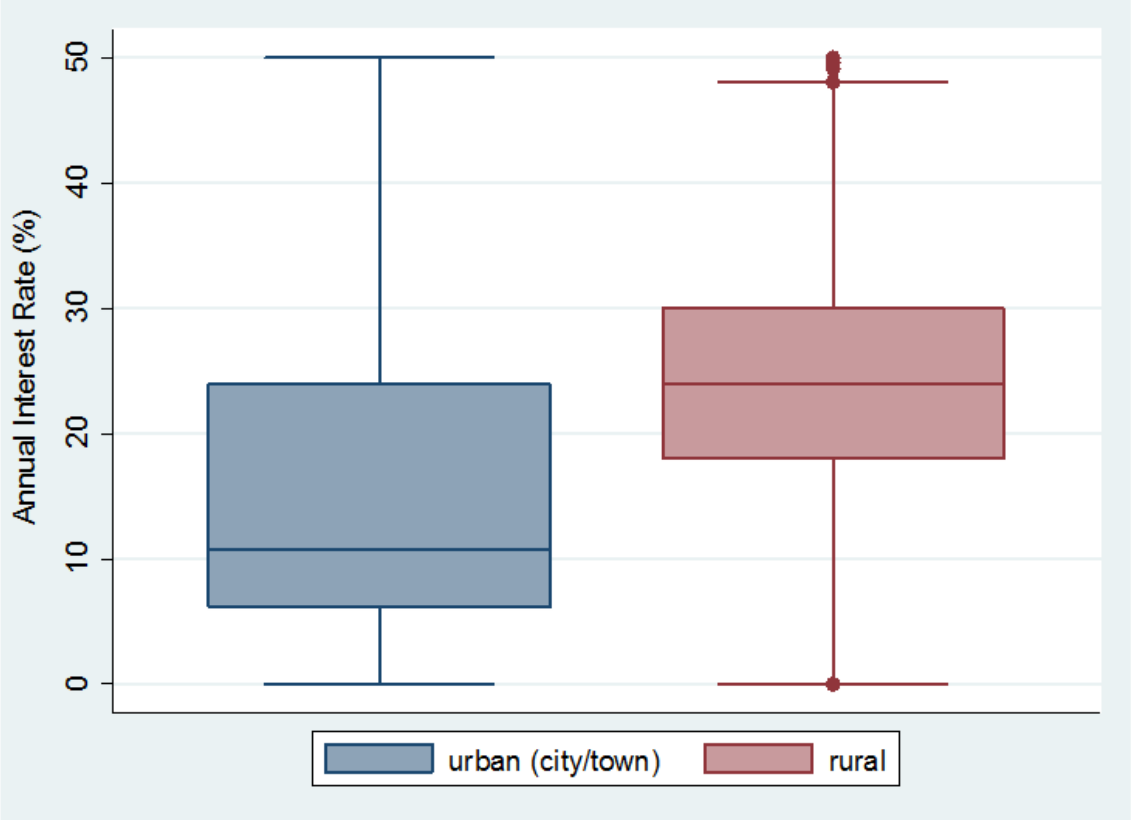
Although there are slight differences in the influence pattern of some attributes, overall the patterns maintained relatively stable during the periods. This addresses the historians' concern mentioned earlier (at the end of variable and model settings). This also suggests that the regression output above is robust to an extent.

We now zoom in for a closer look at various attributes' determination power of interest rates. First of all, regarding the term structure, loans returned in 1-3 months demanded the highest return rates (with the regression coefficient ranging from 0.53 to 1.48). This means the short-term loan cost about 0.53% to 1.48% higher interest payment than the reference group, namely, long-term (>5 years) loans. Besides, coefficients of all variables under this entry of *Maturity* (a, b, c, d) are positive. In other words, the least interest return came from the benchmark group, long-term (>5 years) loans. Two reasons may account for this. Loans with such a long term were made either for large infrastructure projects (such as railroads), or based on a long-term relationship in a low-mobility society. For the former, the volume of principal and its ensuing economy of scale helped secure productivity of investment and rate of return, thus limited the premium of risk.

For the latter, a small community of little mobility helped reduce the risk of payment default. For example, long-term loans with land as a pledge were most commonly seen in villages, with a term from 5 to 10 years. Actually, the term could even be further extended, as long as the borrower could continue to pay the interest instalments. A long-run relationship could be established on the low mobility of peasants, and on land the most important asset to pledge. Accordingly, financial risk was expected to be low. Furthermore, from the standpoint of the lender, what else could they use the money for in the village? The lack of investment channel made the loan a better choice for the money than burying it in the land. It did not matter if the principal was returned sooner or later, as long as there was continuous income from it and the borrower and their land was still in control. No wonder peasantry state of mind regarding finance was described

as "quite insensitive to time".[181] But this scenario was not limited to rural areas or relatives; it could be the case for any long-term personal networks of the Chinese.

It seems confusing that the coefficient of urban changed from positive to negative across different samples. A positive coefficient (such as 0.11 in Column 1), suggests that urban loans cost more interest than rural (by 11%). However, if excluding high interest rates (annual rate larger than 50%, as shown in the box graph below), we find that urban rates were lower than rural, with both the medium and the max level of urban loans much lower than those for the rural loans. Re-running the regression by excluding outliers (larger than 50%) also produced a negative coefficient (-0.03) (see Sample 3, Appendix 5).



[181] Peng, Chen, and Yuan, "Jindai Zhongguo Nongcun Jiedai Shichang de Jizhi 近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)", 153.
Ouyang, "Sichuansheng Nongye Jinrong 四川省农业金融."

Figure 14 Box Plot of Interest Rates by Locality Division

Data Source: own dataset of 26,107 raw data entries containing transactional details or attributes of interest rates, outliers (annual rate higher than 50%) excluded.

Then considering the type of creditor, intermediary interest rates (as on loans from banks and money shops) were lower than personal loans between individuals (merchants and commoners). Those of modern banks (lowest coefficient at -0.33) were lower than those of traditional financial institutions (lowest coefficient for money shops at 0.07). Among financial institutions' rates, the highest came from the pawnshop (lowest pawn rate at 0.74). Commercial capital flow between merchants cost less (lowest at 0.77) than that between commoners (lowest at 0.86 for villagers or urban citizens). Regarding the type of Debtor, modern banks' deposit rates featured negative coefficients, suggesting their interest rate levels were generally lower than those of traditional banks (N7 the reference group); and those of current accounts were generally lower than a fixed-term deposit (ranging from -0.69 to 0.24).

The regression coefficient of loans with collateral is positive (0.06 - 0.3), which suggests that loans with collateral cost higher interest than those without. The sample structure might help understand this: again, if we narrow the sample by excluding interest rates higher than 9% to re-run the regression, we find the coefficient becomes negative (-0.08) (as in Sample 4 of Appendix 5). This means loans with collateral cost lower interest than those without by 8%. The difference between the two samples suggests that many outliers of very high interest rates demanded collateral. A further explanation for this may be adverse selection. In the Chinese community of relationships, the borrower with a better reputation had access to an efficient personal network, and thus to lower-interest loans without compulsory collateral. To the contrary, one who had to pledge a concrete asset (instead of intangible reputation) as collateral was often too poor or of little credibility, thus featured high default risks. In this case, the interest rate might increase in line with the risk premium; thus, collateral was demanded to secure as much investment return as possible.

In terms of the transaction form, loans of silver cost the least, followed by that of dollar, copper coins, paper notes and grain. Silver and silver dollar seemed to be more trustworthy than copper coins and paper notes: less risk meant lower risk premium, namely, interest return. This is probably because copper and paper currencies were more vulnerable to counterfeiting, debasement or deflation. Besides, commodity loans of grain required the highest interest (ranging from 0.04 to 0.41). This might be because similar to a hair-cut service or real estate property, grain capital lacked mobility. As food consumption or seed for reproduction, grain was usually borrowed in the spring and returned after harvest in autumn. Its demand and supply were highly limited by location and season, and its interest return often defined by local customs.

Regarding the amount of principal, a note-worthy point is that, coefficients of all the principal variables above (enormous, huge, large, medium) are negative. In other words, the benchmark group (loans with a volume smaller than 1 tael) required much more interest return than all of them. A hypothesis to understand this phenomenon is: most people who needed such loans were extremely poor that they counted on the loan as consumption capital for day-to-day living.[182] They were usually in such a desperate situation that they had to accept whatever cost it took (even usury of compound interest rate), indeed, beggars could not be choosers. Besides, it was very likely that these poor people could default the contract (assuming there was one) because they were constantly on the edge of bankruptcy. So the risk premium tended to be high, as was the interest rate. Lastly, a small amount of principal meant higher marginal cost in contract enforcement and interest collecting. Trivial transactions were troublesome to maintain (which might include running back and forth for just a few coins of interest payment every week or month), hence higher interest return.

[182] Peng, "Jinxiandai Lilvshi Yanjiu Baogao 近现代利率史研究报告 (Report on Interest Rates of Modern China)."

Table 5 External Influences: Time and Space

Specification		1 (all periods)		2 (all periods)		3 (all periods)		4 (all periods)		5 (all periods)		6 (all periods)	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Trend	by year	-0.00611%	0.30	-0.02904%	0.00								
Dynasty /Period	Tang					3.30	0.00	3.28	0.00				
	Song					3.13	0.00	3.34	0.00				
	Yuan					3.89	0.00	3.76	0.00				
	Ming					3.68	0.00	3.38	0.00				
	Qing					3.42	0.00	3.21	0.00				
	Republican					3.31	0.00	2.99	0.00				
	P.R.C.					2.64	0.00	2.28	0.00				
Century	6th C.									-0.37	0.34	-0.09	0.85
	7th C.									1.83	0.00	2.35	0.00
	8th C.									2.58	0.00	3.17	0.00
	9th C.									0.75	0.00	1.37	0.00
	10th C.									0.41	0.00	-0.17	0.24
	11th C.									0.18	0.20	0.88	0.02
	12th C.									0.84	0.00	1.70	0.00
	13th C.									1.75	0.00	2.23	0.00
	14th C.									1.83	0.00	1.66	0.00
	15th C.									1.59	0.00	1.03	0.00
	16th C.									1.15	0.00	0.67	0.00
	17th C.									1.24	0.00	0.85	0.00
	18th C.									1.19	0.00	0.68	0.00
	19th C.									0.95	0.00	0.56	0.00
	20th C.									1.03	0.00	0.64	0.00
Region	Coastal Area	-0.01	0.67			-0.06	0.00			-0.03	0.08		
	Inland Area	0.03	0.07			-0.02	0.32			0.03	0.07		
	JIANGSU			0.47	0.00			0.37	0.00			1.31	0.00
	HUNAN			0.12	0.22			-0.02	0.90			1.02	0.00
	HUBEI			0.51	0.00			0.41	0.00			1.40	0.00
	SICHUAN			0.49	0.00			0.34	0.01			1.40	0.00
	HEBEI			0.56	0.00			0.45	0.00			1.45	0.00
	HKMC			-0.12	0.36			-0.27	0.07			0.74	0.00
	ZHEJIANG			1.24	0.00			1.11	0.00			2.12	0.00
	INNERMONGOLIA			0.30	0.01			0.07	0.61			1.19	0.00
	DONGBEI			0.34	0.00			0.33	0.01			1.24	0.00
	NINGXIA			0.77	0.00			0.69	0.01			1.67	0.00
	GANSU			0.60	0.00			0.47	0.00			1.42	0.00
	SHANNXI			0.56	0.00			0.38	0.00			1.45	0.00
	SHANXI			0.09	0.34			-0.03	0.79			1.00	0.00
	SHANDONG			0.28	0.01			0.18	0.15			1.17	0.00
	ANHUI			0.01	0.92			-0.16	0.18			0.91	0.00
	HENAN			0.47	0.00			0.37	0.00			1.36	0.00
	YUNNAN			0.68	0.00			0.57	0.00			1.58	0.00
	GUIZHOU			0.92	0.00			0.75	0.00			1.83	0.00
	JIANGXI			0.22	0.03			0.11	0.37			1.10	0.00
	FUJIAN			0.17	0.08			0.06	0.62			1.04	0.00
	CANTON			0.20	0.06			0.13	0.31			1.10	0.00
	GUANGXI			0.69	0.00			0.57	0.00			1.58	0.00
	QINGHAI			0.82	0.00			0.73	0.00			1.67	0.00
	TAIWAN			0.15	0.11			-0.04	0.76			1.01	0.00
	constant	3.37	0.00	3.41	0.00								
no. of observations		25733		25733		25733		25733		25733		25733	
Prob>F		0.000		0.000		0.000		0.000		0.000		0.000	
R-squared		0.4443		0.5040		0.9341		0.9415		0.9326		0.9405	

White-adjusted standard errors and covariances.

Data source: own dataset of 26,107 entries containing transactional details or attributes of interest rates. This is only part of the regression terms' coefficients. For the overall table of output, please refer to Appendix 3.
Specifications 1-6 are different combinations of the terms in the model. Specification 1 stands for the regression output of a Trend term (T), Regional dummies (R) and Feature dummies of loans (F); Specification 2 for that of (T), Provincial dummies (P) and (F); Specification 3 for that of Dynastic dummies (D), (R) and (F); Specification 4 for that of (D), (P), (F); Specification 5 for that of Century dummies (C), (R), (F); Specification 6 for that of (C), (P), (F); Specification 7 that of (P) and (F) with entries only for the Republican era (1911-49).

Regarding external influences, we start from the geographical determination of interest rates. The provincial coefficients take the same pattern for Specification 2, 4 and 6, suggesting to a certain degree that the regression output is robust. All three lines show that Taiwan, Canton, Fujian, Anhui, Jiangxi, Shanxi, and the Hong Kong and Macau area had comparatively low interest rates – five of them were coastal and one of them (Shanxi) developed a financial centre at the end of dynasties. On the other hand, Zhejiang, Ningxia, Guizhou, Guangxi and Qinghai presented high interest rates, four of which were inland. Obviously, coastal financial markets enjoyed lower credit cost than inland markets. This observation is supported by the output of regional dummies below.

Regional coefficients are statistically significant at a 10% level (see Column 5 above). Interest rates of inland areas were 3% higher than those in the north of China (base). This might be because the northern region covered the political (capital) and economic centres of the country from long before the 6th century up until the 13th century.[183] Thus, the regional economy developed earlier; financial markets evolved better or more mature than inland areas, thus saw lower interest rates.

Moreover, interest rates in the coastal area were about 3% lower than that in the northern region of China. This supports our hypothesis about the geographical advantage and convenience of trade enjoyed by the coastal region. Given the convenience in waterborne transport and the ensuing lower transport costs than non-coastal areas, the

[183] From the beginning of the recorded Chinese history, most capital cities of the country were in the north until the Southern Song dynasty. For example, the capital city of Tang dynasty was in Chang'an, Shannxi; that of the Northern Song in Kaifeng, Henan. The economy and civilisation spread and developed from the north to the south. For more details on this, see Bai, "Chapter 10 The Qing Dynasty" or any other Chinese history books.

coastal region might feature a trade-led pattern of development. This meant a higher chance of thriving commerce and capital accumulation, thus greater capital supply and lower interest rates. Besides, regarding the transport process of capital flow, the region probably also enjoyed lower costs. However, the value of the regional coefficient is quite small (at -0.03), suggesting that such a regional difference had only limited influence on interest rates. This might be because in both the Ming and Qing dynasty, the sea-ban policy was in effect for years, thus diminished the regional differences based on overseas trade. Namely, transport cost for the regional region varied during this period. If more data are found in the future, we shall do further tests on more sub-periods (maybe separated by the policy-years on overseas trade), to assess in detail how transport cost and trade convenience affected interest rates in the coastal region. (Also, there is more to be discussed about the geographical divergence of interest rates and reasons behind it. But this section confines itself to the statistic description here; Part II goes further to examine how geographical influence from one or more external markets worked on local interest rates.)

1.4 Time Coefficients: Empirical Trends and Historical Evidence

First of all, how did the trend term (year) affect interest rates? We may judge this by comparing the fitness degrees of different specifications. The fitness degrees in Specification 4 and 6 (see Table 5) seem better than other specifications, with the R-squared value at about 94%. The coefficient of the Trend term (continuous variable) is extremely close to zero, ranging from -0.03% to -0.006%, suggesting that in the long-run, there was hardly a time trend (by year) in the movement of interest rates of China. Still, significant coefficients of other time dummies confirm the existence of ups-and-downs in-between dynasties and centuries (also see Figure 15 below). This may explain why the degree of fitness (R-squared) for Specification 1 and 2 are the lowest (at 44% and 50% respectively). Instead of dynastic dummies or century dummies, they employ the trend term that barely has any explanatory power on interest rates. The degrees of

fitness above may also suggest that intrinsic attributes of loans (such as principal, currency) explain about 44% of the interest rate level; external (social economic) impacts enclosed in time and geographic dummies may account for some 50% of the interest variation.

With intrinsic features and geographical dummies controlled for, we now have a further look at the trend of time coefficients. The following section asks

- According to the empirical results, how did temporal coefficients of the interest rates under study vary in history?
  Note that the trends in figures below present not the original or nominal interest rates as recorded in history, but the interest rate levels explained by the temporal dummies. They may be deemed as a pure trend of time, denoting only external influences (such as social, political and economic conditions to be discussed) and excluding any influences of intrinsic loan features.

  Again, this section does not aim at determining a representative trend for any specific regions or the country as a whole; rather, historical trends observed here speak only for the present dataset (a large dataset, with interest rates scattered over more than 600 localities and during the 6th to the 20th century). Still, to see if the quantitative findings can fit in with the history, we also discuss the following question:
- According to qualitative evidence in the corresponding historical periods, how did social- economic conditions and the ensuing financial development in a historical period affect the interest rate level at the time?

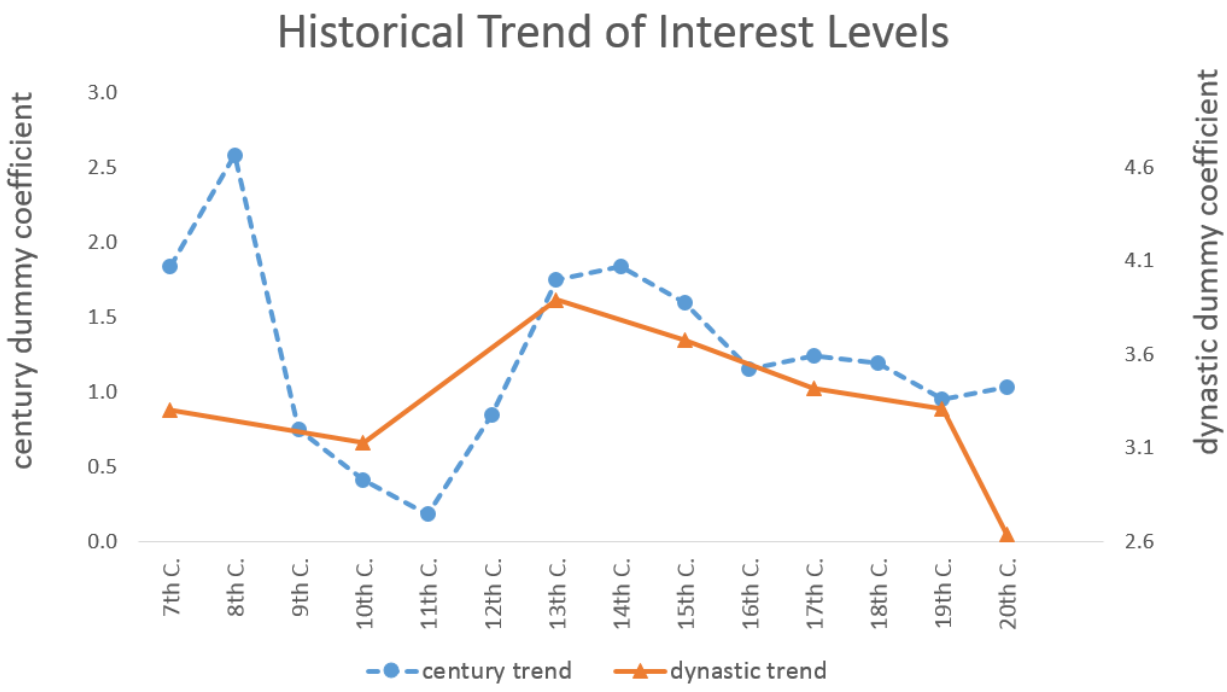


Figure 15 Time Coefficient Trend[184]

Source: regression coefficients in Column 3 and 5 of Table 5.
Notes: the higher is the coefficient point in the figure, the higher interest rates existed in that century or dynasty.

As illustrated by century dummies' coefficients (the dot line above), the interest rate level rose in the 6th and 7th century, the Sui-early Tang period, until the nation revived from war. Interest rates decreased from the peak of Tang dynasty in the 8th century, all the way into the Song dynasty. The 11th century of the Song dynasty witnessed the lowest interest rates in more than a millennium (from the 7th to the 19th century). Interest rates then climbed to another peak from the 12th to the 14th century, with the coefficient of the Yuan dynasty higher than that of the Song by 24%. Then there was a downward trend from the beginning of the Ming dynasty in the 14th century, all the way to the 20th century. During this process, interest rates in the Ming dynasty decreased from the previous period by 4%, in the Qing dynasty by 4%, in the Republican by 2%, and in the

[184] Again, the historical periods are: the Tang dynasty (618-907 AD); the Song dynasty (960-1279); the Yuan dynasty (1279-1368); the Ming dynasty (1368-1644); the Qing dynasty (1644-1911); the Republican China (1911-1949); the People's Republic of China (1949- 1985). This figure drops the coefficient for the 6th century because it is not statistically significant.

PRC period by 17%.

To interpret the regression coefficients in the real unit of interest rates (%), the figure below presents the baseline interest rate levels. A "baseline" interest rate is a "lowest" interest rate that excludes coefficients' influences from diversified loan features (such as credit types, maturity, and so on). "Baseline" means it only contains a benchmark for comparison, in this case, time-specific influences denoted by century dummies' coefficients.[185]

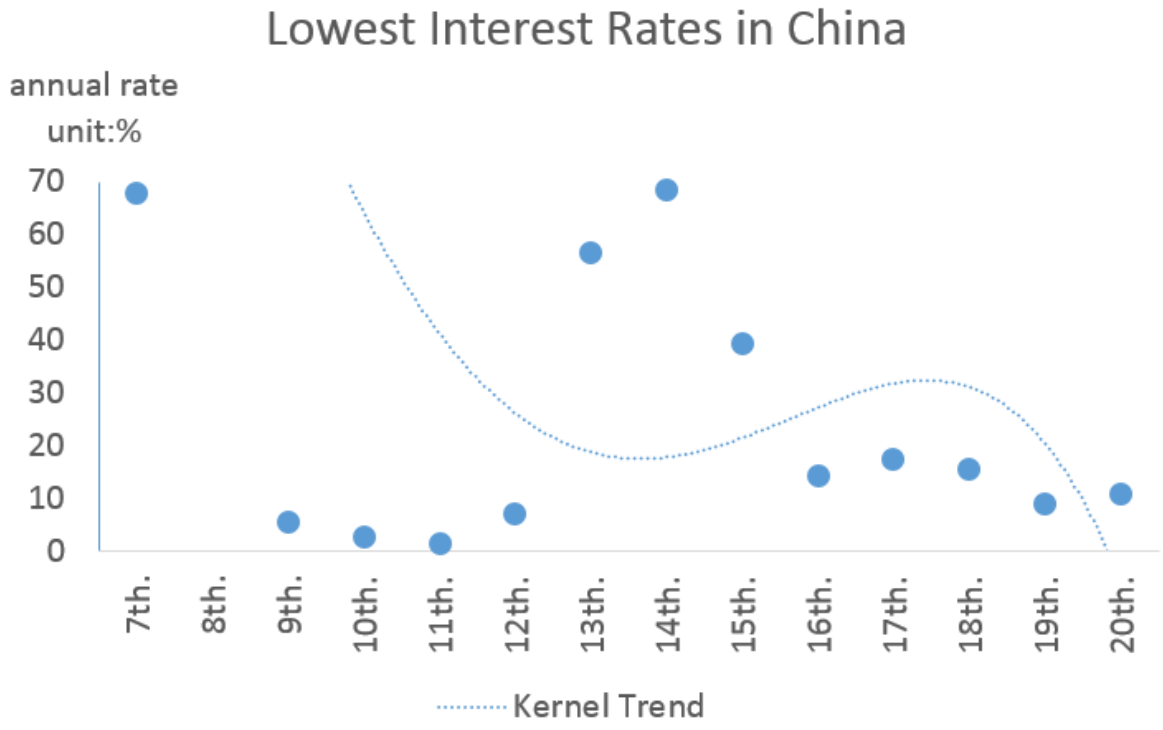


Figure 16 Lowest Annual Interest rate levels

[185] This is of the same concept as "hedonic regression" used in the real estate industry or housing price research. Like interest rates and loans, housing prices are subject to assorted features (location, number of floor, age, structure, with balcony or not, etc.). To compare prices of different houses (or apartments), one needs to control for various features/attributes of the house so that there is a benchmark or baseline for comparison. For more details on this method, please refer to

Joan Ramon Roses, Juan Carmona Pidal, and Markus Lampe, "Housing Market during the Rural-Urban Transition: Evidence from Early 20th Century Spain," *EHES Working Papers in Economic History*, European Historical Economics Society, 2012.

Daniel Raff, Susan Wachter, and Se Yan, "Real Estate Prices in Beijing, 1644 to 1840," *Explorations in Economic History* 50, no. 3 (2013): 368–86.

W.E. Diewert, *Hedonic Regressions: A Consumer Theory Approach* (University of Chicago Press, 2003).

Christian Gourieroux and Anne Laferrere, "Managing Hedonic Housing Price Indexes: The French Experience," *Journal of Housing Economics* 18, no. 3 (2009): 206–13.

Source: Regression coefficients of century dummies (column 5 of Table 5, the trend speaks only for the present dataset of interest rates here.)
Notes: A "lowest" interest rate, also known as a base-line interest rate, considers only the temporal determination of interest rates, excluding the intrinsic influences of diversified features such as credit types, maturity, among others.

Except the two periods of the 7th-8th century and the 13th-15th century, annual interest rates lingered at the level of 10%. The lowest interest rate level in China, compared with the lowest rates reported in European countries of the same time (data source as shown in the figures below), may not always be as high as conventionally thought. For example, in the 12th century, the interest rate level in China (Song) was about 7%, while that in the five key European countries of the time was 8%-10%-20%. However, after the 12th century, interest rates in China were generally higher than those in major European countries.

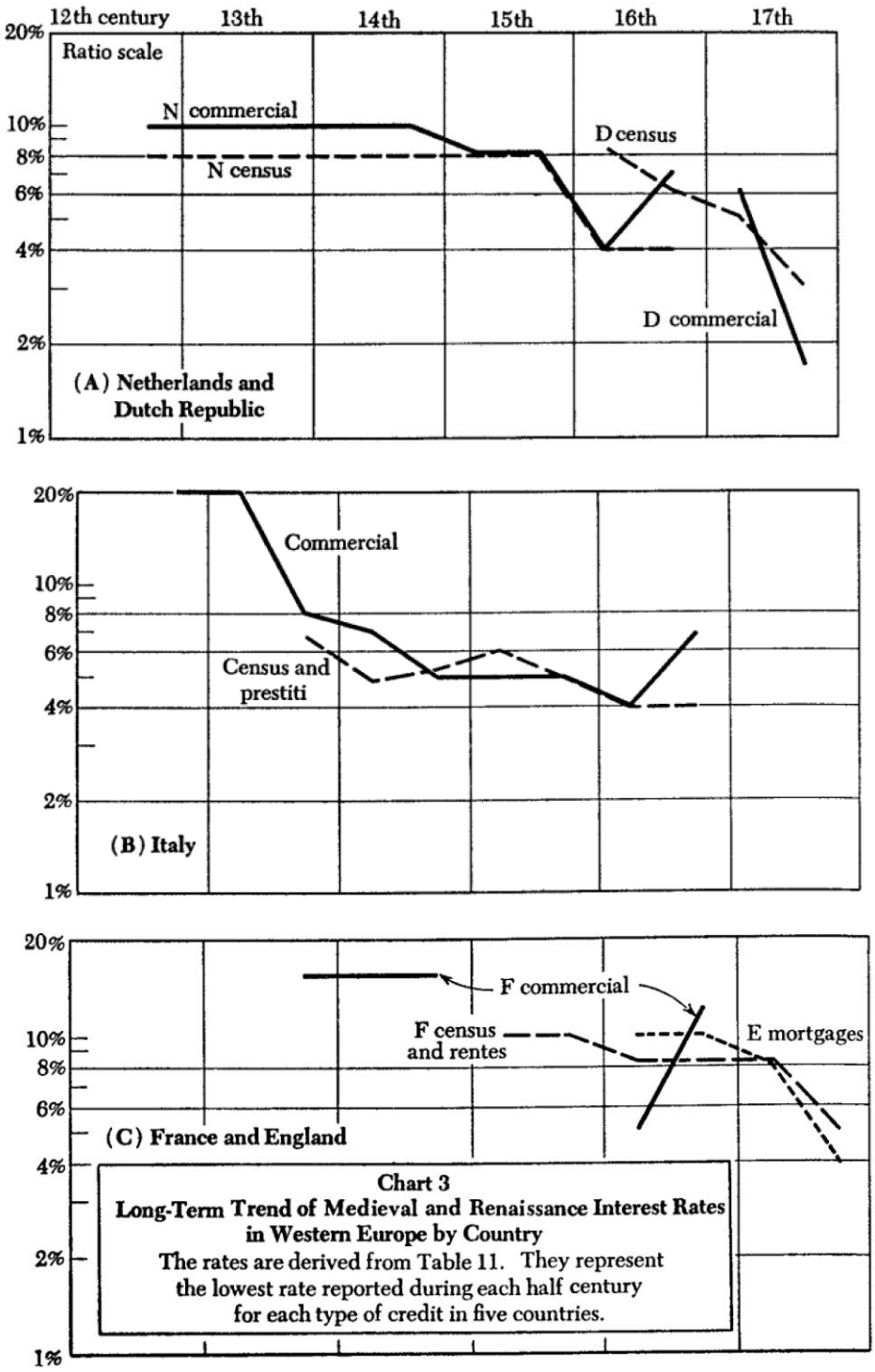


Figure 17 Lowest Annual Interest rate levels in Europe, the 12th -17th Century

Source: quoted from Homer, Sidney and Sylla, Richard, A history of interest rates, New Brunswick, N.J.: Rutgers University, 4th ed. 1996, pp.139. In these figures, N stands for the Netherlands, F for France, E for England, and D for Dutch Republic.

Moreover, as shown in Figure 16, interest rates fell in a non-linear way: two cycles stand out. The two peaks of interest rate levels are at the 8th century and the 14th century. The

two troughs on the line are the 9th-11th century of the Song dynasty, and the 19th century of the late Qing period. Particularly in the 10th to the 11th century, the baseline interest rate was as low as 1.53 to 2.57 per cent per year. This may be financial evidence that supports the Tang-Song transition[186] hypothesis. The hypothesis states that the social-

[186] It is well acknowledged that Japanese scholar Naito Konan was the first to notice the substantial changes in between the Tang and the Song dynasty, stating that the Tang dynasty marked the end of medieval times and the Song dynasty the beginning of modern times in China. His student Miyazaki Ichisada then developed this statement into a full-fledged theory. More Japanese researchers later followed their path and joined the Kyoto historians. Many Chinese scholars also contemplated on the modernity of the Song society. Actually, this theory covers not only the economic sector, but a wide range of subjects and aspects of the society. Scholars believe that in the northern Song dynasty, only economy but also political, social and cultural structure of China experienced substantive changes from the Tang dynasty and before, which made the Song society similar to a modern one (近世) in many aspects. A representative opinion was made by Qian Mu, who stated that: "The most significant social changes happened in the Song dynasty. China before the Song dynasty can be deemed ancient; after, modern. From the first dynasty of Qin all the way to the Tang dynasty, the Chinese society was dominant by the noble and aristocratic clans; since the Song dynasty (except in the Yuan period), the civil elite took over the place of the aristocratic in the ruling class. From then on, everything (ranging from politics, economy to social and daily life) changed." See:

Mu Qian 钱穆,"Lixue Yu Yishu 理学与艺术,"in *Songshi Yanjiu (A Collection of Papers on the Song History)宋史研究*, vol. 6 (Taiwan shuju, 1974), 2.

Similar discussions have been going on among western scholars too. For more details, please see:

Konan Naito 内藤湖南, "Gaikuo de Tang-Song Shidai Guan 概括的唐宋时代观 (A General View on the Tang-Song Period)," *Lishi Yu Dili 历史与地理 (History and Geography)* 9, no. 5 (1922).

—————— *Naito Konan Zenshu 内藤湖南全集 (Collected Works of Naito Konan)* (Tokyo:筑摩书房, 1970).

Miyazaki Ichisada 宫崎市定, "Cong Buqu Zouxiang Dianhu 从部曲走向佃户," in *Miyazaki Ichisada Zenshu 宫崎市定全集* (Tokyo: 岩波书店, 1992).

————, *Jiupin Guanren Fa Yanjiu—Keju Qianshi 九品官人法研究—科举前史* (Beijing: Zhonghua Shuju, 2008).

Guangming Deng 邓广铭, *Self-Selected Academic Works of Deng Guangming 邓广铭学术论著自选集* (Beijing: Shoudu Shifan Daxue Chubanshe, 1994).

——— "Tantan Youguan Songshi Yanjiu de Jige Wenti (Discussions on A Few Issues of the Song History),"*Shehui Kexue Zhanxian* 2 (1986).

Zengyu Wang 王曾瑜, *Song Chao Jieji Jiegou 宋朝阶级结构 (Social Structure of the Song Dynasty)* (Shi Jia Zhuang: Hebei Jiaoyu Chubanshe, 1996).

Xia Qi 漆侠, "Tang-Song Zhiji Shehui Jingji Guanxi de Biange Jiqi Dui Wenhua Sixiang Lingyu Suo Chansheng de Yingxiang 唐宋之际社会经济关系的变革及其对文化思想领域所产生的影响," *Research on Chinese Economic History 中国经济史研究* 1 (2000).

——Xia Qi 漆侠, "Songdai Shehui Shengchanli de Fazhan Jiqizai Zhongguo Gudai Jingji Fazhan Guocheng Zhong Suochu de Diwei 宋代社会生产力的发展及其在中国古代经济发展过程中所处的地位,"*Research on Chinese Economic History 中国经济史研究中国经济史研究* 1 (1986).

Ruixi Zhu 朱瑞熙, *Songdai Shehui Yanjiu 宋代社会研究 (Research on the Song Society)* (Zhengzhou, 1983).

Rulei Hu 胡如雷, "Taong-Song Zhiji Zhongguo Fengjian SHehui de Juda Biange 唐宋之际中国封建社会的巨大变革 (Enormous Social Changes during the Tang-Song Period)," *Shi Xue Yue Kan 史学月刊* 7 (1960).

Bangwei Zhang 张邦炜, *Huyin Yu Shehui 婚姻与社会: 宋代 (Marriage and Society)* (Chengdu: Sichuan Renmin Publishing House, 1989).

Lecheng Fu 傅乐成, "Tangxing Wenhua Yu Songxing Wenhua 唐型文化与宋型文化 (the Tang Culture and the Song Culture)," in *Zhongguo Tongshi Jiaoxue Yantaohui 中国通史教学研讨会*, ed. (Taibei: Taibei Huashi Publishing House, 1979), 314–50.

Wailu Hou 侯外庐, ed., "Zhongguo Sixiang Tongshi 中国思想通史" (Renmin Publishing House, 1992), 1.

Bol, "Reconsidering Tang-Song Transition: With Particular Attention to Intellectual Change."

_____ *斯文-唐宋思想转型 ("This Culture of Ours": Intellectual Transitions in T'ang and Sung China)* (Nanjing: Jiangsu Renmin Publishing House, 2001).

Pareto, *Jingying de Xingshuai 精英的兴衰 (The Rise and Decline of the Elite Class)*.

Robert M. Hartwell, "750-1550 年中国的人口、政治及社会转型（Demographic, Political, and Social Transformations of China, 750-1550）,"*Harvard Journal of Asiatic Studies* 42, no. 2 (1982): 365–442.

Jones, *Growth Recurring: Economic Change in World History*.

Luo, "Moshi Jiqi Bianqian Shixue Shiye Zhongde Tang-Song Biange Wenti 模式及其变迁-史学史视野中的唐宋

economic development in the Song dynasty started to show some modern features, thus this period marked the beginning of the modern times in Chinese history. The observation above may from a financial perspective complement current cultural, political and economic debates regarding the hypothesis. If lower interest rates denote more efficient financial markets, the financial development in the Northern Song was indeed the summit of Chinese financial history, even comparable with extremely low interest rates in modern societies.[187] In this sense, the Song dynasty does bear some resemblance to modern financial markets (more historical evidence is discussed later in this section), thus contributing to the hypothesis.

However, the trend observations above on time dummies' coefficients are based only on the present dataset. We shall be cautious about the quality of the trend, for we cannot rule out the possibility of a different story told by newly discovered data evidence - after all, an empirical study can only go as far as the data allow. But till then, to what extent can we have confidence in this temporal trend of interest rates? Or, how likely are these time coefficients biased by data structure or the empirical processing above? As a complement to the statistic results, we also turn to the corresponding historical periods to see if qualitative evidence in history may validate the empirical findings.

We start from the first cycle in Figure 16, the Tang-Northern Song period in the 7th -12th century. The 7th century was the beginning of the Tang dynasty. From 618 AD, economic prosperity increased to its high point in the Kai-Yuan period of the Tang dynasty (713-741 AD). Developing production and commerce created high demand for capital; there were thriving capital demands from various economic sectors. However, the economy was still recovering from wars; its production capability could not yet meet the capital demand with sufficient capital surplus. In the year 740 AD, the size of the country's

变革问题 (Paradigm and Transformation-the Tang-Song Transition Debate in a Historical Perspective)."

Liu, "Wrestling for Power: The State and the Economy in Later Imperial China, 1000- 1770 (竞逐权力:晚期中华帝国的国家与市场经济)."

[187] The real estate mortgage rate in UK recently has ranged from about 1% to 5%. Annual deposit interest rates in today's China is about 1.5% whereas annual loan rate about 4.5%. Sources: Bank of China website.

population was about 48 million and that in 755 AD 52 million.[188] If production output could not increase at a speed higher than population, which was probably the case during this period, then capital per capita would decrease. Consequently, the interest rate level increased.

Then there came a peak level of interest rates in the 8th century, the timing of which coincides with the An-Shi Rebellion.[189] The war lasted for seven years (755-763 AD). There might be two aspects about the warfare impact on capital markets: one, it decreased investor protection and increased investment risks, hence higher risk premium; second, during war time, liquidity demand for cash tended to strengthen, hence less capital supply left for investment or loaning. Both tended to increase interest rates.

However, interest rates soon dropped from the 9th century, suggesting that political instability was a strong but temporary shock to interest rates. In the short run, this might be because that after the An-Shi Rebellion, the central government lost control of provincial states to local military forces. Political fragmentation and regional conflicts counteracted rural production and inhibited commercial activities, thus lowered investment demand for capital. According to official records, from 713 to 841 AD the monthly interest return of state capital and loans decreased from 7% to 4%.[190]

This decline continued into the Song period (despite some minor fluctuations, of course). During the 9th-12th century, there was a downward trend of the interest rates spanning the Tang-Song period. This might be because in the long run, the economy gradually revived and thrived. Particularly in the Northern Song dynasty, the country's population

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[188] You杜佑 Du, "Shi Huo 食货 (Treatise and Thoughts on Records of Food and Commerce/Social-Economic History of Economy and Finance) 七 Vol.7," in *Tong Dian 通典 Comprehensive Statutes and General History of System* (Zhonghua Shuju 中华书局, 1988). Quoted from Bai, *中国通史 (Chinese History), 214 in Chapter 6, 67 in Chapter 7*.

[189] It was a coup led by General Anlushan and later Shi Siming, thus named the "An-Shi Rebellion".

[190] See Pu Wang, Chapter 18 and Chapter 93 in *Tang Hui Yao 唐会要 (Institutional History of the Tang Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1955). Xiu 欧阳修 Ouyang and Qi 宋祁 Song, Vol.132 in *Xin Tang Shu 新唐书 (New History of Tang)* (Beijing: Zhonghua Shuju 中华书局, 1997). Quoted from Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*, 241.

by the end of the Northern Song period increased to about 100 million.[191] The acreage of arable land increased from 2.95 million hectares in 976 AD to 5.24 million hectares in 1021 AD.[192] National revenue increased from some 30 million strings of coins in 780 AD to 48 million strings around 1186 AD.[193] The increasing size of the economy brought increasing output and then product surplus, which eventually transformed into abundant capital supply thus lowered interest rates. Furthermore, a booming economy during the Tang-Song period rooted for financial development in institutions, innovations and markets.

Firstly, as production and commerce developed, capital surplus went accumulated in rich hands of landowners or merchants. As a result, financial institutions developed. In Chang'an (capital city of the Tang dynasty), "counter-shops (柜坊)"[194] provided many financial services. The business covered not only the safe deposit of valuables, but also money deposit and loan, which in a sense made it a prototype of modern bank. The shops could issue a type of certificate for deposit, which might be given to a third party to claim the deposit as a cheque or payment receivable. Their credit capability was remarkable. Even the royal court sometimes turned to the market for finance. In the year 782 AD, Emperor De Zong drew on the financial market of Chang'an to finance a

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[191] Du, "Shi Huo 食货 (Treatise and Thoughts on Records of Food and Commerce/Social-Economic History of Economy and Finance) 七 Vol.7." Quoted from Bai, *中国通史 (Chinese History), 214 in Chapter 6, 67 in Chapter 7*.

[192] Bai, Chapter 7 in *中国通史 (Chinese History), 275*.

[193] 1 string of coins = 1000 copper coins.
One point to note is that the tax amount does not necessarily mean capital for credit and loans. A large proportion of the tax income could be consumed by corruption, royal or military expenditures, and so on. It does reflect the economic capacity, product and capital surplus to an extent, though.
Another point to note is that some historian argue the increased government revenue in the Northern Song dynasty was the result of much heavier tax burden compared with that in the Tang dynasty. Even though that was the case, considering that the size of the Northern Song territory was much smaller, we can still see the economic development in the Song period. Besides, the number of population and that of arable land are also important indicators of the economy. But the issue of tax and revenue is too complicated to be further discussed by this thesis; still, economic development during this period is well acknowledged by Chinese historians. For more references regarding this, see:
Fangzhong 梁方仲 Liang, *Zhongguo Lidai Hukou Tiandi Tianfu Tongji 中国历代户口、田地、田赋统计(Statistics of Households, Lands, and Land Tax in Chinese History)* (Shanghai: Shanghai Renmin Publishing House, 1980), 286，297.
Xia 漆侠 Qi, *Songdai Jingji Shi 宋代经济史 (Economic History of the Song Dynasty)* (Shanghai: Shanghai Renmin Publishing House, 1988).
Xia 漆侠 Qi and Guangming 邓广铭 Deng, *Liang Song Zhengzhi Jingji Wenti 两宋政治经济问题 (Political Economy in the Song Dynasty)* (Shanghai: Zhishi Chuban She 知识出版社, 1988).

[194] Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*, 247.

military campaign against local rebels. He managed a fund of some 2,000,000 coins, three fifths of which were from counter shops.[195] It was clear that financial institutions were highly capable of mobilizing capital and increasing capital supply. In Kaifeng, the capital city of the Northern Song dynasty, many millionaires played an active role in the credit market.[196] At first, some of them lent money occasionally. Gradually there came professional money-lenders called "Money People" (钱民); they even hired credit agents, called "Money Carriers" (行钱) to collect information on capital demand, locate potential borrowers or operate the fund for them.[197] More players on the market intensified financial competition, and naturally, the interest rates declined.

Secondly, financial innovation in credit tools during this period could also help capital transaction thus reduce credit cost. For instance, the "flying money", a prototype of the bill of exchange, was first recorded in about 806 AD. It helped commodity and capital flows by facilitating remittance and finance.[198] This financial device was widely adopted by officials and merchants.[199] Even the central government wanted to join the business, and tried to compete with local service providers by starting with a free service in July, 812 AD.[200] The "flying money" developed into paper notes in the Song dynasty,

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[195] Xu 刘昫 et al. Liu, Chapter 12, 135 in *Jiu Tang Shu 旧唐书 （Old History of Tang）* (Beijing: Zhonghua Shuju 中华书局, 1975). Quoted from Ibid, *239*.

[196] Ao 李翱 Li, Vol. 9 in *Li Wen Gong Ji 李文公集 Collection of Li's Works*, *Sibu Cong Kan 四部叢刊 （Classified Traditional Chinese Works）* (Taibei: Taiwan Shangwu Yinshu Guan 臺灣商務印書館, 1975).

Zhuo 张鷟 Zhang, Vol. 3 in *Chaoye Qianzai 朝野佥载 (Notes on the Life of the Early Tang Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1985).

Quoted from Qiugen 刘秋根 Liu, "唐宋高利贷资本的发展 (Usury Capital in the Tang and the Song Dynasty)," *Shi Xue Yue Kan 史学月刊* 4 (1992): 31.

Qi 宋祁 Song, *Jing Wen Ji 景文集* (Shanghai: Shanghai Shangwu Publishing House 上海商務出版社, 1936).

Song 徐松 Xu, "Shi Huo 食货 (Treatise and Thoughts on Records of Food and Commerce/Social-Economic History of Economy and Finance)," in *Song Hui Yao Ji Gao 宋会要辑稿 (Institutional History of the Song Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1957).

Quoted from Qiao,"宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)."

[197] Source：Mingqing 王明清 Wang, 投辖录 (Taibei: Taiwan Shangwu Yinshu Guan 臺灣商務印書館, 1986).

Bu 廉布 Lian, *Qing Zun Lu 清尊录* (Beijing: Zhonghua Shuju 中华书局, 1991).

quoted from Qiao, "宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)."

[198] Ouyang and Song, Vol.54 in *Xin Tang Shu 新唐书 (New History of Tang)*.

Lin 赵璘 Zhao, Vol. 6 in *Yin Hua Lu 因话录* (Shanghai: shanghai guji chubanshe 上海古籍出版社, 1979).

[199] Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System),* 254.

[200] Qinruo 王钦若 Wang and Yi 杨亿 et al. Yang, "卷五零一邦计部十九钱帑三条 (Article 19 on Money and Finance in Section of State Finance, Vol.501)," in *Ce Fu Yuan Gui 册府元龟 (Historical Wisdom from the Royal Library-A Chinese History from Ancient Times to the Five Dynasties)* (Beijing: Zhonghua Shuju 中华书局, 1960).

such as “Jiao Zi (交子)”, “Guan Zi (关子)” and “Hui Zi (会子)”, generally known as “money vouchers (钱引)”. They were used in different historical periods,[201] denoting the right to receive payment for goods or services already delivered by the Holder. They facilitated not only trade but also capital flow. For instance, in the Sichuan province of the 10th century, a string of steel coins weighted 6.5 Jin or 3.25 kilograms. A string of amended (not debased) steel coins issued in the year 1005 AD weighted even more at 25.5 Jin (12.75 kilograms).[202] With paper notes, lending and transporting money became much more convenient, and the accelerated financial process meant lower cost. They were so widely accepted and used for more than just remittance that they actually made a prototype of paper note,[203] which eventually took the place of the flying money and left little room for remittance in Chinese financial history.

Another example in the Song dynasty was the salt and tea vouchers (盐引,茶引), two types of official licenses, issued by the state for businessmen to deal in these state-monopolized commodities. With the development of commercial and financial markets, these licenses became tradable on financial markets. One could use the vouchers like discount bonds, selling them on the financial market in exchange for cash or fund. These vouchers were even highly popular on the market because of its high profitability in the monopolized commodity. Namely, they worked as new financial channels or tools, making it more convenient and less costly to mobilize capital, hence the decreasing interest rates.

Thirdly, improvement in financial institutions and instruments amounted to financial market development. The Tang Chang’an was a centre of commodity and capital exchange of Asia at the time, where assorted financial services were available.[204]

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[201] At the end of the 10th century in the Northern Song, merchants in the Sichuan Province were the first to issue and use such paper notes called “Jiao Zi (交子)”. Similar paper notes called “Hui Zi (会子)” were issued in Lin’an, capital city of the Southern Song (1127-1279), used not only in commercial contexts but also to pay for officials’ salary by the state. “Guan Zi (关子)”was also issued in the Southern Song dynasty, originally issued by a military base of the Song government in the year 1131 AD. See Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*.

[202] Ibid., 257-273.

[203] Paper notes of the Song dynasty is different from fiat money in that they were convertible not only with commodities, but also metal cash. Every two or three years, old paper notes would be cashed in and replaced by new ones. Replacement would cost 30 wen (文) per string as mintage, or “Paper & Ink Fee”.

[204] Ibid., 239.

Pawnshops provided credit or loans to merchants running short of turnover capital. Counter-shops provided safes for merchants to store valuables, and mortgage loans too. Shops of goldsmiths or silversmiths (金银铺) formed a market specialized in metal (gold) currency dealings, mintage and exchange.[205] Also, there were merchants' groups that provided remittance services through the flying money. The market covered almost all the essential services that we see in financial markets today, in which sense, the Tang financial market might be deemed a fully-fledged financial market. Such a market surely contributed to less credit cost at the time, at least in the capital region where this study collected data. Financial shops also clustered on the Nantong Avenue of Kaifeng during 1102-112 AD. Assorted metallic currencies, paper notes, discountable commercial bills, salt vouchers, tea vouchers and other securities were all traded here for funds; a single transaction here could involve millions of strings of money.[206] These financial markets meant capital pools that consolidated capital supply and demand. They helped capital transactions, thus tended to lower interest rates.[207] In short, all the economic and financial development above might reduce credit cost and lower interest rates.

[205] Ibid., 251-2.

[206] Yuanlao 孟元老 Meng, *Dongjing Menghua Lu 东京梦华录 (The Eastern Capital: A Dream of Splendor)* (Shanghai: Shanghai Gudian Wenhua Chubanshe 上海古典文化出版社, 1956).

[207] But of course, when capital supply was short everywhere, interest rates here could rise high too. This was a relative issue: where there was a financial market, people often had better access to fund, thus lower financial cost than where there was no market at all.

Figure 18 Jiao Zi of the Northern Song

Content: "Allowed to circulate in all prefectures but Sichuan; Money payable at sight of this; Issued by the Department of Civil Administration; Anyone who counterfeits this shall be beheaded; anyone who reports the counterfeit to the state shall be rewarded with 10 strings of money (silver) – dated: 1023 AD"

During the Southern Song-Yuan period (1127-1368 AD, the 12th -14th century), a new cycle of climbing interest rates seem to emerge, and led to a second peak of the interest rates. The Southern Song dynasty inherited financial institutions and tools from the preceding period, however, little financial innovation and development was recorded for this period. Although the size of population decreased to about 60 million,[208] the national revenue somehow increased,[209] probably because of further developed overseas trade and domestic commercial development. In this sense, capital per capita was likely to increase. However, faced with continuously upgrading threats from the northern

[208] Songdi 吴松弟 Wu, *Liao Song Jin Yuan Shiqi (Vol. 3)*, *Zhongguo Renkou Shi 中国人口史 (Population History of China)* (Fudan Daxue Chuban She 复旦大学出版社, 2003).

[209] Liang, *Zhongguo Lidai Hukou Tiandi Tianfu Tongji 中国历代户口、田地、田赋统计(Statistics of Households, Lands, and Land Tax in Chinese History), 296-303*.

nomadic peoples, military expenditures increased even faster, due to warfare against nomadic peoples in the north. There had been threats from the Tangut (西夏), the Khitan (契丹) and the invasion of the Jurchen (金) people from the end of 10th century. Since 1127 AD (the year when northern invaders forced the Song dynasty to transfer its capital city south to Hangzhou), the threat and impact of warfare upgraded to a new level. Because the frequency and scale of military conflicts increased, and also because the royal court had retreated to the south of the Yangtzi river, the political power was standing on the edge of a cliff. The Southern Song state tended to draw on the people as much as it could to finance the wars, draining capital in the private sector and diminishing financial supply. Moreover, a large amount of silver and gold was taken by the northern conqueror from civilians and households,[210] which further exhausted the capital pool in the private sector. Consequently, the increase of capital demand probably exceeded the increase in capital supply, leading to higher equilibrium points of interest rates on capital markets.

Meanwhile, investment risks soared due to little protection of the investor's return and the difficulty to control contract enforcement in times of crisis. Accordingly, such influences as soaring risk premium continued all the way into the Yuan dynasty. From the 1230s on, the Mongolians marched south. There came a series of large-scale campaigns until the Yuan court was established in Beijing in 1279 AD. Wars counteracted rural production and inhibited commercial activities, thus lowered product surplus and capital supply. Even after 1279, regional wars continued. The Mongolian soldiers kept heading east and south, fighting Japan in 1279-1286, and conquering Champa (Vietnam) and Burma in 1282. This probably contributed to the increasing interest rates in the 13th century.

After the establishment of the Yuan's reign, there should have been a break period for this increasing trend. However, usury became so prevalent during the Yuan times that the nominal interest still held high in the 14th century.[211] It was hard to inhibit because

[210] Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System)*.
[211] Ibid.

many capital sources were actually royal members and state officials. Given all the historical evidence above, it might be reasonable to accept the remarkably high point of interest rates at the 14th century on the trend line. During this whole period (the 12th-14th century), the growth rate of nominal interest was nearly 400%.

Finally, we look at the Ming-Qing period (1368-1911) and after, namely, the 14th -20th century. Despite slight upward fluctuations in the 17th and 20th century, the interest rates were declining all the way down. After years of war at the turn of dynasties, even though the first emperors of the Ming dynasty undertook much to stabilise the country's economy, it took time for their policies to work. It is only from around 1450 that interest rates began to decline again. Regarding capital supply during this time, production development was of course related to capital supply and interest rate decrease. However, the main concern here is silver. Commercial capital and other large-scale investment demand depended mostly on silver the large-denomination currency, rather than copper coins. To start with, silver mining escalated in China from the Ming dynasty. The amount of silver produced in the year of 1430 alone was some 320,297 taels. From 1457 to 1487, some 100,000 taels of silver were produced per year in the Yunnan province.[212] The accumulative effect of such silver mining on the national capital pool took shape from the 16th century.

Moreover, silver inflow from international trade started from 1567 AD, when the sea-ban policy of the Ming state was officially abolished.[213] The late-Ming China was described as a "silver-sucking pump" by the Portuguese; and the Spanish complained that "Chinese merchants almost took away all the silver we shipped from New Spain."[214]

Qiao, "宋元时期高利贷资本的发展 (The Development of Usury Capital during the Song-Yuan Period)."

[212] Yanwu 顾炎武 Gu, "Yin 银 （Silver）," in *Ri Zhi Lu 日知录集釋全校本 （Daily Knowledge）* (Shanghai: shanghai guji chubanshe 上海古籍出版社, 2006).

Tingyu 张廷玉 Zhang, "Keng Ye 坑冶 (Mining)," in *Ming Shi 明史 (History of the Ming Dynasty)* (Beijing: Zhonghua Shuju 中华书局, 1974).

[213] Silver dollars from Spain and Holland came to China through the Philippines and Japan respectively in the 16th century. See Xie 张燮 Zhang, *Dong Xi Yang Kao 东西洋考（Investigations on the Eastern and the Western Oceans）*, ed. Fang 谢方 Xie (Beijing: Zhonghua Shuju 中华书局, 2000).

[214] Ming 万明 Wan, *Wanming Shehui Bianqian 晚明社会变迁：问题与研究 (Social Transformation in Late Ming*

According to the records of the East India Company, from 1681 to 1790 some 40,689,807 taels of silver came into China.[215] This and the ensuing trade surplus surely contributed to the capital pool (though the amount of silver inflow is in dispute).[216] Moreover, there was counterpart evidence on the amount of valuable metal import from America to Europe. The amount of gold imported during 1641-1650 shrank by 92% compared with that during 1591-1600; and that of silver decreased by 61%.[217] The decline of Europe's silver imports probably contributed to the increase of silver import to China.

Silver outflow happened towards the end of the Qing reign. However, reversing trade surplus was a long process, and the amount involved was not large enough to shake what had been done to the capital market in the century ahead. From 1821 to 1833, the net outflow of silver was some 12,204,750 taels,[218] which was no more than 30% of the silver inflow volume during the early Qing period of 1681-1790 mentioned above (40,689,807 taels). Overall, silver inflow increased capital supply, thus helped cut credit

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China) (Beijing: Shangwu Yinshu Guan 商务印书馆, 2005).

Ding 沙丁 Sha and Dianqiu 杨典求 Yang, *Zhongguo He Ladingmeizhou Guanxi Jianshi 中国和拉丁美洲关系简史 (A Brief History on the Relationship between China and Latin America)* (Henan Renmin Chuban She, 1986).

Frederick W. 牟复礼 Mote and Denis C. 崔瑞德 Twitchet, "Volume 7, 明代史 （The Ming Dynasty, 1368–1644）," in *剑桥中国史 (The Cambridge History of China)* (Zhongguo Shehui Kexue Yuan Chubanshe 中国社会科学院出版社, 1992), 665.

Emma Helen Blair and James Alexander Robertson, eds., *The Philippine Islands,1493-1898* (Cleveland: Arthur H. Clark Company, 1903).

Chuanfang 何芳川 He, *Aomen Yu Putaoya Dashangfan 澳门与葡萄牙大商帆 (Macau and Portuguese Merchants)* (Beijing: Beijing Daxue Chubanshe 北京大学出版社, 1996).

[215] For example, in no more than two decades from 1821 to 1833, silver outflow reached some 12,204,750 taels. See Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System), 605*.

[216] Fangzhong 梁方仲 Liang, "Mingdai Guojimaoyi Yu Yinde Shuru 明代国际贸易与银的输出入 (International Trade and Silver Inflow in the Ming Dynasty)," in *梁方仲经济史论文集 (Collection of Economic Historian Papers by Liang Fangzhong)* (Beijing: Zhonghua Shuju 中华书局, 1989), 176.

Yuxun 王裕巽 Wang, "明代白银国内开采与国外流入数额试考(A Study on the Amount of Domestic Mining and Inflow of Silver)," *Zhongguo Qianbi 中国钱币(Chinese Currencies)* 3 (1998).

Kent Deng, "Miracle or Mirage? Foreign Silver, China's Economy and Globalisation from the Sixteenth to the Nineteenth Centuries," *Pacific Economic Review* 13, no. 3 (2008): 320–58.

[217] Earl J. Hamilton, *American Treasure and the Price Revolution in Spain, 1501-1650* (Cambridege: Harvard University Press, 1934).

[218] For example, in no more than two decades from 1821 to 1833, silver outflow reached some 12,204,750 taels. See Peng, *Zhongguo Huobi Shi 中国货币史 (A History of Chinese Monetary System), 605*.

cost, hence lower interest rates.

Financial institutions and innovations resumed development during this time, which probably also helped reduce credit cost. Money shops first appeared about 1465-1487 (成化)[219] of the Ming dynasty, and were officially acknowledged by the royal court in 1577.[220] Since then, the money shop served as a major financial intermediary. In Shanghai from 1776-1796, there were at least 106 money shops.[221] Such money shops were usually based on partnership, unlimited liability and small stock capital, thus restrained to a local level.[222] They dealt in money exchange, deposit and credit, and even issuing paper notes (钱票,庄票,银票) if they were credible enough.

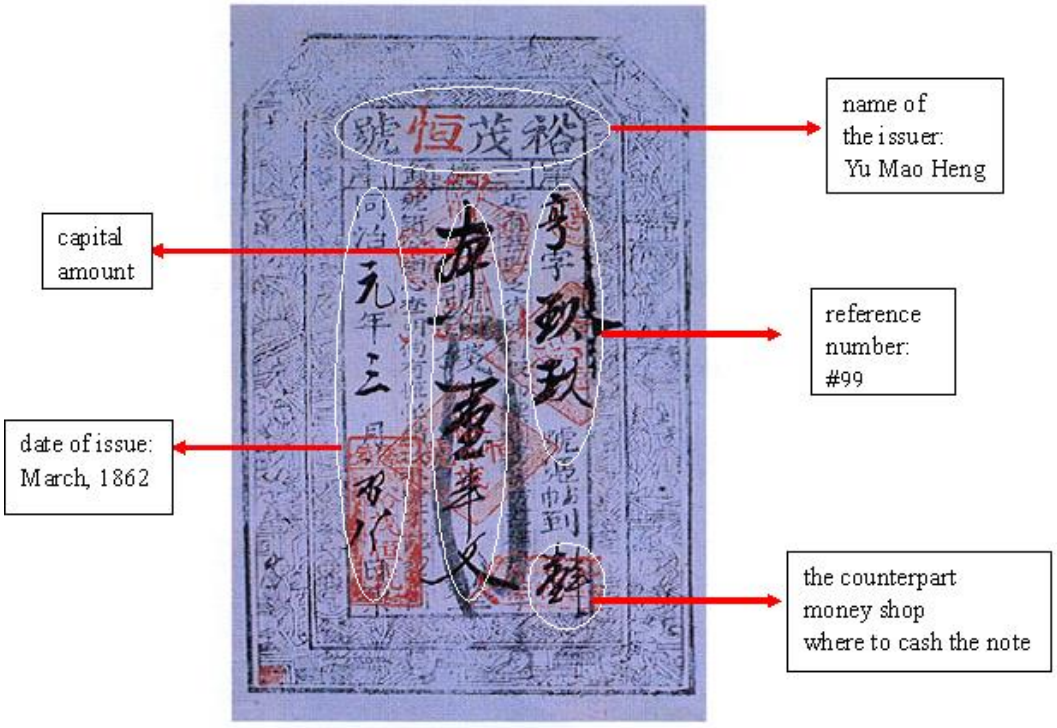

Figure 19 A Paper Note Issued by Money Shop "Yu Mao Heng"

[219] Ibid., 515.

[220] Jin 解缙 et al. Xie, Vol.66 in *Ming Shenzong Shilu 明神宗实录 (Veritabe Records of Shenzong of the Ming Dynasty)* (Beijing: Beijing Daxue Chubanshe 北京大学出版社, 1990).

Quoted from Weiqun 傅为群 Fu, "上海钱庄与钱庄票 (Money Shops and Draft Bills in Shanghai)," *Zhongguo Qianbi 中国钱币 (Chinese Currencies)* 2001, no. 1 (1AD).

[221] Xiangyi 孔祥毅 Kong, "中国银行业的先驱:钱铺,钱庄,银号 (Pioneers in Chinese Financial Industry)," *Zhongguo Jinrong 中国金融 (China's Finance)* 12 (2010).

[222] Thomas G. Rawski, "Banking and the Monetary System," in *Economic Growth in Pre-War China* (Berkeley: University of California Press, 1989), 120–68.

Shanxi bankers derived from Shanxi merchants in the Qing Dynasty. But long before that, the Shanxi people had dealt in assorted business, including trade and financial business, all over the country since the Ming Dynasty. In 1765 there were already 81 money shops run by them in the city of Suzhou.[223] Some Shanxi merchants ran short of capital when doing business in commercial centres such as Beijing, Tianjin and Chongqing, so they developed a system to transfer money efficiently for long-distance trade. Gradually some of them became specialize in bills of exchange.[224] "Ri Sheng Chang",[225] the first famous Shanxi bank that specialized in the remittance business was established in about 1823 AD, which was originally a dye house. Compared with local money shops, they were more dedicated to cross-regional capital transfer than about currency exchange on site locally. Their specialty in this business was so reputable that it earned them the famous name of "Shanxi Bankers", or literally, the Shanxi "exchange shops (票号,票庄,汇兑庄)".

[223] Kong, "中国银行业的先驱:钱铺,钱庄,银号 (Pioneers in Chinese Financial Industry)."

[224] Qitian 陈其田 Chen, *Shanxi Piaozhuang Kalve 山西票庄考略 (A Study on Shanxi Banks)* (Shangwu Chubanshe 商务出版社, 1937).

[225] Huang and 黄鉴晖, *山西票号史料 (Historical Materials of Shanxi Piao Hao)*.

Figure 20 Financial Network of the Shanxi Bankers in the 19th century

Sources: Huang Jianhui, and Mu Wenying[226]
Notes: The four dark points in double circle (map centre), Taiyuan, Taigu, Qixian, Pingyao, were headquarters of Shanxi bankers. The other dark points were regional branch offices. And the white dots were secondary or local branch offices. Apart from branches in Korea on the map, Shanxi bankers also had branches in Japan, Russia, India and Singapore.

As a result, there emerged a fully-fledged financial network: money shops acted as local channels of capital supply; and the Shanxi bankers deployed franchised branches all over the country. Faster capital turnover among financial markets meant faster and easier access to not only local but also regional funds. Financial markets' efficiency during the Ming-Qing period, if not better than that in the Song dynasty, was sufficient to accommodate the growth of financial demand out of a growing economy at the time. In

[226] Wenying 穆雯英 Mu, ed., *Jinshang Shiliao Yanjiu 晋商史料研究 (Research on Historical Materials on Shanxi Merchants)* (Shanxi Guji Chubanshe 山西古籍出版社, 2001).
Huang and 黄鉴晖, *山西票号史料 (Historical Materials of Shanxi Piao Hao)*.

this sense, it helped reduce credit cost.

Furthermore, again, more financial institutions on the market meant stronger competition, which also led to interest decrease. Such cases are found in at least the four provinces of Hubei (湖北), Shannxi (陕西), Sichuan (四川), and Yunnan (云南). For example,[227] under the reign of Emperor Jiaqing, Xu Xin, the provincial leader of Shannxi tried to "persuade" local pawnshops into lowering their interest rates from 3% per month to 2%, which was a common level for pawnshops in other provinces. However, the money lenders followed his instruction only for three months, and then the rate rebounded to the original level. Then the owner of a multi-provincial pawnshop, Mr. He, decided to help. He had 30 pawnshops, 8 of them were in the Shannxi province, which first lowered the interest rate to 20% per year. Thus, he broke the market equilibrium among local pawnshops. Other pawnshops in the game had to either follow, or lose their position in the competition, as poor people on hearing this all chose Mr. He's for pawn. In few months, some 800 pawnshops in 40 counties nearby all lowered their interest rates to the annual rate of 20%. This movement saved interest payment of some 400,000 strings of coins for local people. Shannxi was located in north-western China, a less developed province compared with south-eastern areas of China. So was Sichuan and Yunnan. If competition-driven interest decrease happened in these regions, we may assume such cases were not unique for the whole country.

Consequently, by the end of dynasties, the development of the traditional Chinese financial system "paralleled that of preindustrial Europe in its complexity and sophistication. There were numerous intermediaries, from local money changers and pawnshops to large institutions with full-flung networks of branches or correspondents. The variety of services available was similarly broad, ranging from deposits, exchange, currency transfer and loans, available through small institutions, to large interregional transfers and the financing of long-distance trade, which was offered by larger firms."[228]

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[227] Xing 方行 Fang, "清代前期农村的高利贷资本(Usury Capital in the Countryside of the Early Qing Period)," *清史研究 (Historical Research on the Qing Dynasty)* 3 (1994): 18.
[228] Rawski, "Banking and the Monetary System.", 120, 126.

Such financial development probably contributed to transaction convenience and capital-cost reducing.

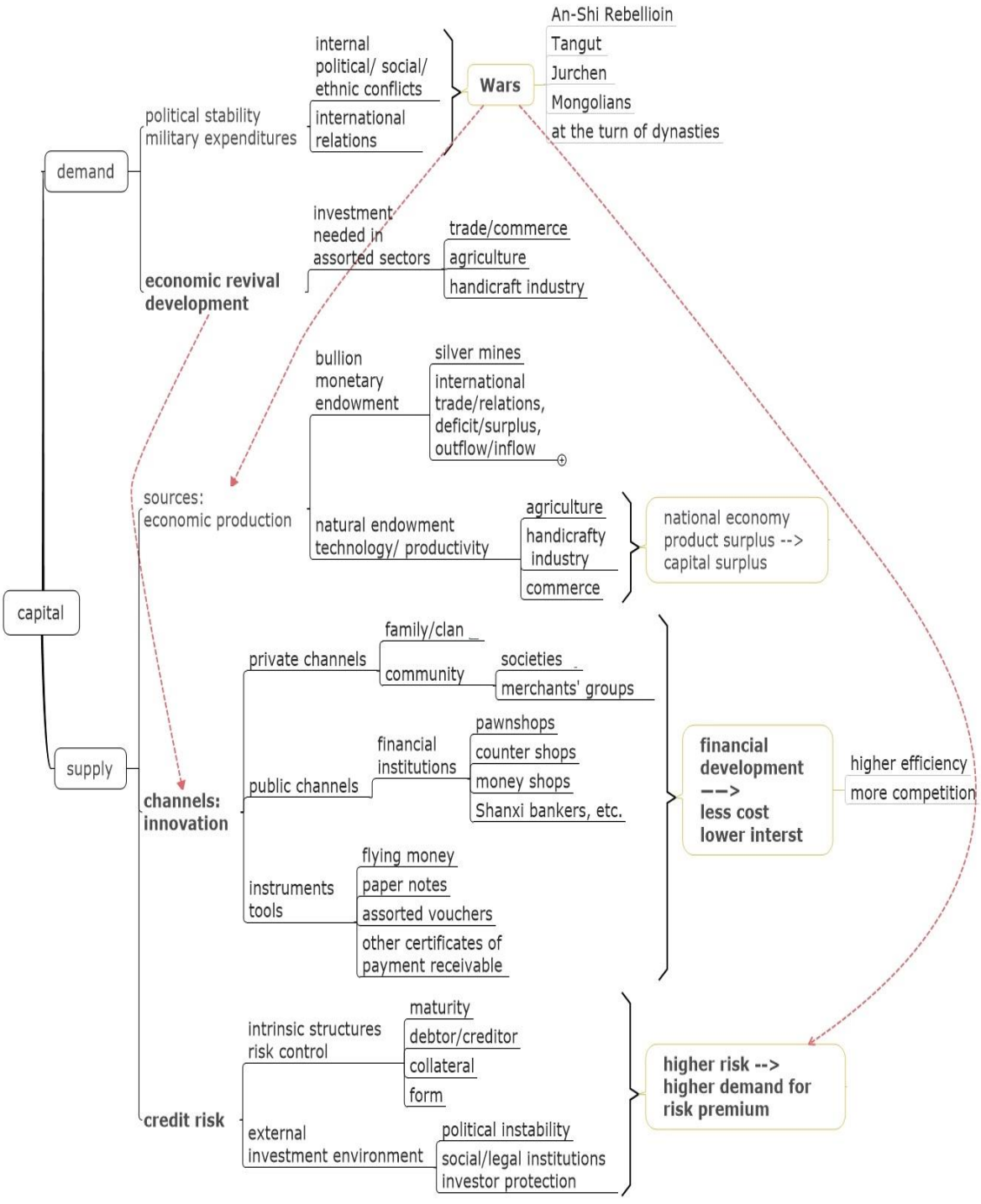

Figure 21 A Framework of Interest Rate Determination

Source: the figure is drawn from historical analysis above. It identifies some key factors, and places them into an analytical framework of capital demand and supply to

show how they affected interest rates in history.

In short, qualitative evidence in the corresponding historical periods above supports the empirical trend of time coefficients to an extent. Overall, peaks and troughs of the interest rates often chime in with dynastic ups-and-downs. Times of peace and prosperity, such as the Tang, the Song and the Ming dynasty, often witnessed declining interest rates, whereas times of crisis and wars saw the opposite. Specifically: social, political and economic conflicts led to political instability and wars that increased investment risks and risk premium, hence higher demand for interest return; economic revival and development created demand and drive for financial innovation in institutions and instruments, hence lower financial costs. Thus, it can be seen that political economy was closely intertwined with financial markets and interest rates.

1.5 Conclusion

Chapter I, Paper I studies interest rates that are scattered over more than 600 localities in 6th-20th century China. It presents their sources and quality, illustrates their distribution in time and space, and analyses their patterns and structural determinants.

Overall, the interest rate level decreased in the markets under study here, with interest fluctuations in pace with dynastic cycles of up-and-down. Economic boom tended to spur commodity and capital flows, provoke financial development and lower financial cost; and vice versa. Significant historical events, such as military and political conflicts, also affected interest rates, but mostly with temporary shocks.

More detailed findings concern loan features and how they affected interest rates. Intrinsic loan features such as maturity, creditor type and currency form, all had a significant influence on interest rates. Loans with the longest maturity cost the least in

interest payments; interest rates of modern banks were generally lower than those of traditional financial institutions; among financial institutions' interest rates, the highest rate came from pawnshops; among personal transactions' rates, commercial loans between merchants cost less than those between friends and relatives; regarding credit form, grain loans cost the highest interest payment, followed by paper notes, copper coins, silver/copper dollars and silver tael; with reference to the amount of principal, the smallest amount cost the most return rate.

With all these intrinsic attributes controlled for, lowest interest rate levels are found for the present dataset. There are ups-and-downs in-between centuries and dynasties. The two interest rate troughs are found around the 9th-11th century of the Song dynasty and the 19th century of the late Qing period. The findings suggest that the Song dynasty might be comparable with the eve of China's industrialisation regarding financial market development. In this sense, the evidence supports the Tang-Song transition school from a financial perspective.

Admittedly, the discussion above is based on time coefficients of the dataset under study here. We cannot exclude the possibility that new evidence found about more markets and years in China may tell slightly different stories. However, qualitative evidence in history also supports the empirical findings to some extent. At least, observations above can shed some light on the time trend and determinant structures of the present dataset. More analysis on their spatial features and market interplay is presented below in Part II.

Part II.

Financial Integration in Late Imperial China

The preceding sections pave way to Part II:

- The Introduction gives a theoretical background to the concept and literature review of market integration;
- Part I provides a historical background of data and of financial developments.

Following those sections, Part II focuses on financial market integration in Late Imperial China (see Appendix 2 for details of Chinese historical periods). Chapter 2 gauges pair-wise financial integration during the 18th -20th century with time-series methods; Chapter 3 explains overall integration among multiple provincial markets on 57 cross-sections (years) scattered over the Ming-Qing period (14th-20th century).

Chapter 2 Regional Integration in the 18th-20th Century

An interest rate shows where capital supply meets its demand in a certain market at one particular point in time. It does not inform us about the dynamic process of convergence or divergence during a historical period (between two or among multiple sub-markets); neither does it illustrate the speed of market adjustment or volume of capital flows. These questions fall into the field of financial integration analysis. Regarding these two aspects, Chapter 2 gauges pair-wise integration in China, applying time series methods on interest rate data from the 18th to 20th century.

2.1 Time-series Methods

The two aspects of financial market integration to be gauged are:[229]

- market convergence, which denotes interest rate differentials, illustrating how large interest rate gaps between two financial markets were;
- market efficiency, which indicates how quickly traders in different markets could eliminate interest rate gaps by arbitrage, namely, adjustment speed in an arbitrage process.

Market convergence is the result of the arbitrage process, thus partially subject to market efficiency.

The methods employed to measure the two aspects above are an Error Correction Model (ECM) and a Threshold Autoregression Model (TAR). In what follows, we justify the model choices and explain their estimation strategies. We start with the Error Correction Model.

"In the short run, market disruptions may result from shocks such as the weather or war, which lead to a departure away from the long run (transaction cost adjusted) equilibrium or price-gap."[230] If there is a long-run relationship between the two markets, the shocks

[229] The two concepts below are based on standard practice in the literature of this research field. For example, see Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy."

[230] See Victoria N. Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price," *Discussion Paper Series, Department of Economics,University of Oxford* 350 (2007), 6-7. Although she was talking about European grain market and grain prices, the mechanism goes for financial markets too. Particularly, on the financial market temporary shocks are most commonly seen based on information transmit. A piece of news can

that makes price ratio deviate from equilibrium are only temporary. Price differentials will be arbitraged away sooner or later. The higher the integration level is, the faster the deviation will be "corrected". To capture such an adjustment process between two markets, many researchers[231] in this field use an error "correction" approach (explained below). This study, because of little chance to construct a perfect panel of interest rate data, aims at estimating China's pair-wise financial market integration. Therefore, we adopt a similar approach here.

Considering that the interest influence was mutual, we set up a model of two equations: Equation (1) uses past prices of Market 1 (at time t-1) to explain current prices of Market 2 (at time t); in Equation (2), the working mechanism is reversed. The first step is to estimate the following two equations with a robust regression.[232]

$$\Delta \log P_{1,t} = \theta_1 (\log P_1 - \log P_2)_{t-1} + c_1 + \varepsilon_{1,t} \quad (3.1)$$

easily shake or build investors' confidence overnight. Short-term fluctuation in financial prices can be a lot greater than that on commodity prices.

[231] Giovanni Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870," *Working Papers HEC, of Department of History and Civilization, European University Institute* 1 (2008), 7.

Persson, *Grain Markets in Europe, 1500–1900 Integration and Deregulation*.

Michael Kopsidis, "The Creation of a Westphalian Rye Market 1820-1870: Leading and Following Regions, a Cointegration Analysis," *Jahrbuch Fur Wirschaftsgeschichte (Economic History Yearbook)*, 2002, 85–112.

Kloveland, "Commodity Market Integration 1850-1913: Evidence from Britain and Germany."

Trenkler and Wolf, "Economic Integration across Borders: The Polish Interwar Economy."

Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price."

Jean-Francois Richard and David F Henry, "The Econometric Analysis of Economic Time Series," *International Statistic Review* 51 (1983): 111–63.

David. F. Hendry, Adrian. R. Pagan, and J. Denis. Sargan, "Dynamic Specification," in *Handbook of Econometrics*, ed. Z. Griliches and M. D. Intriligator (Amsterdam: North-Holland Publishing Co., 1984).

Colin Thirtle and David Schimmelpfennig, "Cointegration and Causality: Exploring the Relationship Between Agricultural R& D and Productivity," *Journal of Agricultural Economics* 54, no. 2 (1994): 220–31.

B. W. Trotter, *Applying Price Analysis to Marketing Systems: Methods and Examples from the Indonesian Rice Market* (London: Natural Resource Institute, 1991).

Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900."

For more detailed literature on statistical methods of market integration, please refer to Appendix 8.

[232] This model is estimated with a robust regression in STATA 11. Specifications of the error correction model make "all the parameters in equations (1) and (2) are unrelated so that the equations can be estimated by simple OLS regressions."(Studer (2008), pp.102). Still, to deal with those potential problems, there are two options: GLS (generalized least square) regression and robust regression. GLS estimation is most efficient if the structure of the covariance matrix of the disturbance vector is clarified, of which, however, we are not sure. Hence, again we take the robust regression method in STATA 11, which allows for the potential problems of heteroscedasticity and auto-correlation to be corrected. For more references, please see: R. Andersen, *Modern Methods for Robust Regression*, *Sage University Paper Series on Quantitative Applications in the Social Sciences* (CA: Sage: Thousand Oaks, 2008), 7-152. And Stromberg, "Why Write Statistical Software? The Case of Robust Statistical Methods."

(3.2) $$\Delta \log P_{2,t} = \theta_2 (\log P_2 - \log P_1)_{t-1} + c_2 + \varepsilon_{2,t}$$

C_1 and C_2 are the constant term. P_1 and P_2 stand for interest rate levels on two markets. The explanatory variables are $(\log P_1 - \log P_2)$ and $(\log P_2 - \log P_1)$, namely, logged interest rate gaps between the two markets. Δ means first differences. The dependent variable is first differences of logged interest rates (rather than levels), the data form[233] of which can help address the potential problem of non-stationary series.

ε_1 and ε_2 are the error terms. The correlation between them, defined as ρ, is an indicator of convergence level between the two markets, a positive measure of financial integration. ρ is expected to be normally distributed with a mean of 0. The larger the absolute value of ρ is, the more closely correlated these markets are.

θ_1 and θ_2 are the regression coefficients of $(\log P_1 - \log P_2)$ and $(\log P_2 - \log P_1)$. They show the speed of adjustment after a shock– the percentage of interest rate gap at time *t-1* which has been corrected in one period by time t, but on each market respectively. To combine their adjustment effect and cancel out their mutual influence, hence, the second step is to estimate the marginal model below,[234] which contains the residuals from step 1 as the error correction component.

(3.3)

$$(1) - (2): \Delta \log P_{1,t} - \Delta \log P_{2,t} = (\theta_1 - \theta_2)(\log P_1 - \log P_2)_{t-1} + (c_1 - c_2) + (\varepsilon_{1,} - \varepsilon_{2,t})$$

The regression coefficient $(\theta_1 - \theta_2)$ is here defined as γ, indicating the total adjustment

[233] Stationary data is a pre-requisite for most time-series analyse. Non-stationary data means there is a trend in the interest rate series. Namely, shocks are permanent and can not be arbitraged away. Thus, there is no need to further gauge convergence or integration level between the two markets under study. However, differences in the logged variables can help address the potential bias from non-stationarity of interest rate series used here. For example, see Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900", 102.

[234] Ibid., 103.

speed in arbitrage between the two markets. If γ is significant[235] and negative, the two markets are adjusting towards each other until their interest rate gap is zero; and the larger the absolute value of γ is, the faster the mutual adjustment process fares.

The ECM approach examines how two markets adjust towards each other. However, it neglects the issue of transaction cost. It assumes that the adjustment process follows a linear pattern, namely, arbitrage will continue all the way until the price gap between the two markets is zero. This complies with the assumption of Law of One Price in an ideal world, where there is no transaction cost; and the equilibrium of the two markets is at the point where the price of Market 1 equals that of Market 2. However, transaction costs are ubiquitous, which, if exceeding the profit of arbitrage, would stop further adjustment movement of the markets. Thus, the ECM estimation on adjustment speed may be biased because it "over-corrects" the price gap.[236] Transaction cost defines the "nonlinearity"[237] in the market adjustment process, including the financial markets.[238] To capture the non-linearity in the adjustment process, many scholars have employed a non-linear strategy in their market integration research. This is where the Threshold Autoregression model (TAR)[239] comes in, which, for example, has been widely used in exchange market integration.[240]

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[235] The critical value of DF-test on a 95% level of confidence here is -2.86 (one-sided). If the DF test result exceeds this value, the hypothesis that $\gamma = 0$ is rejected, and the value of γ is significant.

[236] Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870", 7.

[237] Oliver Volckart and Nikolaus Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?," *Journal of Economic History* 66, no. 1 (2006): 129.

[238] Non-linear price movement is found about optimal hedging; also, local cash prices are likely to be nonlinearly related to the futures' price because of the spatial component; real exchange rates and interest rates present a feature of non-linear behaviour pattern too. For more references, see Yong Sakong, Dermot J. Hayes, and Arne . Hallam, "Hedging Production Risk with Options," *American Journal of Agricultural Economics* 75 (1993): 408–15. F. Bec, M. Ben-Salem, and M Carrasco, "Tests for Unit-Root versus Threshold Specification with an Application To The PPP," *Journal of Business and Economic Statistics* 22, no. 4 (2004): 382–95.

[239] The TAR model was originally introduced by Tong, developed by Tsay, and finally transformed into an Error Correction form by Balke and Fomby. See

H Tong, *On a Threshold Model in Pattern Recognition and Signal Processing*, ed. C Chen (Amsterdam: Sijhoff and Noonhoff, 1978).

R.S. Tsay, "Testing and Modeling Threshold Autoregressive Process," *Journal of American Statistical Association* 84 (1989): 231–40.

N. S. Balke and T. B. Fomby, "Threshold Cointegration," *International Economic Review* 38, no. 3 (1997): 627–45.

[240] Canjels, Prakash-Canjels, and Taylor, "Measuring Market Integration: Foreign Exchange Arbitrage and the Gold Standard, 1879-1913."

Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?"

As complement to and robustness check against the ECM outcome, this paper also employs a three-regime TAR model (as shown below in Equation 3.4). The model features a band of equilibrium defined by "interest points", namely, transaction cost in capital transfer, as illustrated below.

$$(3.4)\qquad \Delta x_t \begin{cases} (x_t = p_i - p_j) \\ = \alpha(x_{t-1} - T_{ij}) + \varepsilon, if : x_{t-1} > T_{ij} & \text{(Regime 1)} \\ = \varepsilon, if : |x_{t-1}| \le T_{ij} & \text{(Regime 2)} \\ = \alpha(x_{t-1} + T_{ij}) + \varepsilon, if : x_{t-1} < -T_{ij} & \text{(Regime 3)} \end{cases}$$

x_t is the interest rate gap between two markets at the time t; Δx_t is the change of interest rate gap. T_{ij} and α are the parameters to be estimated. T_{ij} is the interest points, defined by transaction cost as percentage of the interest rate, hence a negative measure of financial integration. The larger T_{ij} means the higher transaction cost, thus the larger divergence and the lower integration level between the two markets. α is the adjustment speed (explained below)

- When x_t falls into Regime 2 ($-T_{ij} \le x_t \le T_{ij}$ or $|x_t| \le T_{ij}$)

  The interest rate gap falls within the interest points; transaction cost exceeds the interest rate gap. Hence, there is no room for arbitrage profit. In this sense, this regime is a band of equilibrium, or a "neutral band of divergence",[241] where there is no arbitrage to narrow the interest rate gap and x_t moves randomly "like a stationary disturbance term".[242]

Peter Kugler, "Financial Market Integration in Late Medieval Europe: Results from a Threshold Error Correction Model for the Rhinegulden and Basle Pound 1365-1429," *Working Paper, University of Basel*, 2009, 1.

[241] Barry K. Goodwin and Nicholas E. Piggott, "Spatial Market Integration in the Presence of Threshold Effects," *American Journal of Agriculture Economics* 83, no. 2 (2001): 302.

[242] Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?", 132.

- When $x_t > T_{ij}$ (Regime 1) or $x_t < -T_{ij}$ (Regime 3)

  The interest rate gap falls outside the interest points; the interest rate gap exceeds the transaction cost. In other words, transaction cost for one market (say, Market 1) to adjust towards the other (Market 2) is covered by its profit. Hence, there is opportunity for traders to arbitrage until there is not more room for profit.[243] In this process, the movement of x_t follows a linear trend of decreasing.

  The further away is the gap from the interest points, the higher is the adjustment speed.[244] The speed is denoted by the parameter of α, which ranges from -1 to 0 (with -1 indicating perfect integration and 0 no integration). α can be interpreted with a half-life time,[245] which shows the time needed for half of the deviation from the equilibrium band to be eliminated.

- If for any reason x_t exceeds the interest points T_{ij} once again, a "regime switch"[246] process will be triggered, which means arbitrage will resume pushing x_t back to Regime 2. This is where the TAR model captures the non-linearity in market integration.[247]

Before running the model, a hypothesis test shall be done about x_t to confirm that it is stationary. As discussed above, integration and convergence mean that deviation from

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[243] In other words, market agents have access to information from past prices, so that they can have necessary information to make decision about arbitrage. But meanwhile, if they can have all the related information, there will be no room for arbitrage left, because once any chance appeared, it would be seized and price gap filled immediately (which makes a perfect free market, but which cannot possibly happen in the real world). In this sense, market conditions required of the TAR framework is a weak or semi-weak form of Efficient Market (as in the EMH or efficient market hypothesis of Fama discussed earlier in the footnote). For more related discussion see Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy.", 295.

[244] David Chilosi and Oliver Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520," *Journal of Economic History* 71, no. 3 (2011): 789.

[245] A half-life index is defined as $\frac{\ln(0.5)}{\ln(1+\alpha)}$, where α is the adjustment speed index produced by the TAR model. See Goodwin and Piggott, "Spatial Market Integration in the Presence of Threshold Effects", 308.

[246] Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy.", 295.

[247] See: Maurice Obstfeld and Alan M. Taylor, "Nonlinear Aspects of Goods Market Arbitrage and Adjustment: Heckscher's Commodity Points Revised," *Journal of the Japanese and International Economies* 11 (1997).
Canjels, Prakash-Canjels, and Taylor, "Measuring Market Integration: Foreign Exchange Arbitrage and the Gold Standard, 1879-1913."
Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?"

equilibrium will sooner or later induce adjustment back towards equilibrium. But a continuous trend of deviation in non-stationary series is "incompatible" with the analytical framework of TAR.[248] Thus, an ADF test is used to test x_t for a unit root and exclude a non-stationary series.[249] If this assumption is validated, we can then proceed to run the TAR model. The model can be estimated by the Conditional Least Square regression（CLS）method.[250]

One thing to note is that the TAR model assumes that the threshold maintains the same; whereas in the actual world transaction costs varied in time. For instance, it would decrease as the means of communication and transport improved over time. However, it is difficult for the study to find a pair of market series whose data matched for over decades or a century. In a relatively short historical time, we may assume that the transactional conditions held the same and the costs were constant. Besides, given the large sample, it is reasonable to think that the ratio of market pairs that experienced changing transaction cost is small. Hence, varying transaction cost should be no large concern here.

To sum up, this paper will combine an ECM with a TAR model. Five integration measures will be produced. T_{ij} is the static threshold (hereafter written as τ in the empirical result), exceeding which triggers arbitrage. It illustrates bilateral divergence based on transaction cost. ρ indicates the level of binary correlation. γ and α (with its ensuing half-life h) explain the efficiency of market integration, namely, how fast the

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[248] Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?", p.131.

[249] Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?", 132.

Goodwin and Piggott, "Spatial Market Integration in the Presence of Threshold Effects.", 306.

[250] The regression can be done in two stages. In the first stage, the threshold or points of regime switch is estimated, assuming transaction costs are symmetric. In the second stage, parameters of the non-random-walk regimes are estimated with an ordinary least square regression. For examples and more details, please see:

Canjels, Prakash-Canjels, and Taylor, "Measuring Market Integration: Foreign Exchange Arbitrage and the Gold Standard, 1879-1913.", 868-882.

Volckart and Wolf, "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?", 133.

Thanks a lot to Dr. Van Campenhout Bjoern (University of Antwerp) for his kind help with the STATA program to run the TAR model.

two markets adjusted towards each other.

To understand these measures in a historical context, an example of two-market integration is given below. We take the case of Ningbo-Shanghai as a pilot study. They provide high-quality time-series data of a monthly frequency from Jan. 1932 to Dec. 1937, with no need to interpolate. Hence, we proceed to gauge their integration performance resulting from the historical process above. To test for the prerequisite of the TAR model, firstly, we run an ADF test on the series of interest differentials between these two markets.

Table 6 ADF test on Interest Differentials between Ningbo and Shanghai

```
. dfuller deviation

Dickey-Fuller test for unit root                   Number of obs   =        71

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical         5% Critical        10% Critical
               Statistic           Value               Value              Value
------------------------------------------------------------------------------
 Z(t)           -7.496             -3.551              -2.913             -2.592
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

Data source: own dataset of annual interest rates (interest payment for a year) at a monthly frequency, raw data without interpolation.

The test-statistics of X_t the deviation series is -7.496, which exceeds the critical value of -3.551. According to the outcome table, it rejects the hypothesis of unit root. This means X_t is stationary at a significant level of 1%. Then we run the models in STATA 11 and get the following results.

Table 7 Integration between Ningbo and Shanghai, monthly data

Ningbo-Shanghai, 1932.01.-1937.12.

	Coefficient	t-stat.	Prob.-value	Adjusted R-squared of the model
ρ	0.51			0.2
γ	-39.0%	-2.92	0.028	(ECM)
τ(%)	0.72			
α	-98.4%	-5.33	0.000	0.4863
half-life (month)	0.17			(TAR)

γ, α significant at 95% confidence level

The correlation level ρ was 51%, which was strong enough a sign of correlation between the two markets. However, note that ρ alone is not sufficient to denote financial integration. The similarity between the two interest rate series can be the spontaneous result of two independent markets, without arbitrage between the markets. Namely, they just happened to be correlated, without capital flow in-between. In case of that, we need to check if there existed arbitrage adjustment. A negative adjustment speed suggests there were arbitrage activities between the two markets. γ the adjustment speed means that in any given time unit (here in this case, a month), 39% of the interest rate gap between the two markets was eliminated.

The adjusted R^2 of the TAR model (0.48) surpasses that of the ECM model (0.2), suggesting the former fits the case better than the latter. Considering transaction costs, as indicated by α and its ensuing h, it took only 0.17 month (about 5 days) for half of the interest deviation from the threshold (namely, bounds of transaction costs) to disappear. This speed of adjustment suggested to an extent that the two markets were efficiently connected.

Besides, τ between Ningbo and Shanghai was 0.72. It means the arbitrage process

would not start until the interest rate in Ningbo was different from that in Shanghai by more than 72%. Although 72% seemed quite a high level of interest deviation, it might not be the case if we consider the unit of an interest rate itself. An interest rate was recorded by 1% of the principal amount. If a lender in Shanghai had 1 dollar for investment, once the interest rate in Ningbo increased by 0.72%, namely, an extra return of 0.0072 dollar, he would happily lend his 1 dollar to anyone in Ningbo – arbitrage started or triggered by 0.0072 dollar.[251] In short, combining the measures above, it may be drawn that the financial market of Ningbo and that of Shanghai were well integrated.

The case above, however, focuses only on the regional financial integration in the lower Yangtzi area in a short period. We now move to a larger picture of all market pairs[252] available in a longer period of 18th-20th century of China.

2.2 Statistic Description, Market Selection and Data Quality

2.2.1 Data Description

The following part presents descriptive statistics of the dataset studied for pair-wise integration in this chapter. Data series under study here is of annual frequency. The time spans 1709-1952.

[251] Using lower-frequency data, namely, annual data instead of monthly data, will probably enlarge τ because statistically, the price or interest rate gaps accumulated in a longer period such as a year tend to be larger than that in a month.

[252] Data of these market pairs are processed in the same way as Ningbo and Shanghai above. But only those whose model results are statistically significant are summarized, as discussed below.

Table 8 Descriptive Statistics of Individual and Institutional Interest Rates

	Institutional Rates	Individual Rates	total
observations	16391	7866	24257
mean (%)	30.58	45.21	
median (%)	11.88	25.00	
max (%)	10800.00	36000.00	
min (%)	0.00	0.00	
standard deviation	139.64	432.17	

Data source: own dataset, raw data, annual rates, 1709-1952

Institutional data account for the majority of this data sample, which is about 67.5%, while that of individual data around 32.4%. In general, the individual loan (with a mean interest rate at 45%) cost higher interest rates than the institutional loan (with a mean at 31%). Without deleting outliers, both individual and institutional loans show a wide range of variation. Individual rates feature even much larger gap between the max and the min, and are of much greater fluctuation (higher level of standard deviation). The minimum level of both types of interest is zero. This is probably because of the following two reasons. On one hand, free-charge loans were commonly seen between individuals in rural areas, if the creditor and the Debtor had been in a close and good relationship.[253] On the other hand, according to the raw data collected from Shanghai inter-bank market in the 19th and 20th century, the inter-bank rate was often quite low, sometimes even closed to or equalled zero since most of them was an overnight deal. To have a closer look at data distribution of the two types of interest rates, the paper presents the following figures.

Historical distribution of the whole dataset is also given by type: institutional data and individual data. And in each type, the number of observations in a year is shown by two

[253] In collecting raw data from archives of contracts, the author found quite some examples of zero-interest loans (. Besides, actually zero-interest credit among family members and relatives are still quite often today in China. However, there might be hidden cost in "asking for a financial favor" or maintaining the relationship, such as a dinner. Or, a hidden interest return might be recorded in the contract in the form of a revised amount of principal, which was actually higher than the volume of capital loaned.

periods: the 18th – 19th century, and the 20th century. This is because the number of observations increased to a larger scale in the second period.

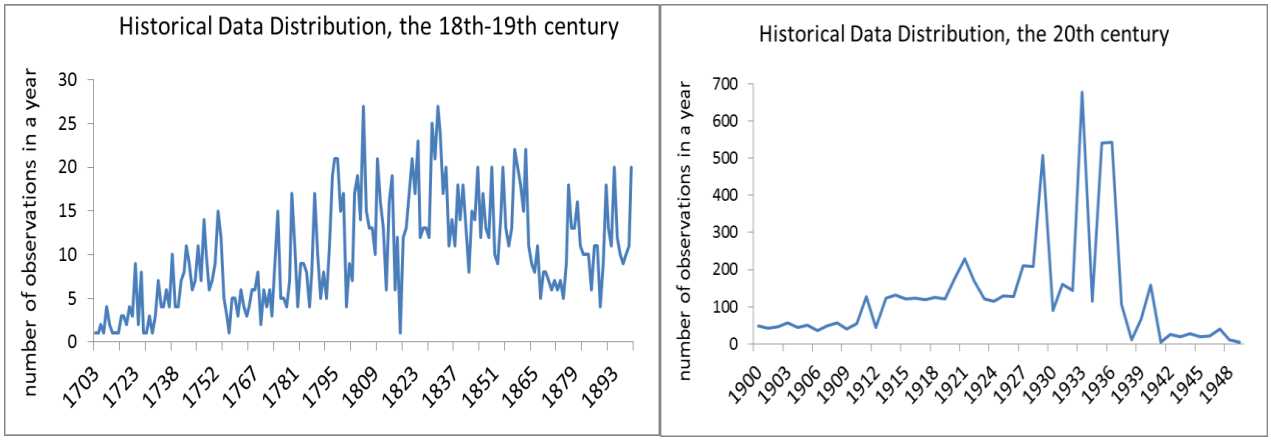

Figure 22 Historical Distribution (Individual Data, the 18th-20th century)[254]

Source: Own dataset. Based on annual aggregate of markets available.

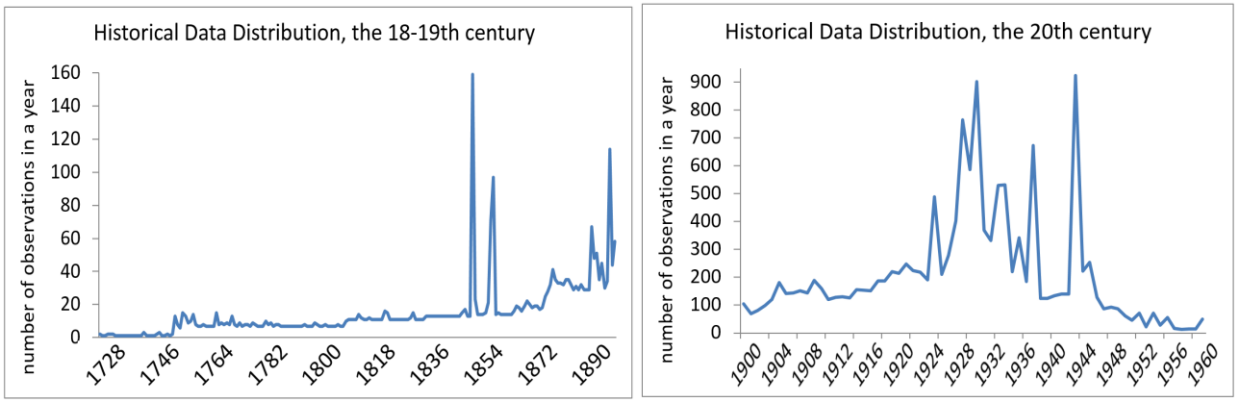

Figure 23 Historical Distribution (Institutional Data, the 18th-20th century)

Source: Own dataset. Based on annual aggregate of markets available.

Considering spatial distribution, the whole dataset is scattered over more than 600 markets scattered over 24 provinces[255] in a pattern of uneven distribution. Many of them

[254] The data distribution in time is divided into 2 parts of figures because the number of entries for each period is on a different scale from each other: during the 18th to the 19th century, the entry number is below 100, whereas in the 20th century the number can range from 100 to more than 600. Putting these numbers in one figure will make the numbers in the 18th to the 19th century barely observable, hence the two figures above.

[255] This paper employs as benchmark the geographic layout of the 1820 province division to define and compare its integration results. The provincial boundaries are as of the year of 1820, when Taiwan was still part of the Fujian

present only one or few entries, hence it does not make much sense to map them all out. From a geographical dimension, north-eastern China, the coastal area and traditional economic powers in the east account for most data. Unfortunately, many markets are dropped because of the gaps in their series. The map below presents only 91 of all the markets, which for this chapter's analysis produce time series data spanning a period from 1709 to 1952.

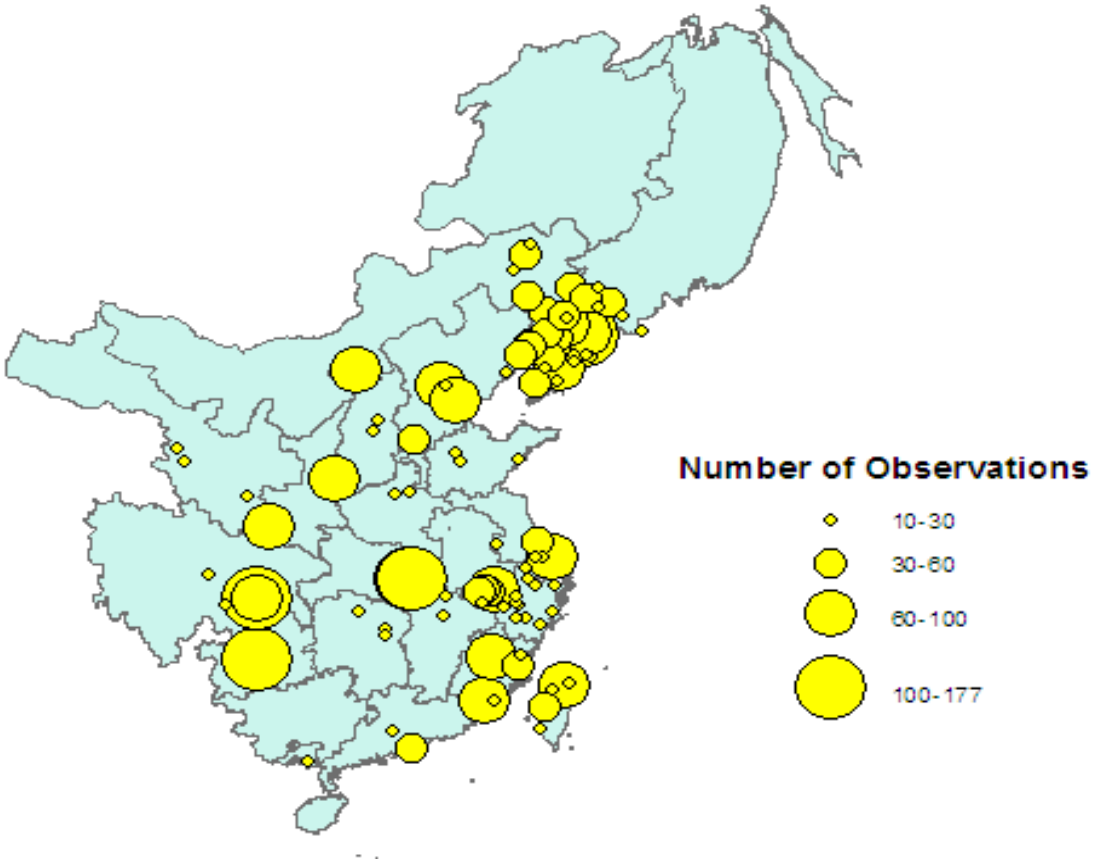

Figure 24 Spatial Distribution (1709-1952)[256]

Notes: Before interpolation; based on annual average of all data in a year at a single market; Source: Own dataset. [257]

province. These provinces/regions are: Jiangsu, Hunan, Hubei, Sichuan, Hebei, Zhejiang, Suiyuan/Inner Mongolia, Dongbei(Northeast China area, including Heilongjiang, Jilin, Liaoning), Ningxia, Gansu, Shaanxi, Shanxi, Shandong, Anhui, Henan, Yunnan, Guizhou, Jiangxi, Fujian, Canton, Guangxi, Qinghai, Taiwan, and Xinjiang.

[256] Time-series analysis later will be based on these 91 markets, but only on data from the 18th to the 20th century.

[257] The map is downloaded from website of The China Historical Geographic Information System, or CHGIS (Version 4 Data Archive) (with funding from Henry Luce Foundation and National Endowment for the Humanities, and with assistance from Harvard Yenching Institute and Harvard Asia Center.)

2.2.2 Market Selection

Giovanni Federico thinks a series can be retained "if it features at least three quarters of observations".[258] Given the dataset in hand, to maintain more markets in the sample means to interpolate more data gaps; but when the interpolation ratio exceeds a certain percentage, the credibility of empirical analysis is seriously undermined. This study set the threshold of data gap at 9%.[259] A data series of a market is kept if it supplies no less than 91% of observations over the period under investigation; otherwise, it is dropped. And because it is very difficult to find a continuous time series at a market across centuries, the length of the period has to be shortened, even to about a decade where applicable.

What is more, to be used for pair-wise analysis here, a market needs to find a match. In other words, it needs a counterpart market that shares a period with it. In doing so, there are two difficulties. Firstly, the time span covered by the individual market series varies a lot. Some of them simply do not share any common years at all; the years of many other series do overlap, but not for a long enough period to do time-series estimation. And secondly, some markets present institutional rates or individual rates only. Again, to avoid comparing apples with pears, institutional series can only be paired up with institutional rates, and vice versa. This requirement also dropped some market series.[260]

Then the selected series were interpolated to fill the gaps of missing data. The interpolation approach is a State Space Model of structural time-series analysis.[261] The model (as shown in Appendix 1) consists of an explanatory factor of trend and that of a cycle. Compared with conventional approaches of linear or spline interpolation, it can

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[258] Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870", 21.

[259] This paper tends to be more rigorous, thus interpolates the dataset to a minimum extent that allows the dataset to work for the model. Admittedly, 9% is still a bit high of interpolation, and it is expected that the sample quality and analysis outcome may not be as strict as a sample with interpolated data under 1% or 5%. But this is the best balance this study can reach between the interpolation rate and market coverage, and the best we can do given the data availability in Chinese financial history. We will also have some robustness check based on outcome comparison between different sample sets.

[260] In addition, for the TAR estimation mentioned above, a hypothesis test shall be done on the interest gap of the two markets to rule out the non-stationary series.

[261] The interpolation is run by the STAMP program in the software pack of OxMetrix. For further details of the model, please refer to Appendix 1.

better resemble the cyclical movement and fluctuation of interest rates,[262] thus producing less bias from and maybe even allowing for higher ratio of interpolated data. As a result, the proportion of interpolated data in the dataset used here is limited to about 9%. This sample is hereafter referred to as Sample 1.

Given the nature of interpolation techniques, certainly, bias is expected to arise from the interpolated data. To test the robustness of the analysis on Sample 1, another sample set (with 15% of interpolated data) is also produced, which is hereafter referred to as Sample 2. Comparing their outcomes may serve as a robustness check. If the output of the different sample groups share a similar pattern, the results are likely to be robust.[263]

This way, the paper derived 125 time-series, 55 of which are individual transactions and 70 of which are institutional rates. Some of the 91 markets produce both a series of institutional rates and a series of individual rates. These series are of different lengths depending on the locality. But overall, they span various periods during 1709-1952. The choice of time spans is mostly data-driven, for which this chapter has to leave out many data scattered over earlier centuries. Still these periods (as shown in the table below) reflect the change of some significant times, and political economy during these centuries.

[262] G.S. Maddala and In-Moo Kim, *Unit Roots, Co-Integration, and Structural Change* (Cambridge: Cambridge University Press, 1998).

[263] Similar approaches are widely used for robustness check, for example, see Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870", 29.

Table 9 The Markets

Institutional Rates

Century	Period	Number of Years	Number of Markets
the 18th century	Early Qing (1728-1820)	93	7
the 19th century	Late Qing (1821-1910)	90	33
the 20th century	Warlord Era (1912-1926)	16	44
	Nanjing Era (1927-1936)	10	18
	Last Wars (1938-1952)	15	8

Individual Rates

Century	Period	Number of Years	Number of Markets
the 18th century	Early Qing (1709-1822)	114	11
the 19th century	Late Qing (1823-1910)	88	29
the 20th century	Warlord Era (1911-1926)	16	53
	Nanjing Era (1927-1937)	11	49

2.2.3 Data Quality

Here under study are two types of data in line with the two types of sources: those of individual personal transaction, and those of institutional intermediary transaction. (Be noted that hereafter, the concept of institutional rates is not limited to interest rates of modern financial institutions like banks. Transactions made by traditional financial intermediaries such as pawnshops or money shops also contribute to dataset of institutional rates.) The question is: are data of all those sources the same type? Or, can they be pooled together for analysis? On the one hand, institutional data are often town or city-based. Thanks to the book-keeping system of financial organisations, these data were better recorded and are more likely to produce time-series analysis. Accordingly, time-series methods will be applied on (not limited to) them.

On the other hand, individual-transaction data mostly come from personal loans in rural areas and towns. Transactions involved farmers, their neighbours, relatives and landlords, professional moneylenders, community, or a local society, etc. Such deals usually followed Chinese financial tradition with interest going by month. Some urban transactions also happened among merchants or lower class workers, but through their commercial or personal networking rather than bankers or money shops. These data are very scattered among all years and all localities. It is difficult to find among them a long and continuous time series for a certain locality. Thus, to complement the time series

method, spatial integration models[264] will also be employed (in Chapter 3). The spatial models estimate and explain interest rate convergence among multiple markets at a time, thus work for those years when there are no time series but cross-sectional data available.

Statistically, Figure 25 below confirms that institutional and individual data are different types of interest rates. The height of each point in the figures shows how many data is at the interest rate level indicated by the x-axis. Institutional rates peak at an annual rate of some 12%, clustering in a lower range from 0% to 36%. Individual rates peak at about 20%, clustering in a range from 12% to 48%. There is obvious difference in the distribution pattern of their interest frequencies – the interest rate level of the individual type is generally higher than that of the institutional type. This structural difference may suggest that these two types of data should be processed separately.

[264] The spatial integration models are based on test of spatial correlation, as opposed to autocorrelation in time-series. To put it simply, it studies how one region's price is influenced by related conditions of another, or many other regions. For details please see the following references:
Anselin, *Spatial Econometrics: Methods and Models*.
Anselin, "Space and Applied Econometrics."
Cliff and Ord, *Spatial Autocorrelation*.
Goodchild, "Spatial Autocorrelation."
Krugman, "Space: The Final Frontier."

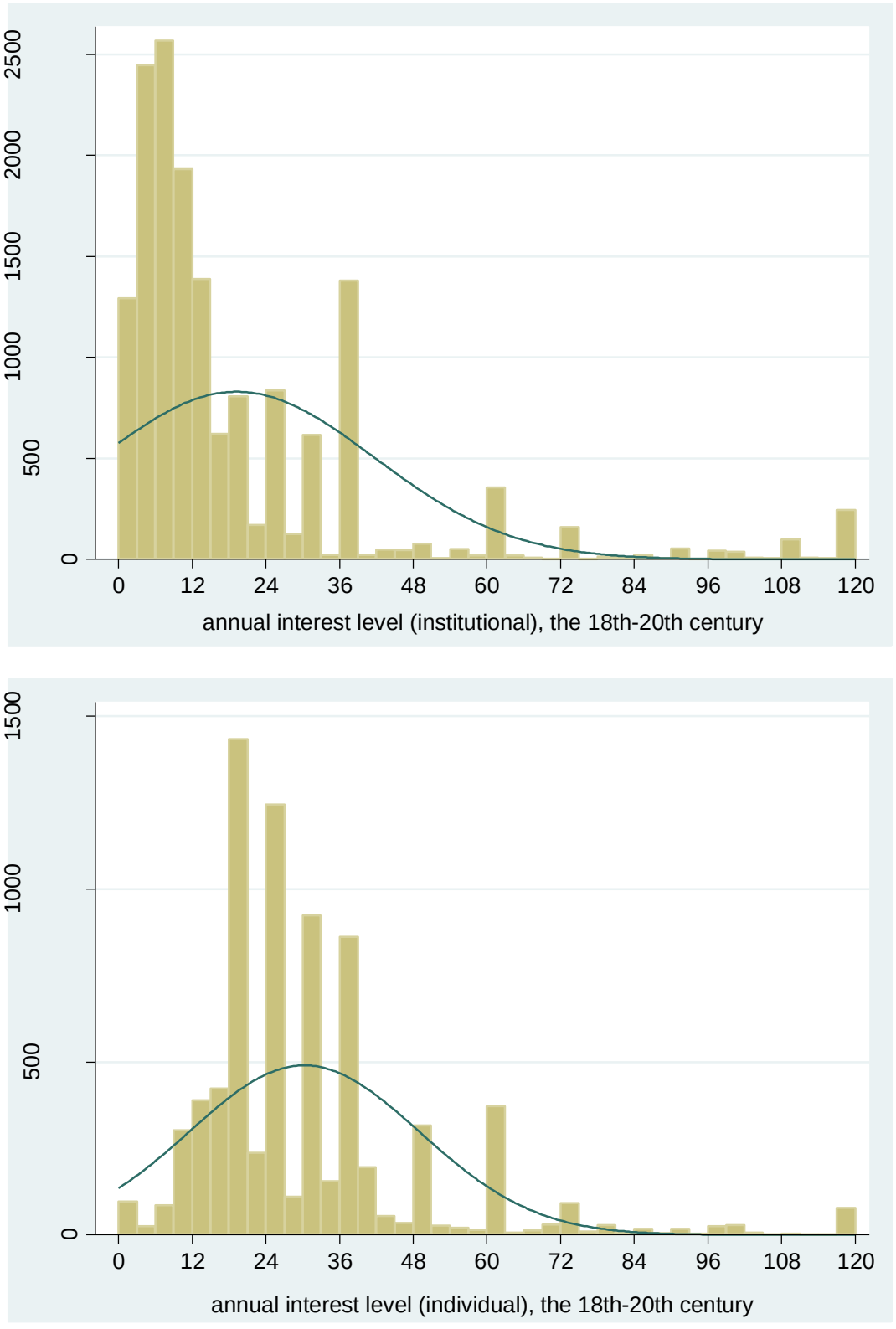

Figure 25 Frequency Distribution of Institutional and Individual Rates

Note: Outliers larger than 120% per year are excluded.

These two types of interest rates are different not only in quantitative distribution, but also in qualitative features (such as capital source, principal amount, form of loan, form of interest, maturity, security, contract enforcement arrangement, and so on). For example, monthly interest rates for annual deposits in two different banks of the same province might be the same; however, two loans between residents of the same village could be quite different. If someone came to a village where he had no relatives, the same annual loan might cost him a higher interest rate than the average or conventional level. The reason is simple: Without a traceable credit history, he was less trust-worthy; without relatives and family root here, he represented a higher risk of default. Even if he could get the loan at the same interest rate, which was a case quite normally seen as well,[265] there could be different transaction details or hidden terms of the contract. He might be required to make instalment at a higher frequency, rather than two times a year. He might also have to pawn his land as mortgage or security. In brief, institutional activities follow relatively standardized business protocols, whereas personal individual transactions are much more flexible, subject to various social economic circumstances.

Regarding these aspects, therefore, institutional and individual data will be processed separately. A series of institutional rates shall be paired only with another institutional series rather than individual rates.

2.3 Empirical Result

This section starts with a robustness check by comparing some key measures estimated from the two samples. Generally speaking, both produce quite similar outputs. Regarding adjustment speed measures overall, the trend line of the 15%-interpolated Sample 2 basically overlaps that of the 9%-interpolated Sample 1, as shown in the following figures. There is slight difference, of course, because in the 9%-interpolation sample more markets are dropped due to the lack of data than in the 15%-interpolation

[265] Peng, Chen, and Yuan, "Jindai Zhongguo Nongcun Jiedai Shichang de Jizhi 近代中国农村借贷市场的机制 (The Mechanisms of Rural Credit Market in Modern China)."

sample. Still, overall we can see the similarity in the output of the two samples.

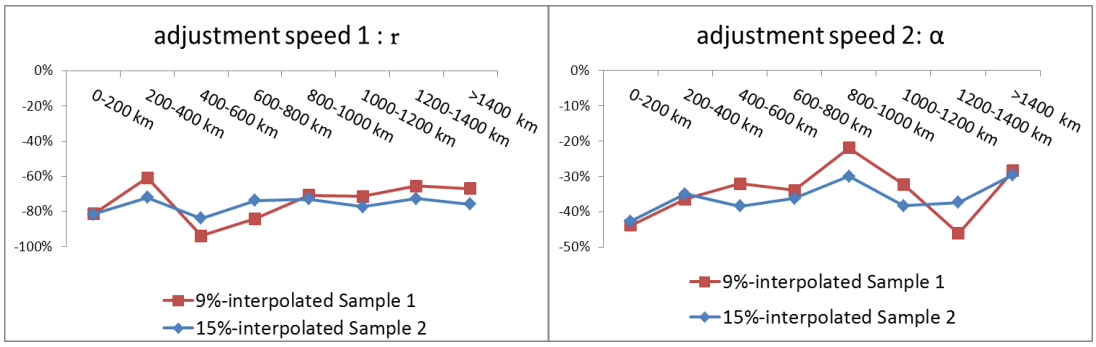

Figure 26 Overall Adjustment Speed across Samples

Each point in the figures is an average of the measure estimated for all market pairs that fall into the distance group in the whole period under study. Again, "r" means in any given time unit (here a year), how much of the interest rate gap between the two markets (in per cent) was eliminated; whereas "a" indicates how much of the interest rate gap till the threshold (determined by transaction cost) was eliminated (in per cent). Further details are given in the explanation to Table 10 below.

Moreover, regarding integration measures on specific time sections, the two samples yield similar trends, too. For example, as shown below the threshold level of the two samples share a similar trend line: it went up first, decreased when the distance surpassed 1,000 kilometres, and increased again when the distance exceeded 1,200 kilometres. Such resemblance also confirms the robustness of the model's estimation to an extent, though the data series are far from perfect.

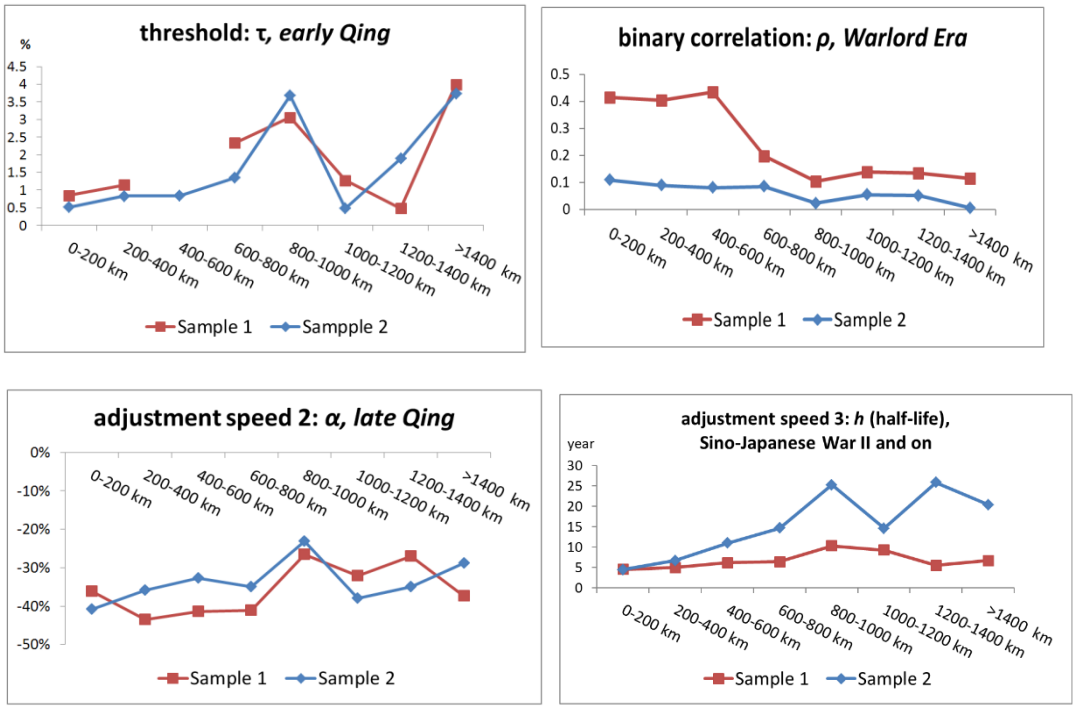

Figure 27 Measures of Integration Degree across Samples

The next part explains in details what these measures mean to financial market integration.[266] Firstly, for a peek at integration of the traditional Chinese economy, we take the early Qing period for a cross-sectional view. The period covered the 18th and early 19th century till the eve of the Opium War (1709-1840), before the economy was shattered, restructured and incorporated into an international economic system by the "western impact".[267] The results of integration measures are described by distance group as below.[268]

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[266] Because Sample 1 lacks market pairs for some distance group (see figures above) in the Early Qing period, we may discuss the outcome of Sample 2 to explain the meaning of coefficients across distance groups. Though the coefficient of Sample 2 might be slightly different from that of Sample 1, overall its trend and fluctuation are pretty much the same as that of Sample 1. But of course, we shall be more cautious about the historical interpretation of Sample 2's results.

[267] The concept of "western impact" was introduced by Fairbank, suggesting that "China's response to the West" was the key in China's modernisation, placing China in a passive role. However, the paper only borrows the concept in that it admits the existence of western impact on the traditional Chinese economy, but does not mean that China could not undertake changes without the "western impact". For more references on the "western impact", see:

John K. Fairbank and Denis C. Twitchett, eds., *The Cambridge History of China* (Cambridge University Press, 2008).

Ssu-yu Teng and John K. Fairbank, *China's Response to the West: A Documentary Survey, 1839-1923* (Harvard University Press, 1979).

[268] Note that the geographic grouping here is different from that in Chapter 1, Part I. Geographic groups in Chapter 1 classify individual entries of interest rates by the locality where the transaction happened. Groups here classify

Table 10 Integration Measures, Early Qing (1709-1840)

	divergence	correlation	adjustment speed		
	τ (%)	ρ	γ	α	h (year)
0-200 km (n=17)	0.51	0.23	-0.81	-0.66	1.00
200-400 km (n=26)	0.83	0.18	-0.75	-0.49	1.24
400-600 km (n=12)	0.84	0.20	-0.76	-0.56	0.88
600-800 km (n=9)	1.34	0.10	-0.75	-0.45	2.73
800-1000 km (n=5)	3.68	0.17	-0.93	-0.42	7.44
1000-1200 km (n=10)	0.48	0.04	-0.67	-0.50	5.16
1200-1400 km (n=7)	1.90	0.16	-0.93	-0.64	0.84
>1400 km (n=7)	3.73	0.08	-0.45	-0.26	72.12

Note: n indicates the sample size, namely, the number of market pairs in the distance group, the total of which is 93 for this period. Each entry in the table is an average of all market pairs that fall into the distance group in the period, with γ and a significant at a 95% confidence level. The critical value for the ADF test is -2.86. [269]

τ the threshold is a negative measure of integration: The higher the threshold level was, the larger divergence there was between the two markets, and the lower integration degree there was about them. For example, interest rates on two markets of no more than 200 kilometres apart had to be at least 51% different before the adjustment process set in to shrink the gap. In other words, the transaction cost for the interest rate level on

market pairs of interest rate series by distance between the two markets in a pair. Data and methods are different, accordingly, the results of grouping are different.

Also, it is impossible to divide geographical groups by rigorous historical standards, because China was such a large country with both large and smaller provinces. To define China's regional economies by historical evolution of provinces would be a whole new thesis, but that is not the goal of the present study. The purpose of the table below is just to present our findings in a comprehensible way, not preparation for the estimation, thus it does not undermine the robustness or quality of our estimation above.

So we only make a general classification/grouping of market pairs by the objective standard of distance. It was common during the Ming-Qing period that a province covered about 400-500 kilometers far from the west to the east or from the north to the south. In this sense, may deem the interplay between markets of no more than 400 kilometers apart as at a prefectural-level (within the reach of a province), that of 400-1000 kilometers at a provincial level (between two provinces), that of 1000 -1400 kilometers at a regional level (covering 2-3 provinces), and that more than 1400 kilometers at a cross-regional level. But it certainly does not mean that all China's prefectures were of the equal size, nor were China's provinces.

[269] Insignificant coefficients are excluded from the average. Because many pairs of markets are examined, not all test-statistics are listed here. For details on the critical value of different significant levels, please see David F. Hendry and Bent Nielsen, *Econometric Modeling, A Likelihood Approach* (Princeton University Press, 2007).

Market A to shift towards that on Market B was 0.51% of the principal; and only when the interest deviation was larger than this would capital started to flow between A and B for arbitrage. When distance between markets reaches more than 1,400 km, they had to differ by 3.73% to trigger the integration process. This suggests that financial integration weakened as distance increased.

ρ tells about the binary correlation level, which is the only positive indicator of the integration degree among the five. Namely, the larger the correlation coefficient was, the higher was the level of integration between two markets. Again, there seems to be a distance-related trend about the measure. The shortest-distanced market pairs (0-200 km) appeared to be the most correlated at 0.23, while the farthest-distanced market pairs (>1400 km) were the second least correlated at 0.08. The former suggests better integration performance than the latter. However, none of the distance groups produces a ρ stronger than 0.4. The average level of the correlation indicator is only about 0.14. This is hardly a sign of well-integrated markets.

γ, α and h are all measures of integration efficiency. A negative value of γ or α denotes adjustment that reduced the interest rate gap, hence an integration process. The smaller they were (or the larger their absolute values were), the faster adjustment there was, and hence higher integration level between the two markets. Though estimated from different models, the pattern of γ and α seems alike (as shown in Figure 28). And they also seem to fall into the distance-defined framework: as distance increased, adjustment speed dropped. For example, the group of markets 0-200 km apart adjusted 66%-80% of the interest rate gap per year, whereas the group (> 1,400 km) adjusted at a speed of 26%-45% per year. To the speed of adjustment in terms of actual time unit with half-life: markets of the 0-200 km group could reduce half of the interest rate gap in 1 year; while markets of the (>1,400 km) group on average had to spend more than 72 years for that.

Overall, it seems all five integration measures abide by the “farther away-lower

integration" principle, as shown in the kernel trends[270] below. However, there are fluctuations and twists of the distance-related integration pattern. Take the adjustment speed as an example.

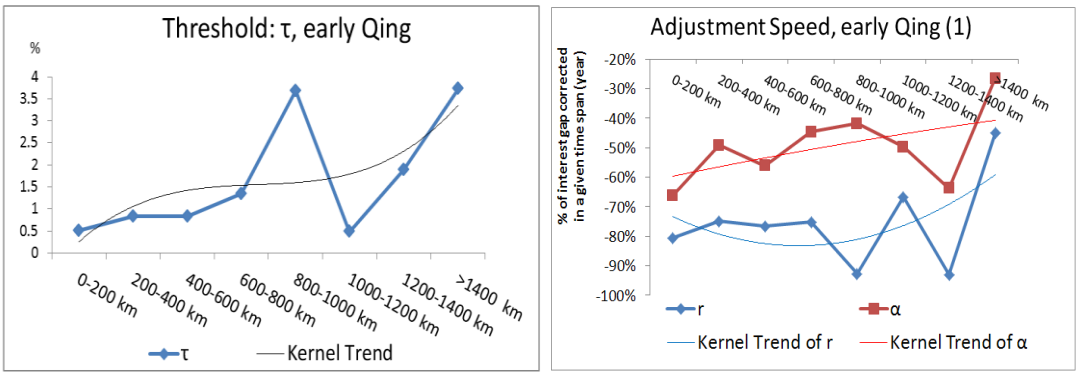

Figure 28 Threshold and Adjustment Speed, Early Qing

Source: regression outcome in Table 10.

Note the group of 1,000-1,200 km and 1,200-1,400 km on the α line in Figure 28, where the adjustment speed went even faster as the distance increased from the preceding group 800-1,000 km. A similar case also happened to threshold, the divergence measure. Market pairs of 1,000-1,200 kilometres apart somehow experienced lower transaction cost than that of all its preceding groups (except the 0-200 km group). Actually, regarding both adjustment speed and threshold performances, the group of 1,000-1,200 km were close to the group of 0-200 km or 200-400 km. All these findings meant that distance was not the only or dominant determinant of integration. There were other factors involved, which made it possible in some special cases for integration between long-distanced markets to be on a par with that between local markets. A hypothesis to understand this is the link of long-distance trade and its ensuing commodity and capital

[270] The trend approximation is done by the polynomial function in Microsoft Excel with the Ordinary Least Square method. The same case goes to all the kernel trend lines below in this paper. This is a simple and commonly used method of smoothing fluctuations and presenting a clearer trend line. For more examples, please see:
Federico, "Market Integration and Market Efficiency: The Case of 19th Century Italy."
Federico and Persson, "Market Integration and Convergence in the World Wheat Market, 1800-2000."
David Chilosi and Oliver Volckart, "Money, States, and Empire: Financial Integration and Institutional Change in Central Europe, 1400–1520," *Journal of Economic History* 71, no. 3 (2011): 779.

flow. Namely, the economic nexus in this period could enlarge the scope of market integration to as far as over 1,000 kilometres (1,000-1,400 km), either on land or by waterway. For example, Ha'erbin was closer to Tianjin than Guangzhou was.

It is interesting to compare the power of financial radiation with the scope of commodity (represented by grain) markets. According the grain market research by Shiue and Keller, in early 18th century, there was "a significant degree of market integration for distance up to about 700 kilometres"; and in the late 18th century, there was also "positive autocorrelation for distances up to 800 km" and "negative autocorrelation for distances above 1,000 km".[271] The discussion above shows that financial integration between markets of 1,000-1,400 kilometres apart could be on about the same level as that between adjacent markets. Hence, we may draw an observation that until the late 18th century, the radius of capital flow was larger than that of commodity flow. This was probably because of lower transport cost for the former than for the latter. Capital flow was realized through either physical transporting of currency or open-account transaction. Currency transporting was more efficient than grain or other commodities because currency was often more standardized, higher-valued and less weighed than common commodities. Not to mention continuous financial innovation that made capital faster and more convenient, such as paper note, bill of exchange, etc.

Furthermore, we can relate the discussion to the physiography-macroregion hypothesis of G. William Skinner, who divided China's rural economy into nine large regions according to geographical attributes of the land.[272] He claimed that the nine macro-

[271] Wolfgang Keller and Carol H Shiue, "Market Integration and Economic Development: A Long-Run Comparison," *Review of Development Economics* 11, no. 1 (2007): 108.
Carol H. Shiue and Wolfgang Keller, "The Origins of Spatial Interaction-Evidence from Chinese Rice Markets, 1742-1795," *Journal of Econometrics* 140, no. 1 (2007): 316.

[272] The Nine physiographic macroregions are defined by Skinner based on his studies on China's rural market structure. According to his theory, because of the differences in geomorphological features, travel-constraining factors, social economic conditions, etc. these regions experienced unsynchronized developmental macrocycles; and there was little connection between or among these regional economies. For further references, please see:

regions had their own cycle of development respectively, hence, there was little or weak connection among the marcroregions. In other words, market development was subject to regional integration, and independent of cross-regional interplay. The findings of this paper about cross-regional market interplay may confirm his opinion from the perspective of financial markets.

Judging from the macro-region division of Skinner, as shown below, the maximum distance between two markets within a macro-region ranged from 1,200 km to 1,400 kilometres. In this sense, interplay between two markets of more than 1,400 km apart was cross-regional, which, according to Skinner's theory, was very weak.

Table 11 Areas of the Nine Macroregions

macroregion	area (square kilometres)
North China	746,470
Northwest China	771,300
Upper Yangtze	423,950
Middle Yangtze	699,700
Lower Yangtze	192,740
Souteast Coast (including Taiwan)	226,670
Lingnan (including Hainan Island)	424,900
Yungui	470,570
Northeast China (Manchuria)	793,300

Source: Skinner, G. William, "Regional urbanisation in nineteenth-century China", in Skinner ed. The City in Late Imperial China, Stanford University Press, 1977. The area of Manchuria is the total of provincial areas of Liaoning, Jilin and Heilongjiang.

Skinner, "Regional Urbanization in Nineteenth-Century China."

Skinner, "Marketing and Social Structure in Rural China, I."

Skinner, "Marketing and Social Structure in Rural China, II."

G. William Skinner, "Marketing Systems and Regional Economies: Their Structure and Development," in *Symposium on Social and Economic History in China from the Song Dynasty to 1900* (Beijing, 1980), 43–44.

William G. Skinner, "Presidential Address: The Structure of Chinese History," *Journal of Asian Studies* 44, no. 2 (1985): 271–92.

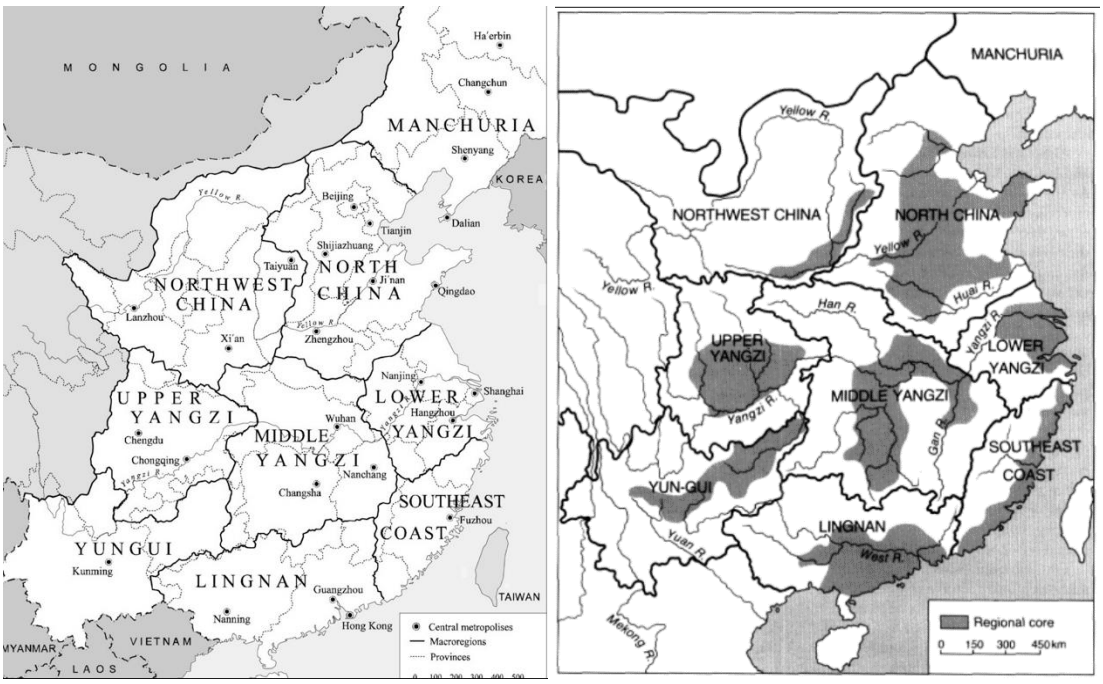

Figure 29 Provinces and Nine Macroregions of China

Source: Skinner, G. William, "Regional urbanisation in nineteenth-century China", in Skinner ed., The City in Late Imperial China, Stanford University Press, 1977.

In the cross-sectional analysis above, we find market pairs of the 1,200-1,400 km group still present some quality of integration in the early Qing period. Particularly, their adjustment speed (α and γ) was no worse than that of the 200-400 km group. And their threshold τ was about the same level as that of the 600-800 km group. However, the integration level of the last group (distance >1,400 km) was much weaker than all other groups. Regarding the threshold τ , the group of market pairs whose distance in-between is more than 1,400 km was 7.46 times that of the 0-200 km group. Regarding adjustment speed, the former was only 39% (regarding α) to 48% (regarding γ) of the latter. If these two measures are not sufficient to tell the difference between inner-regional and inter-regional performances, the other measure of adjustment speed, namely *h*, may present a clearer picture, as shown below.

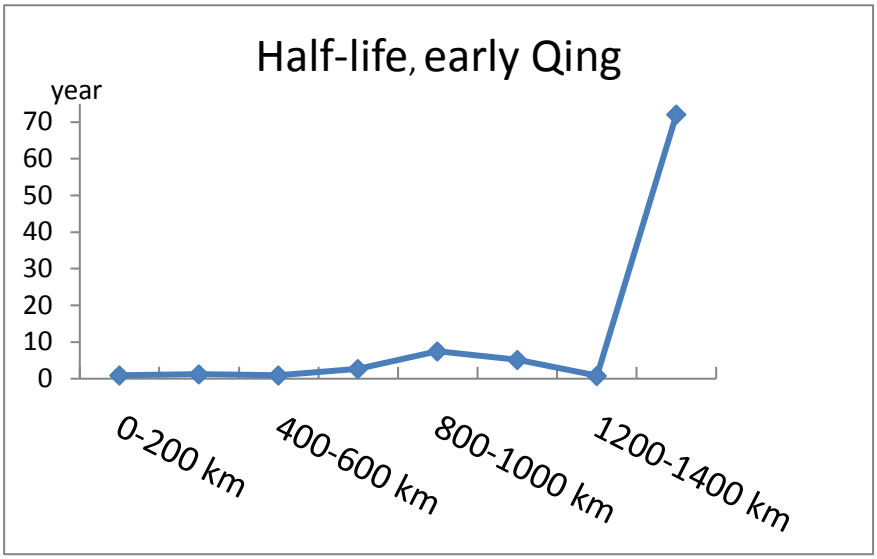

Figure 30 Adjustment Speed: Half-life, early Qing

Regarding the measure of half-life *(h,* the time needed to reduce half of the interest difference between two markets), the last group (distance>1400 km) took more than 72 years, which clearly means no integration at all; whereas all other groups ranged from 0.84 year to 7.44 years. In other words, the time needed by the former was 10 to 85 times of that by the latter. Given the communication and transport circumstances at the time, if two markets took about 0.84 year to eliminate half of their interest rate gap, we may deem them integrated. Hence, we may draw an observation that integration between markets more than 1,400 kilometres apart barely existed.[273]

This suggests the maximum range of financial integration at the time was up to 1,400 kilometres, which to a certain extent testifies Skinner's theory from a financial perspective: Regarding financial market development, there was active integration for inner-regional market pairs (distance < 1,400 kilometres), and little integration for cross-regional market pairs (distance > 1,400 kilometres).

[273] Although the average performance of the (>1,400 km) group was too weak to be integrated, we do not rule out the possibility that some unique cases in this group might still have close financial co-movement. The economic link behind this could be long-distance trade, mostly by water, either on the river or oversea. The political drive for inter-regional integration, more importantly, could be much stronger. In the centralized political regime on the vast land, the authority was able to mobilize resources over a long distance towards some key areas. The area was usually of great political or militarily importance. A typical example is the Great Canal, which, from the 6th century connected the capital market of Beijing with those in the lower Yangtzi area (such as Suzhou, Hangzhou, Ningbo, etc.) over a distance as far as over 1,700 kilometers. This is an interesting topic for my future research.

But of course, Sample 2 is not strictly selected as Sample 1 is; particularly, the markets and data series for the 18th century are much fewer than those for the 19th and 20th century. Thus, cautions shall be taken when interpreting the statistical findings above. But the following discussions about later periods are based on Sample 1, which may be more revealing about integration performance in different periods.

The above is a cross-sectional view of integration performances on traditional Chinese financial markets by the end of early Qing period. The next question is: In a longer history, how did the inner and inter-regional integration level vary as it approached the contemporary times? Next we proceed with historical observations on integration performance by period respectively. Below summarized are output tables and figures by period which the market pair belongs to. The five historical periods: Early Qing (1709-1840), Late Qing (1841-1911), Warlord Era (1912-1926), Nanjing Era (1927-1936), Last Wars (1937-1949).[274]

The following passage judges pair-wise integration performances by period respectively from the combined work of p and r. It shall be noted that the adjustment speed r could affect the level of co-movement p: Two markets with faster capital flow in-between tended to produce higher integration performance. This is particularly the case when low-frequency (annual) dataset is adopted, for there is one year's time to smooth short-run shocks and the ensuing differences between two markets.[275]

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[274] These periods are defined by significant historical events. The last wars refer to the second Sino-Japanese war and the Civil war. However, it is impossible that all the market pairs happened to match within these periods. If the matching years of a market pair spanned two periods, the study labels it by the period where more than half of the matching years belong to.

Note that the market pairs in one period are not exactly the same ones as in another (See Table 9). This is due to the unbalanced distribution and availability of the data. Thus, one must be cautious in reading the historical observations below. Still, none of the periods above contains only short-distanced market pairs or markets in a particular area of China. In this sense, the geographical bias from market selection in different periods should be limited by a hybrid of many market pairs. Moreover, we will also check empirical outputs here against the corresponding historical background, to see if they make sense in history. Anyway, this is also a most common scenario in the research of market integration. For example, please see Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900." and Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870."

[275] See Studer p.107: "If there is intensive year-round trade between two places, the co-movement between these prices will be higher than in a place where trade is limited. Moreover, the price differences after a shock in one place will in such cases (low frequency/annual data) not be fully detectable in an annual data series, as part of this difference will be corrected for by intra-annual arbitrages. This means that one could encounter a high degree of

Table 12 Integration Output by Period

	Late Qing (1840-1911)		Warlord Era (1912-1926)		Nanjing Decade (1927-1936)		Last Wars (1937-1952)	
	ρ	γ	ρ	γ	ρ	γ	ρ	γ
0-200 km	0.57	-0.84	0.41	-0.45	-0.13	-1.01		
200-400 km	0.24	-0.78	0.40	-0.48	0.01	-0.81		
400-600 km	0.60	-0.57	0.43	-0.49	0.34	-1.76		
600-800 km	0.41	-0.65	0.20	-0.62	0.06	-1.78	-0.43	-0.49
800-1000 km	-0.05	-0.46	0.10	-0.40	0.01	-1.32	0.9900	-0.72
1000-1200 km	0.39	-0.55	0.14	-0.44	0.48	-1.16		
1200-1400 km	-0.10	-0.67	0.13	-0.44	0.09	-0.96		
>1400 km	0.15	-0.76	0.11	-0.52	0.19	-1.39	-0.64	0.32
average	0.32	-0.66	0.24	-0.48	0.16	-1.27	-0.03	-0.30
max	0.60	-0.46	0.43	-0.40	0.48	-0.81	0.99	0.32
min	-0.10	-0.84	0.10	-0.62	-0.13	-1.78	-0.64	-0.72

Source: the 9%-interpolation sample of own dataset.
The average for p is the average of absolute values of p in the same distance group, because both positive correlation and negative correlation can contribute to integration performance between two markets.

Regarding the Late Qing period, there are four distance groups whose p are about or above 0.4, suggesting middle-level adjustment between markets. Besides, the average adjustment speed was -0.66, which was slightly above the middle-level. Judging from these two aspects, one may observe a trend of financial integration during this period. As for the Warlord Era, the correlation degree p for three market groups was above the middle level of 0.4, with the force of market integration reaching up to 600 kilometres. On average the adjustment speed was -0.48, nearly -0.5. Combining these two indicators, it may also be reasonable to assume the existence of integration, though it was not strong. The decrease in adjustment speed probably reflected the impact of frequent military conflicts among warlords. Then in the Nanjing Era, only one group of markets produced a ρ higher than 0.4, with the average level at only 0.16. But meanwhile, the adjustment

co-movement together with a moderate degree of inter-annual adjustment."

speed became quite high. In one year's time, from 0.81% to 1.78% of the interest rate gap could be corrected for. However, given such a high speed of adjustment, the level of correlation p was still low. This meant hardly a sign of well-integrated market. Finally, the Last Wars period could not produce significant result for all distance groups. But based on current data output, a preliminary observation is that between some particular markets of long-distance, there was strong correlation of interest rates. Data records show this happened between pivot cities such as Shanghai, Changsha, Wuhan, Chongqing, and so on. This is a bit intriguing because these markets were often under different authorities (the Japanese, the Nationalist Party and the Communist Party) during this time. We have no clear hypothesis on why there was strong interplay between any two of them yet. But again, the synchronisation process became slow, the slowest among all the periods here, actually. The average adjustment speed was only -0.3. This was probably due to the stagnation in commodity and capital flow in the war time. Overall, the limited findings tend to reject the existence of good integration in this period.

The figures below present the output of threshold τ in different period and their adjustment speed accordingly. Each point in the figures represents a distance group's average of the integration measure at the time.

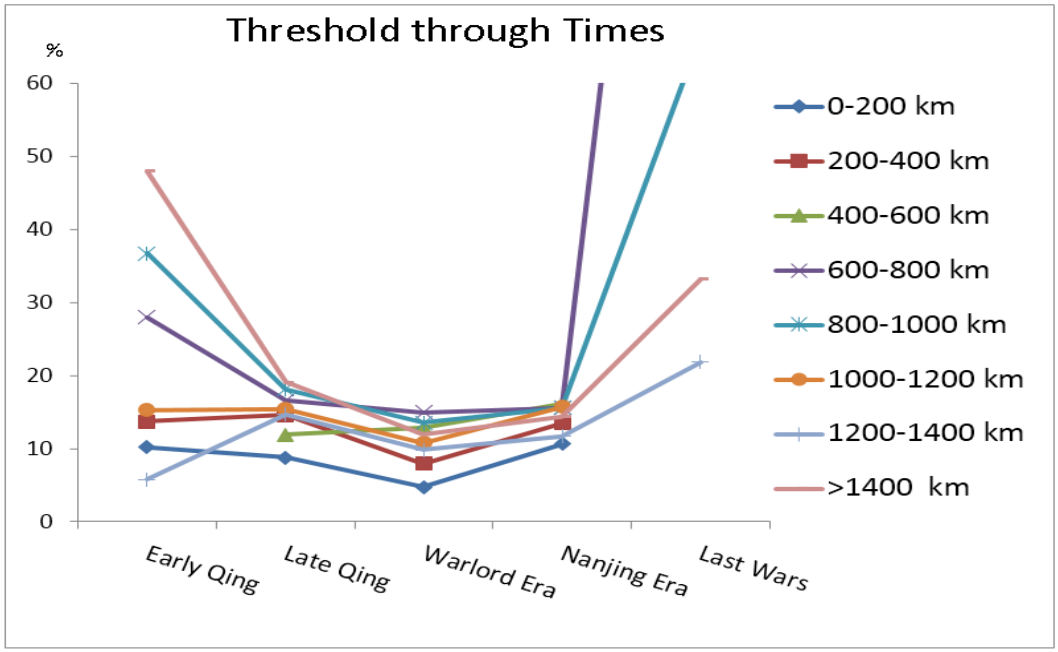

Figure 31 Threshold through Times

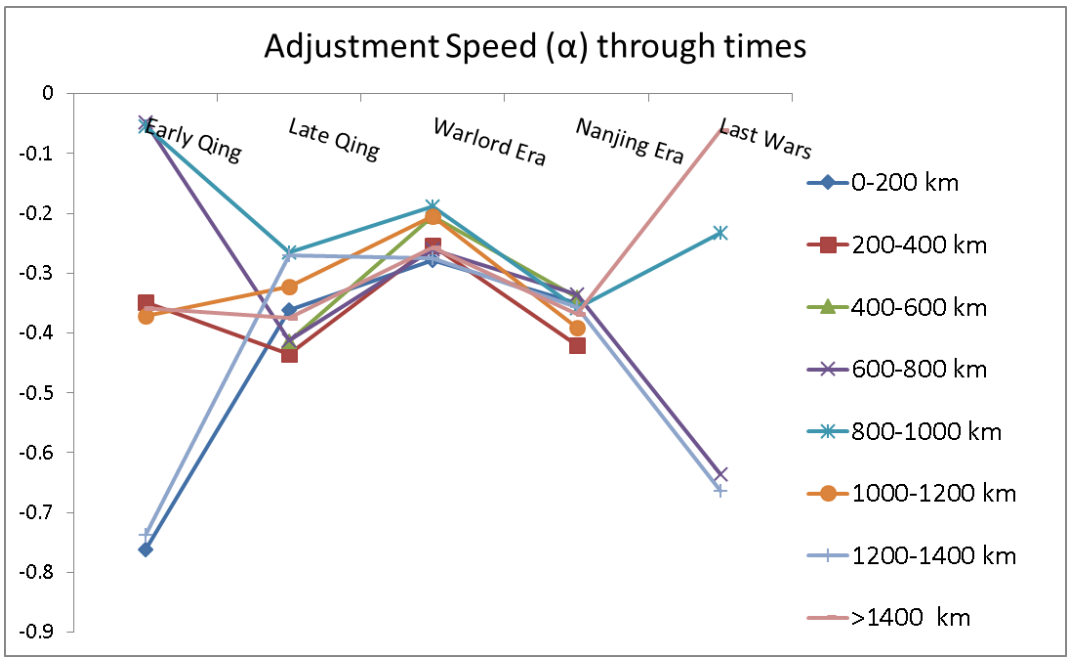

Figure 32 Adjustment Speed through Times

Notes: Early Qing (1709-1840), Late Qing (1841-1911), Warlord Era (1912-1926), Nanjing Era (1927-1936), Last Wars (1937-1949).

In the first period of Early Qing, the distance groups are quite scattered over the vertical dimension of both figures above, which suggests they differed a lot in both market

divergence and adjustment speed. In other words, in this period distance mattered very much to the integration degree between two markets. The interest rate gap between two markets of a short distance differed a lot from that between two markets of a long distance. The adjustment speed between two markets within a certain distance was also quite different from that of another distance. In brief, financial markets were of strong local or regional character, presenting little trace of a national market. This observation reflected the status of Chinese economy before the watershed year of 1840. At the time, China was still on the traditional economic trajectory. Limited by the conditions of transport and communication and restrained by fragmenting financial institutions (such as Likin,[276] a type of cross-regional tariff), distance played a significant role in financial market co-movement.

In the following three periods from Late Qing to Nanjing Era, however, all the groups clustered regarding both market divergence and adjustment speed, with gaps among their trend lines narrowing down. This means in determining the level of market integration, the influence of distance weakened. Regional differences of financial markets were diminishing. Local integration may not be much stronger than provincial, regional or inter-regional integration. Namely, financial market structures were turning homogeneous despite of distance or regional difference, and financial markets were

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[276] For more details, see:

Bihong 曹必宏 Cao, "Nanjing Guomin Zhengfu Cailigaishui Pingshu 南京国民政府裁厘改税述评 (Review on the Financial Reform of the Nanking Government)," *Xue Hai 学海* 6 (1992).

Chen, "Qingdai Qianqi Liangguang Shichang Zhenghe 清代前期两广市场整合 (Market Integration in the Liang-Guang Area of Early Qing China)."

Wang, Chen, and Zhou, "Shiba Shiji Dongnan Yanhai Mijia Shichang de Zhenghexing Fenxi 十八世纪东南沿海米价市场的整合性分析 (Integration Analysis on Coastal Rice Markets in the 18th Century)."

Xuncheng 杜恂诚 Du, *Minzu Ziben Zhuyi Yu Jiuzhongguo Zhengfu 民族资本主义与旧中国政府 1840-1937 (National Capitalism and the Old Chinese Government 1840-1937)* (Shanghai: Shanghai Shehui Kexue Chubanshe 上海社会科学出版社, 1991).

Hou, "Changjiang Zhongxiayou Diqu Migu Changtu Maoyi 1612-1937 长江中下游地区米谷长途贸易：1612—1937 (Long-Distanced Grain Trade in the Lower Yangtzi Area during 1612-1937)."

Wenmo 黄文模 Huang, "Wanqing Lijinzhi Chansheng de Niandai Jiqi Shehui Weihaixing 晚清厘金制产生的年代及其社会危害研究 (Research on the Times and Social Problems of Likin Institutions in the Late Qing Period)," *现代财经 （Modern Finance and Economy）* 3 (2000).

Liuyan 赵留彦 Zhao, Yan 赵彦 Zhao, and Zhiqiang 窦志强 Dou, "Caili Gaitong Dui Guonei Liangshi Shichang Zhenghe de xiaoying'裁厘改统'对国内粮食市场整合的效应(The Effect of Abolishing Likin on Domestic Grain Market Integration)," *Jingji Yanjiu 经济研究* 8 (2011).

converging on a national scale.

Besides, the height of group points on the vertical axis reflects local or regional integration by giving the average of market pairs' co-movement within a distance group. The higher a point is, the lower was the group's integration level. Hence, the consecutive threshold decrease within most groups in the Late Qing and Warlord periods suggests lessened divergence within these distance groups. In this sense, these two periods saw enhanced regional integration in addition to fortified national market convergence discussed above. Namely, integration strengthened on both national and local levels. Overall, it is reasonable to assert that a national financial market was coming into being at this stage.

The integration development may be attributed to the economic restructuring, industrialisation and financial modernisation since 1840. Substantial economic changes were triggered by the western impact and opening-up since the first Opium War. It brought not only competition and deterioration to the traditional economy, but also new businesses, governance structure, and technologies such as railway and telecommunication. Both commodity and capital flow benefited from these factors, hence strengthened financial integration. Once the transformation started, even regional wars in the Warlord Era could not stop the shrinking of market divergence (they might slow it down though, affecting the adjustment speed).

Nonetheless, the integration progress was not simple and straightforward. The new market system was built on the collapse and re-structuring of the old economic order. Hence, partial or temporary setback of integration would happen due to de-connecting of original economic ties before the new ones could be established. For example, in Figure 32 the adjustment speed of most groups decreased in the Warlord Era, probably because regional wars between warlords hindered commodity and capital flow. But soon when the Nanjing government managed to hold a relatively peaceful political status, local and regional adjustment of financial integration speeded up again.

Besides, after continuous shrinking of cross-group gaps in the Late Qing and Warlord periods, the Nanjing Era encountered a slight increase of divergence within most distance groups. It seemed that the economic-restructuring proceeded to a substantive stage at the time, when some markets, particularly some coastal and major port cities started to made strides in industrialisation and modern businesses. These first-developed markets could leave their hinterland markets so far behind in financial development that their interest rate gaps enlarged despite on-going financial networking or channel building.

Finally, in the period of Last Wars, the trend lines of all the distance groups went apart, which means the overall integration across all the distance groups decreased. Economic fragmentation resulted from separate military regime by different political powers. During the second Sino-Japanese war, the Manchuria area was under the reign of the Japanese, where a new set of Japanese currencies was applied. And in the years of civil war between the nationalist party and the CPC (Communist Party of China), economic blockade policies were carried out by the nationalist government to seal off the communist areas. These conditions directly counteracted national financial integration.

Besides, market divergence within all the available groups also went up, suggesting that even local integration was significantly affected by the political economic crisis. The adjustment speed presented mixed responses to the wars, with some groups adjusting faster and some slower. The groups with faster adjustment speed probably covered some market pairs, the capital flow between which mobilized military resources for the fighting forces.

We summarize integration performances captured above in Table 13 below.

Table 13 Further Integration Performances (TAR)

across groups of distance					
	Early Qing	Late Qing	Warlord	Nanjing	Last Wars
integration		+	+	+	-
adjustment speed		+	+	+	-
within each group					
	Early Qing	Late Qing	Warlord	Nanjing	Last Wars
integration		+	+	-	-
adjustment speed			-	+	

Note: "+" means an increasing integration degree compared with the preceding period, whereas "-" means a decreasing integration level. The period of Early Qing is the base of such comparisons, thus left empty. The adjustment speed in the Late Qing and Last Wars periods presented mixed performances without a clear pattern of change, thus is left empty. Again: Early Qing (1709-1840), Late Qing (1841-1911), Warlord Era (1912-1926), Nanjing Era (1927-1936), Last Wars (1937-1949).

2.4 Conclusion

Chapter 2 discusses pair-wise integration based on time-series data in the 18th-20th century. Before the Late Qing period, China's financial integration presented a strong regional feature. Financial market integration was mostly determined by distance and other geographical conditions. But special trade and economic links could provoke a long-distance financial flow: capital flow could reach a market some 1,000-1,400 kilometres away, slightly farther than commodity (grain) flow. There was little co-movement between markets of more than 1,400 kilometres apart, which echoes McKinnon's macroregion theory in that there was little financial integration across regions. Still, some groups' performances did not speak for the whole country. The overall integration performance for the pre-1840 period was limited, with large gaps among distance groups regarding both interest divergence and adjustment speed.

National financial integration did not initiate until the Late-Qing period in the 19th century. There was less integration difference across distance groups, which suggests that distance mattered less to market interaction; also, there were better-integrated markets within most groups themselves. Overall, there were converging interest rate gaps and synchronizing adjustment speed. In other words, markets all over the country became more homogeneous; a national financial market began to take shape. Integration progress mostly involved economic, technological and institutional changes that lowered transaction costs, spurred trade, and assisted capital flow. Still, there were regional setbacks in adjustment speed (in Warlord era) and increasing interest gaps (in Nanjing period). This might be a sign of market reconstruction in times of great changes in both politics and economy.

The last period of wars did not provide sufficient data results, but it is clear that all the distance groups once again became much diversified regarding both interest divergence and adjustment speed. This suggests the integration process stopped at devastating wars.

The time series analysis above focuses on the interplay between two markets. However, "pair-wise comparisons … become difficult to interpret for large data-bases, as the number of pair increases exponentially with the number of series."[277] To observe overall market integration on a larger scale, we adopt another approach of spatial analysis.

[277] Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870.", 16.

Chapter 3 Overall Integration and Explanation

While the temporal approach presents a dynamic but partial mechanism of interaction between a pair of localities, the spatial approach can achieve a larger picture of overall integration. This means that spatial methods observe the interplay among all spatially correlated places within the region under study on one time-section. The following chapter picks up 57 years scattered over the Ming-Qing period (1368-1910), and discusses the key factors influencing financial integration on the cross-section. We start by introducing the spatial models.

3.1 Spatial Integration: The Method

In explaining market integration, time-series models based on pair-wise data usually adopts distance between two markets as proxy of spatial impact on the integration degree. The spatial integration method replaces "distance" with a "spatial-weight matrix". The matrix[278] (hereafter denoted by w_{ij}) tells the position of a target market (i) relative to all other markets (j) on the map under study. And it is used to weigh influences from every other market on the local/target market. No matter how the model specifications may change below, this is the essence of the spatial integration method.

The full spatial models are shown below. The first is a spatial lag model (SLM).[279] y_{it} denotes the interest rate gap between Province i and national average in Year t.

[278] In Stata, the spatial matrix is based on inverse distance among the markets. Namely, the impact of one market on another market decreases with distance. And the distance is calculated based on geographic coordinates of each region/province's center. For details of the coordinates, please see Appendix 9.
But in ArcGis there are other weighing measures, such as K Nearest Neighbors, polygon Contiguity, etc. For example, polygon Contiguity is a simple method to do so: the weight is 1 if market *i* and j shares a border and 0 if they don't. For more details, please refer to
Anselin, "Space and Applied Econometrics."
Cliff and Ord, *Spatial Autocorrelation*.
Goodchild, "Spatial Autocorrelation."
[279] It is also known as the Spatial Autoregressive Model, SAR. For more details on SAR and SEM models, please see Anselin, *Spatial Econometrics: Methods and Models*.

Coefficient β explains the impact from structural variables (X), including the number of population, that of arable land, and a proxy of education for Province i in Year t.

(1) SLM: $y_{it} = \rho W_y + \beta X_{it} + \varepsilon$

where $(W_y = \sum_{j \neq i} w_{ij} y_{jt})$

W_y is the spatial impact term[280] in the regression, standing for the overall influences from all other provinces. It is defined as aggregate of spatially-weighted interest rates from all other market j. Accordingly, the spatial autoregressive coefficient ρ accounts for collective influence from all other markets j.

(2) SEM: $y_{it} = \beta X_{it} + (\delta W_\varepsilon + \mu)$

where $(W_\varepsilon = \sum_{j \neq i} w_{ij} \varepsilon_{jt})$

The second is a spatial error model (SEM). It follows the same logic as SLM, but is slightly different in that: The spatial matrix w_{ij} is adopted to weigh the error term of other markets j. Accordingly, the spatial autoregressive coefficient δ shows the collective influence from other markets j on the local market i.

[280] W_y is also called "spatial lag operator", denoting "a weighted average of random variables at "neighboring" locations. … The spatial weights crucially depend on the definition of a neighborhood set for each observation." See: Luc Anselin, Chapter 14 in *A Companion to Theoretical Econometrics*, ed. Badi H Baltagi (Blackwell Publishing Ltd, 2001). For example, a simple method to do so is to define the weight as 1 if market *i* and j shares a border, and 0 if they don't.

$$y_{it} = \rho W_y + \beta X_{it} + \delta W_\varepsilon + \mu$$

$$(W_y = \sum_{j \neq i} w_{ij} y_{jt})$$

(3) SAC:

$$(W_\varepsilon = \sum_{j \neq i} w_{ij} \varepsilon_{jt})$$

$$(\mu_{it} = \mu_i + \nu_{it})$$

If spatial impact on the target market comes through both interest rates on other markets and their error term, Model (3) comes in handy. It is a compound model called Spatial Autocorrelation Model (SAC), which combines the specification of (1) and (2). We will try out these three specifications of the spatial integration model, and compare their result for a best fit. Additionally, a set of year dummies are added to control for time-related factors (un-identically distribution of the data, particularly, as discussed below in data quality).

3.2 Data Distribution and Quality

To obtain a macro-view, this chapter uses the dependent variable and explanatory variables on a provincial scale.[281] Again, we choose the 1820-year map as the geographic base. And again, it does not mean the administrative division of provinces stayed the same, neither does it means that the empire covered the same size of area through all the years under study here. We just need a time-invariant geographical base to tell where these transactions happened (relative to each other's location). We choose

[281] Spatial integration analyses mostly adopt regional/provincial aggregates of prices or other target data. For example, aggregated soybean meal prices were applied to study in grain market integration in Canada, USA, Japan and Taiwan; aggregated whole prices in different regions of Philippines were employed to test for food market integration; aggregated indicators of house prices in 31 China's provinces/regions were adopted to show spatial patterns of real-estate markets. See:
Barrett and Li, "Distinguishing between Equilibrium and Integration in Spatial Price Analysis."
Bob Baulch, "Transfer Costs, Spatial Arbitrage, and Testing for Food Market Integration," *American Journal of Agricultural Economics* 79, no. 2 (1997): 477–87.
Joerg Baten et al., "Evolution of Living Standards and Human Capital in China in the 18-20th Centuries: Evidences from Real Wages, Age-Heaping, and Anthropometrics," *Explorations in Economic History* 47, no. 3 (2010): 347–59.
He 王鹤 Wang, "Jiyu Kongjianjiliang de Fangdichan Jiageyingxiang Yinsu Fenxi 基于空间计量的房地产价格影响因素分析 (Analysis of Influential Factors on Real Estate Price Based on Spatial Econometrics)," *经济评论 (Economic Review)* 1 (2012).

the provincial division of the 1820 Qing map as the main spatial framework because: one, the Qing dynasty connects the Ming dynasty and the Republican era in history, a natural common ground in territory division of both periods; two, the 19th and 20th century provide a major proportion of the interest rate data – fitting them in their corresponding spatial framework would be more convenient. Given this geographic base, when inputting data of interest rate and other variables, we stick to the provincial division of the 1820 base.

Regarding spatial representativeness of the data, the observations cover a major part of China, 23 provinces/regions, which was the hard core of traditional Chinese economy. Anhui ranks top in the frequency of data available for the years under study here, followed by Sichuan, Guizhou, Fujian, Shannxi, Zhejiang, Hebei, Jiangsu, Shandong, etc. The region covered in dark colours provides more data than those in the light, which (as shown below) are located both on the coastal line and on the hinterland.

Table 14 Data Distribution in Space

	Province/Region	Freq.	Percent
	Anhui	46	10.57
	Sichuan	41	9.43
	Guizhou	41	9.43
	Fujian (including Taiwan)	39	8.97
	Shannxi	35	8.05
	Hubei	31	7.13
	Shanxi	28	6.44
	Zhejiang	27	6.21
	Zhili (Hebei)	24	5.52
	Jiangsu	18	4.14
	Shandong	14	3.22
	Jilin	13	2.99
	Shengjing (Liaoning)	13	2.99
	Heilongjiang	13	2.99
	Guangdong (Canton)	8	1.84
	Guangxi	7	1.61
	Jiangxi	7	1.61
	Hunan	7	1.61
	Neimenggu (InnerMogolia)	6	1.38
	Gansu	6	1.38
	Yunnan	5	1.15
	Henan	5	1.15
	Qinghai	1	0.23
count:	23	435	100

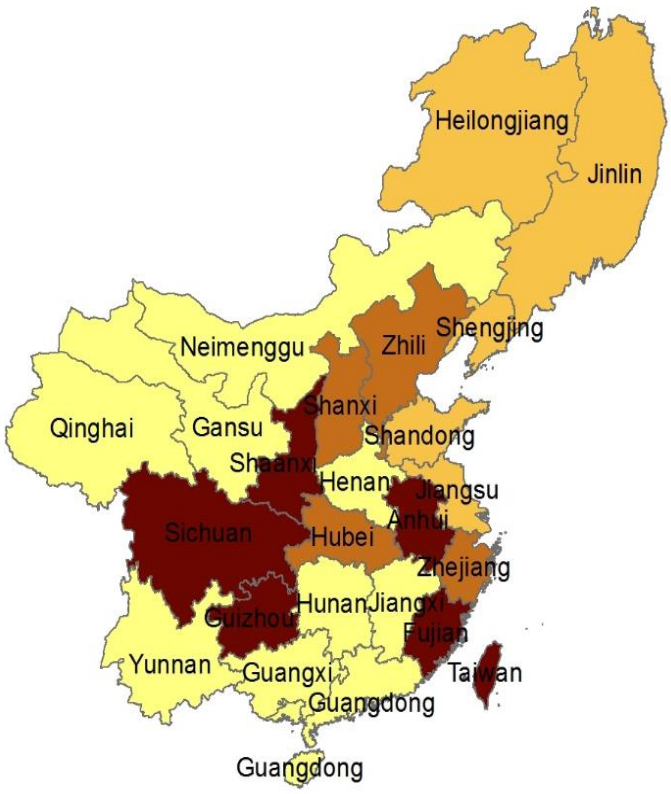

Figure 33 Data Distribution in Space[282]

A picture to illustrate the data-distribution table on the left
The darker a region is, the more observations it provides for the model.

The data distribution in time, specifically in 57 years scattered over the Ming-Qing period (1368-1910), is illustrated below.

[282] Note that Nanzhili (southern capital area) in the Ming dynasty was divided into Jiangsu and Anhui in the Qing dynasty, and Huguang into Hunan and Hubei, and Shannxi into Shannxi and Gansu. When inputting data of interest rates, land, population and education, the paper complies with the provincial division of the 1820 Qing division of provinces.

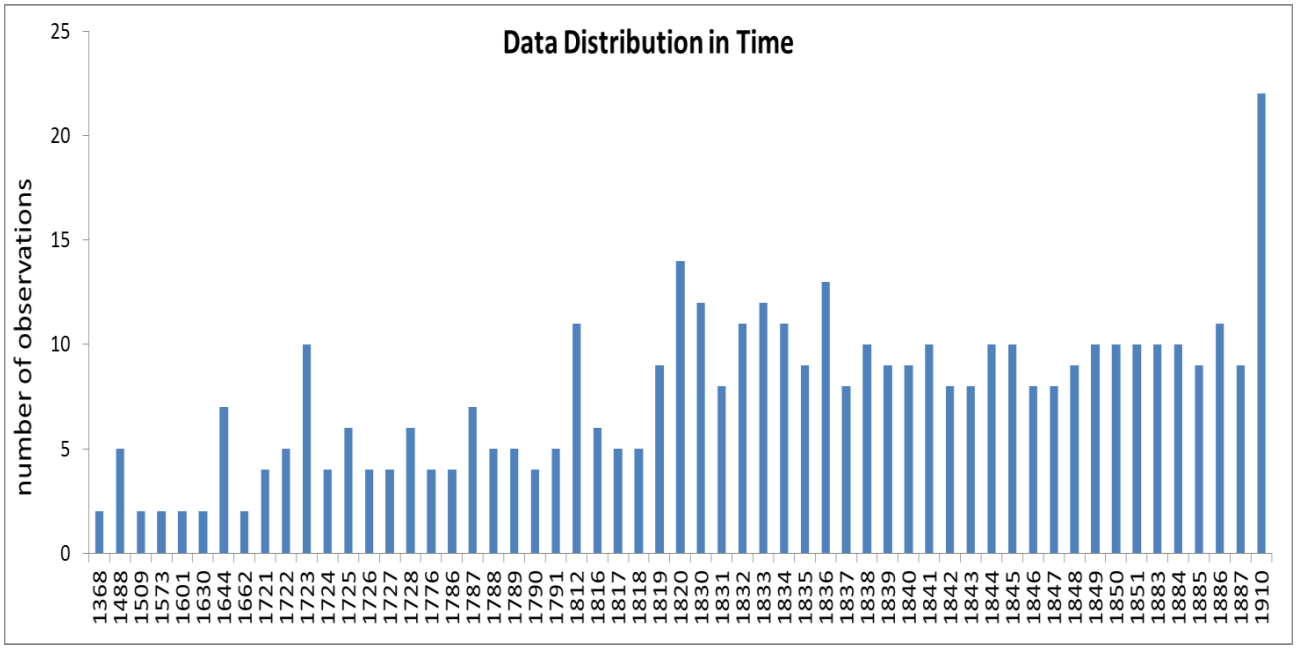

Figure 34 Data Distribution in Time

The dependent variable y_{it} is defined as interest rate gap between a target province (the local market, i) and the national average of interest rates in the year (t). It is a negative indicator of the integration degree between the local market and all other markets of the same time. In other words, the larger y_{it} is, the weaker financial integration there was.

y_{it} is drawn from 435 provincial averages of interest rates scattered on 57 cross-sections of time, which in turn are based on about 2,000 raw interest rate data. The scope in time is mainly subject to data availability of both the dependent variable and the explanatory variables. As shown in the figure below, the earliest observation came from the year 1368, and the last 1910. Note that the provinces with interest rate data and their distribution in the years under study below are different. However, we are not analysing time-series or panel data, but structural models; every dependent variable is time-and-location specific. Thus, there is no need for interpolation. Besides, the time-feature of observations, such as different distributions at different time points,[283] will be controlled

[283] The data structure here is more of "independently pooled cross-sections". The data base under study here is independently pooled, because: whether historical interest rates for this particular year in this particular province can be recorded and preserved is essentially a random event. It is decided by the compound work of numerous historical factors, but not by the author of this paper. Consequently, "sampling randomly from a large population at different points in time… likely leads observations that are not identically distributed", which, "is easy to deal

for by year dummies. The purpose is to investigate and explain the spatial pattern of interest cluster or divergence among provinces.

The explanatory variables include:

- W_y: the spatial term of overall impact from all other markets of the same time. It is spatially-weighted interest of other provinces in the same year *t*, as defined by the model above. It denotes the overall spatial influences from all other markets on the same time-section.

- land: the number of arable land in the target province *i* in Year *t,* which stands for the development status of the agricultural sector. The traditional rural economy in China featured a self-sufficient style. Given a particular level of output or expenditure, more investment in land meant less investment in commodity and capital market, hence less trade and capital flow. Thus, we may expect the land variable to be negatively associated with financial integration. The data of Ming land come from Perkins and Wang, that of Qing land from Cao et al. and Zhang.[284] All of them are based on the land records compiled by Liang Fangzhong,[285] though they made historical or geographical adjustments onto specific numbers. Since their essential dataset are the same, hence the compatible with each other.[286] We pick these years partially because of the data

with in practice by allowing the intercept…and in some cases the slope, to change over time". In other words, in the regression we include "dummy variables for all but one year…as the base year". For more details, please see Jefffrey M. Wooldridge, *Introductory Econometrics, A Modern Approach*, 3rd ed. (Cengage Learning, 2006), 448-9.

[284] Dwight Perkins, *Agricultural Development in China, 1368-1968* (Chicago: Aldine, 1969), 225.
Yeh-chien 王业键 Wang, *Land Taxation in Imperial China 1750-1911（帝政时期的中国土地税）* (Harvard University Press, 1974).
Xue 曹雪 Cao et al., "近 300 年中国耕地数据集重建与耕地变化分析（Reconstruction and Change Analysis of Cropland Data of China in Recent 300 Years）," *地理学报(ACTA GEOGRAPHICA SINICA)* 7 (2014).
Youyi 章有义 Zhang, "Jinda Zhongguo Renkou He Gengdi de Zaiguji 近代中国人口和耕地的再估计 (A Review on Chinese Population and Arable Land in the Modern Times)," *中国经济史研究（Research on Chinese Economic History）*1 (1991).

[285] Fangzhong 梁方仲 Liang, *Zhongguo Lidai Hukou Tiandi Tianfu Tongji 中国历代户口、田地、田赋统计 (Statistics of Households, Lands, and Land Tax in Chinese History)* (Shanghai: Shanghai Renmin Publishing House, 1980), 286,297.

[286] Just one step needs to go before pooling them together --to unify their units of land. Of course, there might be slight variation in local measures of area, but all the national records of land, as well as land studies, have to stick to a national standard of area measure. Based on our data sources, this study also uses a unified measure by following these equations: 1 mu in Ming-Qing specification 明清亩 = 0.92 mu 亩 (modern specification); 1 Ming-Qing hectare =6.14 square hectare meters. For more references on this, please see Zhang, "近代中国人口和耕地的再估计 (A Review on Chinese Population and Arable Land in the Modern Times)."

availability for land. Actually there are more data recorded by state reports or historical materials than what are used here. But not all of them are solid, scrutinized and thoroughly adjusted by historians specialized in land research. So we stick to the solid data only.[287]

- pop: the number of population of the target province i in Year t, which is a proxy of the provincial economy overall. Generally speaking, more population brought more labour.[288] And labour was a strong drive for production and economic growth, which in turn suggested thriving trade and credit behavior, namely, booming commodity and capital flow. Did better local economy lead to greater cross-section financial integration? We do not have sufficient evidence to tell at this moment. How far could the capital go depends on specific social economic conditions, as to be discussed later.

  The data sources of population include Cao, Lu and Teng, Ge and Zhang.[289] The data of Cao is most credible, because this latest works thoroughly scrutinized all related local gazetteers and built the provincial numbers from county-level sub-totals. The numbers of Lu and Teng make good complements to those of Cao, as they also did specialized population research province by province. The works of Ge and Zhang were done relatively earlier than Cao and Lu and Teng, and not from as detailed sources as county-level records. So their numbers mainly work as a framework or benchmark here, to tell if a specific number of population is out of range for that particular time and place.

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[287] For missing values in a particular province and year, the paper estimates them based on the growth rate between the proximate numbers before and after. The same method is used to estimate missing population numbers.

[288] This should be the case except when the population structure turned the country into an ageing society. However, in the traditional Chinese society, particularly in rural areas, old people often kept working until they really could not and were about to die. So evening in an ageing society, the number of population still strongly denoted that of labour.

[289] Shuji 曹树基 Cao, *Vol.4 and Vol.5 in Zhongguo Renkou Shi 中国人口史 (Population History of China)* (Fudan Daxue Chuban She 复旦大学出版社, 2003).

Zezhi 滕泽之 Teng and Yu 路遇 Lu, *Zhongguo Fensheng Renkou Kao 中国分省区历史人口考 (A Study on Chinese Population by Province)* (Shandong Renmin Chubanshe 山东人民出版社, 2006).

Jianxiong 葛剑雄 Ge, *Zhong Guo Ren Kou Fa Zhan Shi 中国人口发展史 (A History of Population Development in China)* (Fujian Renmin Chubanshe 福建人民出版社, 1991), 355.

Zhang,"近代中国人口和耕地的再估计 (A Review on Chinese Population and Arable Land in the Modern Times)."

- edu: the 3-time moving average of the numbers of *Jinshi* (进士) in the target province *i* of Year *t*. *Jinshi* was a higher-education degree granted by the imperial court. To obtain a *Jinshi* degree, one must pass the imperial civil-service examinations on both the provincial and national level. Receiving education at the time was costly regarding not only about 10 years' tuition fee, but also the opportunity cost for a family to lose a productive labour. Besides, preparing for the exams and travelling to the exam center were also expensive. In this sense, education may be deemed a proxy of provincial household income and the local economy. Furthermore, better education suggests higher chance of innovation, hence smoother and faster flow of commodity and capital. In this sense, we may draw an assumption that education should contribute to integration, thus negatively to the independent variable of interest rate gap. Will this hypothesis hold for the period under study here? Further empirical discussion may shed light on this.

  Considering that the impact of education was not immediate, but lagging in time, we take the 3-year moving average to capture the lagging effect. The data for *Jinshi* before 1713 come from Li, those from 1713-1910 from Zhu and Xie and also with reference to Yin and Cao, Fang and Du.[290] Clarifying the number of *Jinshi* is relatively simple, for there is always a concrete name and specific record to track. Hence, the result number is more solid than that of land and population. But we track the number according to the registered "province of origin" (籍贯) for the *Jinshi.* If his registered origin was different from where he really lived, we cannot identify this situation. However, such a case was not as

[290] Data before 1713 are quoted from Guojun 李国钧 Li and Bingzhao 王炳照 Wang, eds., Section 4, Chapter 7, Vol.4 in *Zhongguo Jiaoyu Zhidu Tongshi 中国教育制度通史(A History of Education in China)* (Shandong Jiaoyu Chuban She 山东教育出版社, 1999). Data after 1713 come from:

Baojiong 朱保炯 Zhu and Peilin 谢沛霖 Xie, *明清进士题名碑录索引 (Index of Jinshi in the Ming-Qing Period)* (Shanghai: shanghai guji chubanshe 上海古籍出版社, 1980).

Haijin 尹海金 Yin and Ruixiang 曹端祥 Cao, *Qingdai Jinshi Cidian 清代进士辞典 (Jinshi Dictionary for the Qing Dynasty)* (Zhongguo Wenshi Chubanshe 中国文史出版社, 2004).

Zhaoying 房兆楹 Fang and Lianzhe 杜联喆 Du, *Vol. 19 增较清朝进士题名碑录附引得 (Modified Jinshi Index for the Qing Dynasty)*, *Speical Issue, Harvard-Yenching Institute 哈佛燕京学社引得特刊* (哈佛燕京学社, 1941).

often as to shake our observation, but only a random case, hence not a large problem for the empirical analysis below.

- War: a dummy variable that takes the value of 1 if the province was involved in a war in a particular year, and 0 if not. A hypothesis to be tested here is that warfare might work against financial integration, because it tended to destroy economic and commercial outputs. The data source is A Chronology of Warfare in Dynastic China edited by China's Military History Editorial Committee. This book covers the whole military history of China, recorded wars, battles and campaigns from Before Christ to 1911 AD[291]

- As discussed earlier, we will also need a group of year dummies to control for the differences of non-identically distributed observations.

Below is a table of summarized statistics by province for the variables above.

[291] 中国军事史编写组 (China's Military History Editorial Committee), ed., *Zhongguo Lidai Zhanzheng Nianbiao 中国历代战争年表 (A Chronology of Warfare in Dynastic China)* (Beijing, 1985).

Table 15 Descriptive Statistics, Overall Integration

Province	statistics	interest gap (%)	population (capita)	land (1 Ming-Qing hectare =6.14 hm2)	edu (capita)	Province	statistics	interest gap (%)	population (capita)	land (1 Ming-Qing hectare =6.14 hm2)	edu (capita)
Yunnan	Obs	5	5	5	5	Zhejiang	Obs	27	27	27	27
	Mean	124.4	7,463,483	303,659	7		Mean	24.2	23,200,000	596,828	25
	Std. Dev.	144.6	2,659,405	126,955	4		Std. Dev.	37.7	7,604,114	88,531	9
	Min	20.1	3,545,079	170,084	1		Min	0.6	4,199,189	450,202	14
	Max	364.2	10,300,000	468,098	11		Max	178.4	29,300,000	693,649	42
InnerMongolia	Obs	6	6	6	6	Hubei	Obs	31	31	31	31
	Mean	17.6	3,184,574	492,452	3		Mean	46.8	28,400,000	771,654	9
	Std. Dev.	33.3	154,362	33,706	0		Std. Dev.	75.6	7,664,968	136,222	2
	Min	1.9	3,093,824	472,772	3		Min	6.3	3,497,754	135,262	6
	Max	85.5	3,497,000	560,698	4		Max	423.0	33,400,000	898,817	15
Jilin	Obs	13	13	13	13	Hunan	Obs	7	7	7	7
	Mean	14.7	769,342	91,045	2		Mean	18.3	18,100,000	407,827	8
	Std. Dev.	18.6	1,415,788	79,257	1		Std. Dev.	13.6	6,917,840	150,513	3
	Min	2.0	324,616	49,476	1		Min	6.2	4,061,686	77,737	3
	Max	69.7	5,477,000	302,111	5		Max	43.6	26,300,000	523,879	14
Sichuan	Obs	41	41	41	41	Gansu	Obs	6	6	6	6
	Mean	31.8	32,000,000	733,668	7		Mean	128.8	13,300,000	419,386	3
	Std. Dev.	65.3	12,400,000	88,145	3		Std. Dev.	160.5	3,451,721	91,155	4
	Min	0.5	8,884,777	602,930	2		Min	4.1	7,161,000	236,901	0
	Max	385.2	50,000,000	1,100,000	15		Max	379.9	15,400,000	486,953	9
Anhui	Obs	46	46	46	46	Liaoning	Obs	13	13	13	13
	Mean	29.3	30,200,000	608,611	13		Mean	14.7	2,123,021	133,840	2
	Std. Dev.	62.2	9,054,978	110,068	4		Std. Dev.	18.6	2,618,517	130,935	1
	Min	1.3	6,502,994	417,161	7		Min	2.0	1,041,971	50,568	1
	Max	404.6	37,600,000	922,361	19		Max	69.7	10,700,000	497,237	3
Shandong	Obs	14	14	14	14	Hebei	Obs	24	24	24	24
	Mean	27.6	27,100,000	1,328,571	17		Mean	58.8	22,700,000	1,169,260	23
	Std. Dev.	26.4	8,718,631	132,599	3		Std. Dev.	121.0	5,865,360	228,518	3
	Min	4.1	13,400,000	1,100,000	11		Min	0.1	5,593,787	274,763	19
	Max	77.5	43,900,000	1,500,000	22		Max	538.4	37,300,000	1,300,000	33
Shanxi	Obs	28	28	28	28	Fujian	Obs	39	39	39	39
	Mean	31.7	14,000,000	796,910	10		Mean	17.7	13,500,000	184,839	12
	Std. Dev.	77.0	1,939,503	15,382	1		Std. Dev.	25.0	6,211,752	16,591	5
	Min	0.8	9,569,673	775,972	8		Min	1.3	57,740	123,632	5
	Max	399.7	15,800,000	843,875	11		Max	133.1	19,400,000	213,337	27
Canton	Obs	8	8	8	8	Guizhou	Obs	41	41	41	41
	Mean	17.9	18,200,000	421,713	11		Mean	34.4	5,874,561	102,132	6
	Std. Dev.	24.8	11,300,000	120,545	4		Std. Dev.	56.7	1,273,478	77,338	3
	Min	0.6	3,754,614	231,831	4		Min	3.0	4,807,000	38,574	2
	Max	69.7	29,500,000	540,568	16		Max	373.3	12,000,000	409,992	12
Guangxi	Obs	7	7	7	7	Shannxi	Obs	35	35	35	35
	Mean	34.3	8,530,509	227,654	7		Mean	72.6	11,000,000	360,418	9
	Std. Dev.	37.1	2,648,684	50,695	2		Std. Dev.	204.6	1,788,078	157,818	4
	Min	2.0	7,371,000	129,253	6		Min	0.8	7,400,000	441	4
	Max	112.1	14,500,000	285,378	12		Max	1137.3	13,300,000	496,906	16
Jiangsu	Obs	18	18	18	18	Qinghai	Obs	1	1	1	1
	Mean	27.9	27,600,000	886,063	28		Mean	16.9	344,000	93,750	0
	Std. Dev.	26.4	12,700,000	219,787	10		Std. Dev.	.	.	.	.
	Min	1.0	7,549,970	450,119	17		Min	16.9	344,000	93,750	0
	Max	100.4	44,700,000	1,100,000	45		Max	16.9	344,000	93,750	0
Jiangxi	Obs	7	7	7	7	Heilongjiang	Obs	13	13	13	13
	Mean	488.0	20,600,000	560,662	19		Mean	14.7	314,437	13,601	2
	Std. Dev.	1182.9	3,485,882	77,368	5		Std. Dev.	18.6	405,772	40,911	1
	Min	6.9	15,000,000	453,434	9		Min	2.0	168,000	1,172	1
	Max	3170.1	24,600,000	683,148	25		Max	69.7	1,663,000	149,736	3
Henan	Obs	5	5	5	5						
	Mean	32.1	22,900,000	1,120,000	13						
	Std. Dev.	25.9	8,407,243	83,666	3						
	Min	1.5	8,973,778	1,000,000	10						
	Max	59.8	31,100,000	1,200,000	17						

Before proceeding with regression, some conditional tests should be implemented.

In case of a multicollinearity problem, we run a Pearson test for correlation among variables. It is worth paying attention that land is highly correlated with both population and educational level. So we will try a specification of the model with and another without "land", and then compare their empirical results.

Table 16 Correlation Test

	int-gap	popu	land	edu	war
int-gap	1				
popu	-0.009	1			
land	0.006	0.678***	1		
edu	0.034	0.276***	0.416***	1	
war	-0.019	0.108***	0.101**	-0.056	1

*** significant at 1% level
** significant at 5% level
* significant at 10% level

Also, we will run a robust OLS regression without the spatial impact term W. Firstly, it may work as a benchmark for comparison with the spatial models; and secondly, we can run a test of spatial diagnostics after it, and confirm whether the spatial models are applicable. The result is as follows:

Table 17 Test Statistics of Spatial Models

Test	Statistic	df	p-value
Spatial error:			
Lagrange multiplier	***10.21	1	0.001
Robust Lagrange multiplier	***6.991	1	0.008
Spatial lag:			
Lagrange multiplier	**3.98	1	0.046
Robust Lagrange multiplier	0.756	1	0.385

*** significant at a 1% level
** significant at a 5% level

Regarding the SEM model, both the Lagrange multiplier and the robust Lagrange multiplier are significant at a 1% level. This suggests that the SEM model is applicable on the dataset. Regarding the SLM model, the Lagrange multiplier is also significant, but at a 5%; while the robust Lagrange multiplier is not significant at all. Judging from these test statistics, maybe the SEM method is more applicable than the SLM method. But still, we will run both of them to see their degrees of fitness.

And finally, the study uses the software STATA 14 to do a Maximum Likelihood Estimation (MLE) on structural models above.[292] To reduce the problem of heteroscedasticity and autocorrelation, we will also use the variables in their logged form.

3.3 Empirical Result

[292] The GLS (Generalized Least Square) estimation method can diminish heteroscedasticity and serial autocorrelation in time. But spatial autocorrelation is different from time-series models because the spatial influence is of multi-directional in space, whereas autocorrelation in time is always one-directional (the earlier influences the latter). Linear estimation methods for time-series data are not most suitable here; a non-linear maximization method like MLE is a better choice.

Table 18 Overall Spatial Impact and Explanation

	OLS robust		SLM		SEM		SAC	
	1	2	3	4	5	6	7	
Lnland	0.044		-0.043		-0.048		land	0.000
Lnpop	-0.043	0.011	0.073	0.038	*0.105	0.071	pop	0.000
Lnedu	*0.161	*0.153	*0.151	*0.146	0.081	0.068	edu	***3.431
war	-0.187	-0.174	-0.142	-0.130	-0.101	-0.074	war	0.079
spatial coefficient			ρ		δ		ρ	δ
			*-0.679	*-0.657	***-1.888	***-1.863	-0.6236	-0.93
z			-1.88	-1.82	-6.02	-5.74	-0.97	-1.1
P>z			0.061	0.069	0	0	0.332	0.27
R-squared	0.601	0.600	0.607	0.606	0.613	0.612	0.37	
P-value	0	0	0	0	0	0	0	
Wald test			3.5	3.3	36.3	32.921	217.04	
p-value			-0.061	-0.069	0	0	0	
No. of Obs.	435	435	435	435	435	435	435	

Type: Distance-based (inverse distance) coefficient with * significant at 10% level
Row-standardized: Yes coefficient with *** significant at 1% level

We start with the benchmark OLS regression without the spatial influence term W. The degree of fitness is about 0.6, which means the explanatory power of the OLS model is 60%. Meanwhile, the R-squared values of both SLM and SEM show that they fit slightly better than the OLS model. In other words, the spatial models have slightly higher power of explanation than the robust OLS model, probably through the spatial term of W. But the SAC specification seems much less explanatory than all other three models, with its value of R-squared at only 0.37. Thus it is the least fit model among the four.

Regarding the spatial models, the Wald test and F-test for all three specifications reject the hypothesis that all the coefficients are 0. That confirms the existence of spatial impact from all other markets on the local market. And the regression coefficients of education in Column 3 and 4 are generally lower than those in the OLS regression. This may suggest that some of the explanatory power goes to the spatial impact term W.

Comparing the SLM column and the SEM column, it seems that the latter is a better fit than the former. For one thing, the spatial coefficient of ρ is significant at a 10% level,

whereas δ is significant at a 1% level. For another, the Wald-test statistics and corresponding p-values of SEM are also much more significant than those of the SLM method. Both ρ and δ are negative, which means that regarding financial integration, the local provincial market was negatively associated with all other provinces. This was barely a sign of financial integration.

Now we look at how the explanatory variables affect the overall financial integration respectively. Because the dependent variable is the interest rate gap between the target province and the overall average, it is a negative indicator of the integration. What increases the interest rate gap decreases the integration degree.

Obviously, the level of education is the most influential factor here. The first four regressions in the table above show that education could increase the interest rate gap by 0.15-0.16; and the SAC regression shows it could increase the gap by 3.4, significant at a 1% level. If education denoted local household income and local economy, why did it appear to be negatively related to financial integration?

A possible hypothesis to understand this is relative financial advantages. In the long run, a growing economy would have more capital surplus and easier access to fund, hence lower interest rates. The interest rate on a better developed capital market could keep decreasing even after it was below the average level, thus enlarging the interest rate gap between the market and the rest of the country. This was likely the case considering the large size of the country and its status of uneven development. In this sense, financial "dis-integration" was not a bad thing for market development. It might take some time before the leading market produced sufficient spill-over effect, through arbitrage and capital flow, to lower the interest rate level on adjacent markets too. Before that time, a temporary increase in the interest spread might happen.

A similar case may go to the coefficient of population, which is 0.105 and significant at a 10% level. When the productivity was relatively low, with no capital-or-innovation intensive industries, labour was a major drive for growth. Larger provincial population

likely led to more product and capital surplus on the local market, which in turn would accelerate capital circulation. However, the capital might not necessarily leave the local market to strengthen inter-provincial integration. Whether cross-province capital flow could happen depended on at least three conditions. Firstly, if there was economic drive, namely, arbitrage need for capital flow; secondly, if there were efficient channels, mainly financial tools to assist the flow; and thirdly, if there were policies or institutions that allowed for the flow. Judging from the positive coefficients of population, it is possible that: no sufficient capital surplus on these provincial markets made it out to arbitrage on other markets. But of course, this preliminary observation is only based on the provinces in the years under study here.

Dropping the variable of land does not improve the analysis. Compared with Column 1, the degree of fitness in Column 2 even slightly slides, while the number of significant variables stays the same. This means the variable had little power of influence on financial integration during the period under study. This is likely because land was not only a proxy of the agricultural sector, but also closely connected with many other factors such as population.

The coefficient of warfare is not significant in any of the specifications above. It turns out that warfare did not affect provincial financial integration at all. This may be because that warfare could both stop capital flow (way-blocking and economy broken) and accelerate it (military expenditure and commodities). In other words, there simply was not a pattern of influence between them.

For a closer look, next we categorize the provincial observations by period. Again, considering dynastic patterns on interest rates, we divide the sub-periods by dynasty. The Qing dynasty is divided into two parts by a watershed of the 1840 Opium War, which aims to capture market changes from the western impact on the traditional Chinese economy. Therefore, we repeat the regression on samples of three sub-periods: the Ming period (1368-1644), the Early Qing period (1644-1840) and the Late Qing

(1840-1910) period.

The Ming period does not have sufficient observations to produce statistically significant coefficients, as shown below. (My future research means to collect more data for this period and re-run the test. Still, here we can see that the results here bear some resemblance to the overall-period output above. The spatial impact coefficients are negative. The coefficient of both population and land are extremely close to zero; only education shows some influence on the dependent variable through a negative coefficient.)

Table 19 Overall Integration Test on Sub-periods

		Ming Dynasty				Early Qing Dynasty				Late Qing Dynasty			
		Coef.	Std. Err.	z	P>z	Coef.	Std. Err.	z	P>z	Coef.	Std. Err.	z	P>z
OLS	Lnland	0.00	0.00	-0.28	0.78	-0.06	0.07	-0.81	0.42	-0.0000036	0.00	-0.65	0.52
	Lnpop	0.00	0.00	-0.81	0.43	*0.2	0.11	1.71	0.09	**-0.0000003	0.00	-2.01	0.05
	Lnedu	-0.52	0.69	-0.75	0.46	0.07	0.14	0.48	0.63	**0.4341093	0.20	2.12	0.04
	war	3.84	27.65	0.14	0.89	-0.45	0.44	-1.02	0.31	-14.72	11.77	-1.25	0.21
	R-squared		0.54				0.66				0.53		
SEM	land	0.00	0.00	-0.49	0.63	0.00	0.00	-1.26	0.21	0.00	0.00	0.22	0.82
	pop	0.00	0.00	-0.76	0.45	0.00	0.00	-0.96	0.34	**-0.0000004	0.00	-2.16	0.03
	edu	-0.71	0.55	-1.29	0.20	***9.37	2.73	3.43	0.00	0.54	0.40	1.37	0.17
	war	5.31	26.02	0.20	0.84	9.47	65.23	0.15	0.89	-14.04	8.79	-1.60	0.11
	spatial coefficient δ	-1.70	0.86	-1.96	0.05	**-1.28	0.55	-2.33	0.02	*0.63	0.38	1.66	0.10
	Wald test of lambda=0	chi2(1) = 3.849 (0.050)				chi2(1) = 5.423 (0.020)				chi2(1) = 2.743 (0.098)			
	Squared corr.		0.53				0.37				0.53		
SLM	land	0.00	0.00	-0.33	0.75	0.00	0.00	-0.81	0.42	0.00	0.00	-0.43	0.67
	pop	0.00	0.00	-0.70	0.48	0.00	0.00	-0.70	0.48	0.00	0.00	-1.59	0.11
	edu	-0.51	0.52	-0.99	0.32	***9.36	2.83	3.30	0.00	0.46	0.39	1.18	0.24
	war	4.21	26.33	0.16	0.87	15.15	65.41	0.23	0.82	-14.61	8.89	-1.64	0.11
	spatial coefficient ρ	-0.47	0.69	-0.68	0.50	**-0.99	0.50	-1.98	0.05	0.16	0.59	0.27	0.79
	Wald test of rho=0	chi2(1) = 0.464 (0.496)				chi2(1) = 3.918 (0.048)				chi2(1) = 0.075 (0.785)			
	Squared corr.		0.55				0.39				0.53		
	Number of Obs.		60				237				172		

* SEM and SLM fail to regress the variables in a logged form for these sub-periods.

Type: Distance-based (inverse distance) Row-standardized: Yes

coefficient with * significant at 10% level，coefficient with* * significant at 5% level，coefficient with *** significant at 1% level

The Ming period refers to 16 years scattered during the dynasty (1368-1644);

The Early Qing refers to 33 years scattered during the period (1644-1840);

The Late Qing refers to 17 years scattered during the period (1840-1910).

As for the Early Qing period, the spatial coefficients are significant at a 5% level.

However, the OLS model has higher explanatory power (R^2 at 0.66) than both SEM and SLM (squared correlation at about 0.4). This suggests during this period, spatial interplay barely affected local provincial markets. Meanwhile, the spatial impact coefficient is still negative (-1.28 for SEM and -0.99 for SLM). As discussed above, a negative coefficient of the spatial impact term W suggests the integration performance of the local market was negatively related to that of other provinces. In other words, provincial financial markets were still divergent, hardly a sign of financial integration. (This observation also confirms the findings in Chapter 2. In the study earlier on pair-wise integration at a micro-market level, it is found that during the Early Qing period, financial integration was largely restricted in local and regional economy, and distance had a significant influence on pair-wise market interplay.)

As for Late Qing, the OLS and the spatial models are rivals in explaining provincial integration with the overall market (about 0.53). This suggests the increasing power of spatial coefficient. Namely, the impact of the overall market on local provincial markets became strengthened. Meanwhile, the spatial impact coefficient became positive (0.63 for SEM). It implies that regarding financial integration, the local provincial market was positively connected with all other markets. These two points may be deemed evidence of overall financial integration, namely, a national market started to take shape among provinces at the time. (Again, this echoes the findings of Chapter 2. The pair-wise integration study also shows that a national market did not start to take shape until the Late Qing period.)

Regarding the influence of other explanatory variables (than spatial influence) on integration performances, the sub-period regressions here produce similar results to the overall-period regression above. Land and war are statistically insignificant. Population is significant; but its coefficient is extremely close to zero, suggesting little power in explaining provincial integration performances.

In all the three sub-periods, education is still the most influential variable, statistically significant in both the Early (at 9.36 for SLM and 9.37 for SEM) and Late Qing period (at 0.43 for OLS). This confirms the corresponding findings on the overall regression

above. Local education and economic development probably did not have strong enough a spill-over effect on adjacent markets. If interest rates on a provincial market decreased relative to those on other markets, the interest gap between the former and the latter would be enlarged. But education alone could not fully explain overall integration. Spatial impact was also significant in determining financial interplay among provincial markets. This may explain the improvement in financial integration from the Early Qing to the Late Qing period. Moreover, even combining the work of education and spatial influence, their total explanatory power on the dependent variable was approximately 53% (sub-periods) - 61% (overall period). There were probably other explanatory factors that may help understand the overall integration level. Future research following this PhD thesis shall cover this aspect as further discussion.

3.4 Conclusion

Chapter 3 studies multiple market integration at a provincial level. It aims to explain the overall integration among 23 provinces scattered over 57 years selected from the Ming-Qing period of 1368-1910 AD.

In the overall-period regression, the spatial autoregressive coefficients were negative, suggesting that a local provincial market was negatively related to all other markets. Neither the total acreage of arable land nor being involved in warfare was significant in determining the overall interplay of interest rates. The size of the provincial population is statistically significant, but it has little influence on the dependent variable because the coefficient value is very small. Education is statistically significant and negative. This means the improvement of education tended to increase the interest gap between the local market and other markets, thus to decrease overall integration. A possible hypothesis is that the conditions for cross-province capital flow were not yet fully achieved. Thus, education, economic and financial development in one province was largely restrained within the provincial boundary, but not transformed into positive spill-overs on other provinces to improve overall integration.

The results for three sub-period regressions confirm the findings above on the variables of land, population, war and education. Particularly, education is significant and negative in both the Early and the Late Qing period. From the Early Qing to the Late Qing period: the explanatory power of the spatial impact term *W* strengthened; and the spatial autoregressive coefficient turned from negative to positive. Accordingly, two observations are drawn: There was barely evidence of financial integration before 1840 in the Early Qing period; however, provincial financial markets became more homogeneous and integrated in the Late Qing period. These observations echo the findings on pair-wise integration in Chapter 2.

Conclusion

This thesis studies interest rates scattered over a long period of Chinese financial history (the 6th to 20th century), and gauges financial market integration during the Ming-Qing period (the 14th -20th century). Part I paves way to Part II with a historical background in both the data (sources, quality and patterns) and financial development (instruments, markets and institutions).

Paper I studies interest rates scattered over 6th -20th century China and structural factors that determined them. Overall, the interest rate level decreased in the markets under study, with interest fluctuations in pace with dynastic cycles of up-and-down. Significant political events such as military and political conflicts also affected interest rates, but mostly with temporary shocks. Economic boom spurred commodity and capital flows, thus provoked financial development (institution, innovation, markets, etc.) which had profound and secular impact on interest rates.

More detailed findings concern loan features and how they affected interest rates. Intrinsic loan features such as maturity, creditor type, currency form, and so on, all had a significant influence on interest rates. Loans with the longest maturity cost the least in interest payment; interest rates of modern banks were generally lower than those of traditional financial institutions; among financial institutions' interest rates, the highest rate came from pawnshops; among personal transactions' rates, commercial loans between merchants cost less than those between friends and relatives; regarding credit form, grain loans cost the highest interest payment, followed by paper notes, copper coins, silver/copper dollars and silver tael; with reference to the amount of principal, the smallest amount cost the most return rate.

With all these intrinsic attributes controlled for, the baseline/lowest interest rate level in China is found for the dataset. There are ups-and-downs in-between centuries and dynasties. The two interest troughs on the line are the 9th-11th century of the Song dynasty and the 19th century of the Republican era. Qualitative evidence from the history

of economic and financial development also support the empirical findings to some extent. This suggests that the Song dynasty might be comparable with the eve of China's industrialisation regarding financial development. In this sense, the evidence supports the Tang-Song transition school from a financial perspective. Still, we cannot exclude the possibility that new evidence may be found about more markets of China and in more years of Chinese financial history. One should be cautious in reading the results above, and the present study is also open to further discussions.

Part II researches financial integration in Late Imperial China (namely, through the Ming-Qing period to the Republican era (the 14th-20th century).

Chapter 2 discusses pair-wise integration based on time-series data in the 18th-20th century. It shows that before 1840, distance was the major (but not the only) determinant of financial integration. Special trade and economic links could provoke a long-distance capital flow, which could reach slightly farther than the commodity (grain) flow. The maximum range of financial integration at the time was up to 1,400 kilometres, which complements Skinner's theory on the macro-regional economies with new evidence from financial markets: there was financial market integration for inner-regional market pairs (no more than 1,400 kilometres apart), and little integration for inter-regional market pairs (more than 1,400 kilometres apart).

Overall, the integration performance before 1840 was limited, with large gaps among distance groups regarding both interest divergence and adjustment speed. National financial integration did not start until the Late-Qing period in the 19th century, when both local and cross-regional capital markets became more homogeneous with converging interest rate gaps and synchronizing arbitrage speed. Integration progress mostly involved economic, technological and institutional changes that lowered transaction cost, spurred trade and assisted capital flow. But the last wars (the 2nd anti-Japanese war and the 2nd civil war in China) before the establishment of the People's Republic of China stopped this integration process. All the distance groups once again

became much diversified regarding both interest divergence and adjustment speed.

Following pair-wise integration analyses in Chapter 2, Chapter 3 studies overall integration among multiple provincial markets scattered over 57 years in the Ming-Qing period (1368-1910). The overall integration performance can be explained by three factors: education, population, and the relative position of the local market to all other markets. The spatial autoregressive coefficients were negative, suggesting that a local provincial market was negatively related to all other markets. Neither land nor war is statistically significant. Population is statistically significant, but has little influence on the dependent variable because the coefficient is very small. The level of education is positively associated with interest rate gaps, accounting for some 60% of them, hence negatively connected with integration. But this might be a good sign of local financial development, which lowered interest rates and temporarily enlarged interest rate gaps. Judging from the results in the three sub-periods, there was barely evidence of financial integration before 1840 in the Early Qing period; however, financial markets became more homogeneous and integrated in the Late Qing period. Namely, findings on overall integration among multiple provincial markets confirm those of pair-wise integration analyses in Chapter 2.

Appendix

Appendix 1 Interpolation Technique

To develop and match time series for integration analysis, uneven data distribution in time and space suggests the necessity of interpolation. Time series of a certain locality can be supplemented by using this technique before being matched or compared with data from other localities.

Simple methods such as linear interpolation and spline interpolation were tried first. But their outputs are either out of range or apparently do not follow historical changes of the financial system. Maybe this is because time series of interest rates closely relate to on-going social transformation of economic structures in the past centuries. [293]And this is exactly the case for which the state space approach is better fit.

Thus the paper employs the state-space form of a structural time series model, with unobserved components such as historical trend and cycle. Its observation equation is as below:

$$y_t = \mu_t + \psi_t + \varepsilon_t, t = 1, \cdots, T, \varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$$

μ_t represents the trend component, which in turn is defined by the three state equations below.

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \omega_t + \eta_t, \eta_t \sim NID(0, \sigma_\eta^2)$$
$$\omega_t = \alpha\omega_{t-1} + \nu_t, \nu_t \sim NID(0, \sigma_\nu^2)$$
$$\beta_t = \beta_{t-1} + \zeta_t, \zeta_t \sim NID(0, \sigma_\zeta^2)$$

where μ_{t-1} is the level component, and β_t the slope component (as in a local level linear trend model), while ω_t is disturbance in an AR(1) form.

[293] Maddala and Kim, *Unit Roots, Co-Integration, and Structural Change*.

ψ_t represents the cycle component, which in turn is determined by the next two state equations.

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \xi_t \\ \xi_t^* \end{bmatrix} + \begin{bmatrix} k_t \\ k_t^* \end{bmatrix}, \begin{bmatrix} k_t \\ k_t^* \end{bmatrix} \sim NID(0, \begin{bmatrix} \sigma_k^2 & 0 \\ 0 & \sigma_k^2 \end{bmatrix})$$

$$\begin{bmatrix} \xi_t \\ \xi_t^* \end{bmatrix} = \theta \begin{bmatrix} \xi_{t-1} \\ \xi_{t-1}^* \end{bmatrix} + \begin{bmatrix} h_t \\ h_t^* \end{bmatrix}, \begin{bmatrix} h_t \\ h_t^* \end{bmatrix} \sim NID(0, \begin{bmatrix} \sigma_h^2 & 0 \\ 0 & \sigma_h^2 \end{bmatrix})$$

where c is the period of the cycle, and ρ is a damping factor as which approaches to 1 ψ_t reduces to a deterministic stationary sine-cosine wave.[294] Again ξ_t is disturbance in an AR(1) form.[295]

The software of OxMetrix/STAMP[296] is used to process the state space model. Please refer to papers in the footnotes below for details of estimation.

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[294] Siem Jan Koopman, Neil Shephard, and Jurgen A. Doornik, "Statistical Algorithms for Models in State Space Using SsfPack 2.2," *Econometrics Journal* 2, no. 1 (1998): 116 of 107–60.
A. C. Harvey and Streibel，M., "Testing for Deterministic versus Indeterministic Cycles," *Journal of Times Series Analysis* 19 (1998): 505–29.

[295] Such autoregressive form of disturbance is based on Peng Kaixiang's revision of the original state space model. See his paper "Historical Explanation and Re-interpretation of Crop Prices since the Beginning of Qing Dynasty", *FED Working Paper Series*, No. FC20050046 , Henan University.

[296] STAMP (Structural Time Series Analyzer, Modeler and Predictor) is a commercial, graphical user interface (GUI)-based package for the analysis of both univariate and multivariate state-space models written by Koopman, Harvey, Doornik, and Shephard (2009). It runs on Windows, Macintosh and Linux operating systems as part of the larger OxMetrics System, a software system for (econometric) data analysis and forecasting (Doornik 2009). See
SJ Koopman et al., *STAMP 8.2: Structural Time Series Analyser, Modeler, and Predictor* (London: Timberlake Consultants, 2009).
Roy Mendelssohn, "The Stamp Software for State Space Models," *Journal of Statistical Software* 41, no. 2 (2011).

Appendix 2 Time Table of Chinese Dynasties

Chinese Dynasties		start	end	Years in Reign
Spring and Autumn Period	春秋	770 B.C.	476 B.C.	294
Warring States Period	战国	475 B.C.	221 B.C.	254
Qin	秦	221 B.C.	206 B.C.	15
Western Han	西汉	206 B.C.	A.D. 24	229
Eastern Han	东汉	25	220	195
Three Kingdoms	三国	220	265	45
Western Jin	西晋	265	317	52
Eastern Jin	东晋	317	420	103
Southern and Northern Dynasties	南北朝	420	589	169
Sui	隋	581	618	37
Tang	唐	618	907	289
Five Dynasties and Ten Kingdoms	五代十国	907	960	53
Northern Song	南宋	960	1127	167
Southern Song	北宋	1127	1279	152
Yuan	元	1280	1368	88
Ming	明	1368	1644	276
Qing	清	1644	1911	268

The imperial China period starts from the first Chinese empire of Qin, when the first emperor united all seven kingdoms of feudal lords and set up a centralized polity over the whole country in 221 BC; it ends at the end of the Qing dynasty in 1911 AD
The imperial period may be further divided into two parts, with the Tang-Song era as the turning point. Times since the Tang-Song era are deemed the "late imperial China" period.[297]

[297] Liu, "Wrestling for Power: The State and the Economy in Later Imperial China, 1000- 1770 (竞逐权力:晚期中华帝国的国家与市场经济)."
G. William Skinner, *The City in Late Imperial China*, ed. G. William Skinner (Stanford: Stanford University Press, 1977).
Benjamin A. Elman, *A Cultural History of Civil Examinations in Late Imperial China*, ed. Philip E. Lilienthal Book (University of California Press, 2000). (The "late imperial China" period here covers the dynasty of Yuan, Ming, and Ch'ing, 1315-1904).

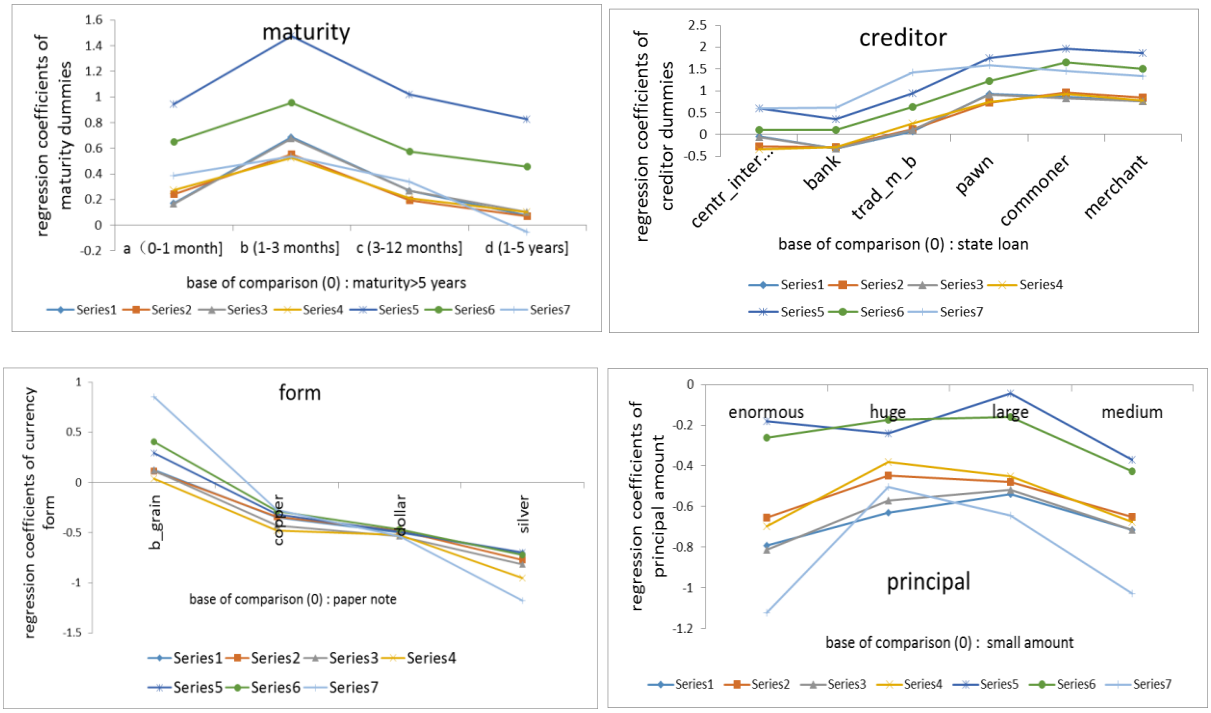
Appendix 3 Regression Coefficients: External and Internal

Specification		1 (all periods)		2 (all periods)		3 (all periods)		4 (all periods)		5 (all periods)		6 (all periods)		7 (Republican Era)	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Trend	by year	-0.00611%	0.30	-0.02904%	0.00										
Dynasty /Period	Tang					3.30	0.00	3.28	0.00						
	Song					3.13	0.00	3.34	0.00						
	Yuan					3.89	0.00	3.76	0.00						
	Ming					3.68	0.00	3.38	0.00						
	Qing					3.42	0.00	3.21	0.00						
	Republican					3.31	0.00	2.99	0.00						
	P.R.C.					2.64	0.00	2.28	0.00						
Century	6th C.									-0.37	0.34	-0.09	0.85		
	7th C.									1.83	0.00	2.35	0.00		
	8th C.									2.58	0.00	3.17	0.00		
	9th C.									0.75	0.00	1.37	0.00		
	10th C.									0.41	0.00	-0.17	0.24		
	11th C.									0.18	0.20	0.88	0.02		
	12th C.									0.84	0.00	1.70	0.00		
	13th C.									1.75	0.00	2.23	0.00		
	14th C.									1.83	0.00	1.66	0.00		
	15th C.									1.59	0.00	1.03	0.00		
	16th C.									1.15	0.00	0.67	0.00		
	17th C.									1.24	0.00	0.85	0.00		
	18th C.									1.19	0.00	0.68	0.00		
	19th C.									0.95	0.00	0.56	0.00		
	20th C.									1.03	0.00	0.64	0.00		
Region	Coastal Area	-0.01	0.67			-0.06	0.00			-0.03	0.08				
	Inland Area	0.03	0.07			-0.02	0.32			0.03	0.07				
	JIANGSU			0.47	0.00			0.37	0.00			1.31	0.00	2.17	0.00
	HUNAN			0.12	0.22			-0.02	0.90			1.02	0.00	1.56	0.00
	HUBEI			0.51	0.00			0.41	0.00			1.40	0.00	2.03	0.00
	SICHUAN			0.49	0.00			0.34	0.01			1.40	0.00	2.17	0.00
	HEBEI			0.56	0.00			0.45	0.00			1.45	0.00	2.20	0.00
	HKMC			-0.12	0.36			-0.27	0.07			0.74	0.00	1.15	0.00
	ZHEJIANG			1.24	0.00			1.11	0.00			2.12	0.00	2.84	0.00
	INNERMONGOLIA			0.30	0.01			0.07	0.61			1.19	0.00	2.81	0.00
	DONGBEI			0.34	0.00			0.33	0.01			1.24	0.00	2.02	0.00
	NINGXIA			0.77	0.00			0.69	0.01			1.67	0.00	2.43	0.00
	GANSU			0.60	0.00			0.47	0.00			1.42	0.00	2.53	0.00
	SHANNXI			0.56	0.00			0.38	0.00			1.45	0.00	2.87	0.00
	SHANXI			0.09	0.34			-0.03	0.79			1.00	0.00	1.51	0.00
	SHANDONG			0.28	0.01			0.18	0.15			1.17	0.00	1.83	0.00
	ANHUI			0.01	0.92			-0.16	0.18			0.91	0.00	1.87	0.00
	HENAN			0.47	0.00			0.37	0.00			1.36	0.00	2.05	0.00
	YUNNAN			0.68	0.00			0.57	0.00			1.58	0.00	2.16	0.00
	GUIZHOU			0.92	0.00			0.75	0.00			1.83	0.00	2.01	0.00
	JIANGXI			0.22	0.03			0.11	0.37			1.10	0.00	1.68	0.00
	FUJIAN			0.17	0.08			0.06	0.62			1.04	0.00	1.75	0.00
	CANTON			0.20	0.06			0.13	0.31			1.10	0.00	1.94	0.00
	GUANGXI			0.69	0.00			0.57	0.00			1.58	0.00	2.61	0.00
	QINGHAI			0.82	0.00			0.73	0.00			1.67	0.00	2.56	0.00
	TAIWAN			0.15	0.11			-0.04	0.76			1.01	0.00	1.47	0.00
Location	urban	0.11	0.00	0.12	0.00	0.13	0.00	0.10	0.00	0.18	0.00	0.19	0.00	-0.22	0.00
Maturity	a（0-1 month]	0.17	0.00	0.24	0.00	0.17	0.00	0.27	0.00	0.95	0.00	0.65	0.00	0.39	0.00
	b (1-3 months]	0.69	0.00	0.55	0.00	0.68	0.00	0.53	0.00	1.48	0.00	0.95	0.00	0.54	0.00
	c (3-12 months]	0.27	0.00	0.19	0.00	0.27	0.00	0.21	0.00	1.02	0.00	0.58	0.00	0.34	0.00
	d (1-5 years]	0.08	0.07	0.07	0.12	0.10	0.02	0.10	0.02	0.83	0.00	0.46	0.00	-0.05	0.48
Creditor	centr_inter_bank	-0.05	0.50	-0.28	0.00	-0.06	0.34	-0.34	0.00	0.60	0.00	0.10	0.15	0.60	0.00
	bank	-0.32	0.00	-0.30	0.00	-0.33	0.00	-0.29	0.00	0.35	0.00	0.11	0.06	0.61	0.00
	trad_m_b	0.07	0.30	0.13	0.08	0.11	0.09	0.25	0.00	0.95	0.00	0.63	0.00	1.43	0.00
	pawn	0.94	0.00	0.74	0.00	0.91	0.00	0.75	0.00	1.75	0.00	1.22	0.00	1.59	0.00
	commoner	0.86	0.00	0.97	0.00	0.83	0.00	0.93	0.00	1.96	0.00	1.66	0.00	1.46	0.00
	merchant	0.77	0.00	0.84	0.00	0.76	0.00	0.79	0.00	1.87	0.00	1.51	0.00	1.34	0.00
Debtor	N1	-0.69	0.00	-0.64	0.00	-0.68	0.00	-0.63	0.00	0.24	0.00	-0.09	0.13	0.19	0.04
	N2	-1.65	0.00	-1.56	0.00	-1.66	0.00	-1.59	0.00	-0.73	0.00	-1.02	0.00	-0.87	0.00
	N3	-1.44	0.00	-1.33	0.00	-1.45	0.00	-1.32	0.00	-0.54	0.00	-0.80	0.00	-0.43	0.00
	N4	-1.27	0.00	-1.18	0.00	-1.07	0.00	-0.97	0.00	-0.33	0.00	-0.64	0.00	-0.33	0.01
	N5	-1.17	0.00	-0.98	0.00	-1.21	0.00	-1.00	0.00	-0.25	0.03	-0.43	0.00	-0.12	0.36
	N6	-1.30	0.00	-1.19	0.00	-1.32	0.00	-1.20	0.00	-0.40	0.01	-0.66	0.00	-0.30	0.07
Collateral	yes	0.08	0.00	0.11	0.00	0.06	0.01	0.10	0.00	0.30	0.00	0.23	0.00	0.06	0.31
Form	b_grain	0.13	0.04	0.11	0.06	0.12	0.06	0.04	0.55	0.30	0.00	0.41	0.00	0.85	0.00
	copper	-0.35	0.00	-0.34	0.00	-0.43	0.00	-0.48	0.00	-0.32	0.00	-0.29	0.00	-0.28	0.00
	dollar	-0.50	0.00	-0.48	0.00	-0.53	0.00	-0.52	0.00	-0.49	0.00	-0.46	0.00	-0.54	0.00
	silver	-0.71	0.00	-0.77	0.00	-0.82	0.00	-0.95	0.00	-0.70	0.00	-0.72	0.00	-1.18	0.00
Principal	enormous	-0.79	0.00	-0.65	0.00	-0.81	0.00	-0.70	0.00	-0.18	0.00	-0.26	0.00	-1.12	0.00
	huge	-0.63	0.00	-0.45	0.00	-0.57	0.00	-0.38	0.00	-0.24	0.00	-0.17	0.04	-0.50	0.00
	large	-0.54	0.00	-0.48	0.00	-0.52	0.00	-0.45	0.00	-0.04	0.39	-0.16	0.00	-0.64	0.00
	medium	-0.71	0.00	-0.65	0.00	-0.72	0.00	-0.68	0.00	-0.37	0.00	-0.43	0.00	-1.03	0.00
	constant	3.37	0.00	3.41	0.00									0.98	0.00
no. of observations		25733		25733		25733		25733		25733		25733		17287	
Prob>F		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
R-squared		0.4443		0.5040		0.9341		0.9415		0.9326		0.9405		0.4953	

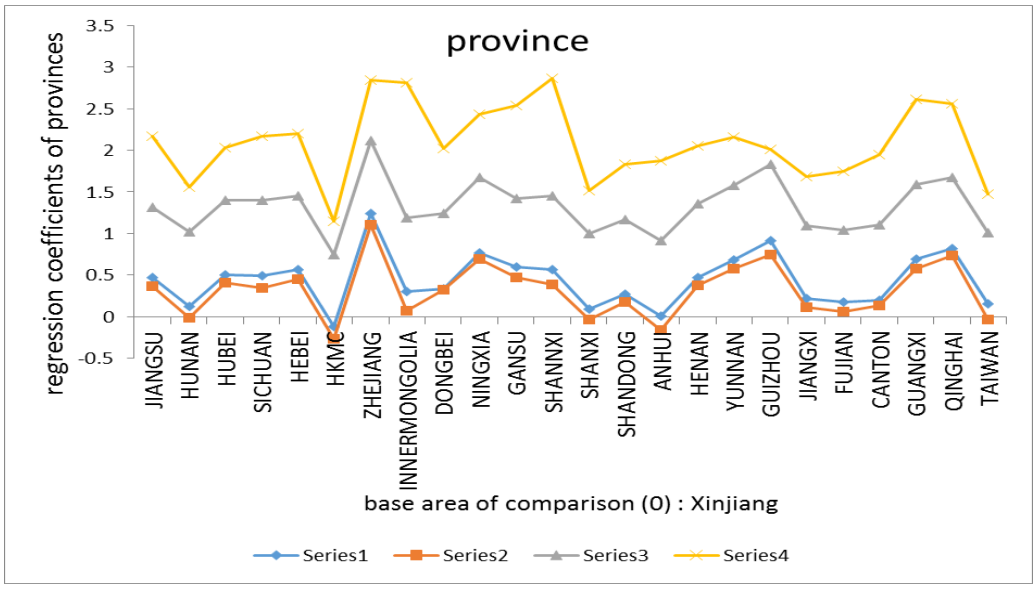
White-adjusted standard errors and covariances.

Data source: own dataset of 26,107 entries containing transactional details or attributes of interest rates.
Notes: Specifications 1-6 are different combinations of the terms in the model. In all these tables, Specification 1 stands for the regression output of a Trend term (T), Regional dummies (R) and Feature dummies of loans (F); Specification 2 for that of (T), Provincial dummies (P) and (F); Specification 3 for that of Dynastic dummies (D), (R) and (F); Specification 4 for that of (D), (P), (F); Specification 5 for that of Century dummies (C), (R), (F); Specification 6 for that of (C), (P), (F); Specification 7 that of (P) and (F), based only on data from the sub-period of the Republican era (1911-49).

Appendix 4 Robustness Test (1): Specifications and Samples



Notes: Series 1-7 in the figures above match the regression coefficients of Column 1-7 in the table of Appendix 3.



Notes: Series 1-4 in the figure above match the regression coefficients of Column 2, 4, 6, 7 in the table of Appendix 3.

Overall, the trend lines in each variable group resemble each other very much, though

the values of coefficient have slight differences across samples.

In the figure of principal and that of creditor, coefficients of Series (7) – namely the specification for the sub-period of Republican Era – are slightly more different from others. This suggests the influence of principal and creditor on interest rates slightly varied from that for the overall period. It may also be interesting to make an interactive term, such as (the principal dummy *time dummy), to see how the explanatory power of these features varied in time. And explanation for this may require more detailed historical analysis. All these may be of interesting topic for future research. But this study confines itself to the description so far, and does not tend to make further historical argument.[298]

[298] This is because the focus of the thesis is the long-term pattern of loan features, not any particular dynasty. Moreover, current data availability for other dynasties does not allow for statistically significant output of the regression. Thus, the paper cannot compare and find out how or why the influence of these features varied in time.

Appendix 5 Robustness Test (2): Different Samples

Sample No.		(1)		(2)		(3)		(4)	
Data Selection		all		annual rate<=120%		annual rate<=50%		annual rate<=9%	
Dummy Group		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Maturity	a（0-1 month]	0.17	0.00	0.11	0.01	0.02	0.56	-0.089752	0.001
	b (1-3 months]	0.69	0.00	0.52	0.00	0.41	0.00	-0.190217	0
	c (3-12 months]	0.27	0.00	0.25	0.00	0.15	0.00	-0.183325	0
	d (1-5 years]	0.08	0.07	0.06	0.14	0.12	0.00	-0.336693	0
Location	urban	0.11	0.00	0.03	0.09	-0.03	0.04	-0.309164	0
Creditor	centr_inter_bank	-0.03	0.66	-0.10	0.09	-0.07	0.16	-0.0432	0.643
	bank	-0.32	0.00	-0.32	0.00	-0.22	0.00	0.04299	0.63
	trad_m_b	0.07	0.30	-0.01	0.89	0.05	0.33	0.109023	0.154
	pawn	0.95	0.00	0.97	0.00	0.95	0.00	-0.13254	0.47
	commoner	0.86	0.00	0.79	0.00	0.76	0.00	-0.446038	0
	merchant	0.77	0.00	0.69	0.00	0.64	0.00	-0.457897	0
Debtor	N1	-0.70	0.00	-0.55	0.00	-0.49	0.00	-0.061634	0.194
	N2	-1.64	0.00	-1.41	0.00	-1.21	0.00	-0.949914	0%
	N3	-1.44	0.00	-1.20	0.00	-0.98	0.00	-0.584325	0%
	N4	-1.28	0.00	-0.95	0.00	-0.70	0.00	-0.159186	2%
	N5	-1.18	0.00	-0.84	0.00	-0.55	0.00	-0.387804	0
	N6	-1.31	0.00	-1.03	0.00	-0.80	0.00	-0.544521	0
Collateral	yes	0.08	0.00	0.14	0.00	0.12	0.00	-0.078342	0.274
Form	b_grain	0.18	0.00	0.37	0.00	0.51	0.00	0.137678	0.451
	copper	-0.35	0.00	-0.15	0.00	-0.05	0.00	0.181747	0
	dollar	-0.50	0.00	-0.20	0.00	-0.02	0.09	0.17438	0
	silver	-0.70	0.00	-0.37	0.00	-0.14	0.00	0.138485	0
Principal	enormous	-0.80	0.00	-0.61	0.00	-0.60	0.00	-0.684899	0
	huge	-0.65	0.00	-0.57	0.00	-0.72	0.00	-0.263735	0.034
	large	-0.55	0.00	-0.51	0.00	-0.47	0.00	-0.694351	0
	medium	-0.73	0.00	-0.58	0.00	-0.47	0.00	-0.505673	0
	constant	3.27	0.00	2.95	0.00	2.75	0.00	2.834113	0
	no.of observations	26107		25061		22867		7196	
	R-squared	0.44		0.55		0.64		0.34	

White-adjusted standard errors and covariances.

Note: Sample 1 is 26,107 interest rates containing transactional details or attributes of interest rates. Sample 2 drops those data larger than 120% at an annual level. Sample 3 covers only those smaller than 50% at an annual level, and Sample 4 those smaller than 9%...

Appendix 6 Independent Variable Settings and Pearson Test of Correlation[299]

var2	time trend	var28	inland area	var54	medium principal
var3	Tang dynasty	var30	a（0-1 month]	var55	JIANGSU
var4	Song dynasty	var31	b (1-3 months]	var56	HUNAN
var5	Yuan dynasty	var32	c (3-12 months]	var57	HUBEI
var6	Ming dyansty	var33	d (1-5 years]	var58	SICHUAN
var7	Qing dynasty	var34	centr_inter_bank	var59	HEBEI
var8	Republican era	var35	bank	var60	HKMC
var9	P.R.C. era	var36	trad_m_b	var61	ZHEJIANG
var10	the 6th century	var37	pawn	var62	INNERMONGOLIA
var11	the 7th century	var38	commoner	var63	DONGBEI
var12	the 8th century	var39	merchant	var64	NINGXIA
var13	the 9th century	var40	N1, fixed deposit of modern banks	var65	GANSU
var14	the 10th century	var41	N2, cheque	var66	SHANNXI
var15	the 11th century	var42	N3, passbook	var67	SHANXI
var16	the 12th century	var43	N4,lump sum withdraw on expiration	var68	SHANDONG
var17	the 13th century	var44	N5, notice deposit	var69	ANHUI
var18	the 14th century	var45	N6, temporary deposit	var70	HENAN
var19	the 15th century	var46	with collateral	var71	YUNNAN
var20	the 16th century	var47	grain loan	var72	GUIZHOU
var21	the 17th century	var48	copper coin loan	var73	JIANGXI
var22	the 18th century	var49	dollar loan	var74	FUJIAN
var23	the 19th century	var50	silver loan	var75	CANTON
var24	the 20th century	var51	enormous principal	var76	GUANGXI
var26	urban	var52	huge principal	var77	QINGHAI
var27	coastal area	var53	large principal	var78	TAIWAN

[299] Note that these variables are not regressed all together at one time. It depends on the specification of the model, which we have several to test and compare different performances. For example, we do not regress Var 2 at the same time with any of the variable ranging from Var 3 to Var 24 (see the parameters in grey), for they are all time dummies and may cause multicollinearity.

	var2	var3	var4	var5	var6	var7	var8
var2	1						
var3	-0.9281	1					
var4	-0.1343	-0.0047	1				
var5	-0.0813	-0.0039	-0.0008	1			
var6	-0.1626	-0.0113	-0.0023	-0.0019	1		
var7	-0.0899	-0.0953	-0.0195	-0.0161	-0.0473	1	
var8	0.4056	-0.2167	-0.0445	-0.0367	-0.1077	-0.9069	1
var9	0.052	-0.0166	-0.0034	-0.0028	-0.0083	-0.0696	-0.1582
var10	-0.094	0.0821	-0.0004	-0.0003	-0.0009	-0.0078	-0.0178
var11	-0.2677	0.2429	-0.0011	-0.0009	-0.0027	-0.0231	-0.0526
var12	-0.206	0.2052	-0.001	-0.0008	-0.0023	-0.0195	-0.0445
var13	-0.8364	0.911	-0.0043	-0.0035	-0.0103	-0.0868	-0.1974
var14	-0.2842	0.3182	-0.0016	-0.0013	0.0269	-0.0318	-0.0723
var15	-0.0585	-0.0019	0.3998	-0.0003	-0.0009	-0.0078	-0.0178
var16	-0.1165	-0.0041	0.8717	-0.0007	-0.002	-0.017	-0.0388
var17	-0.0525	-0.0021	0.2681	0.2167	-0.001	-0.0087	-0.0199
var18	-0.0858	-0.0042	-0.0009	0.8134	0.0907	-0.0175	-0.0398
var19	-0.1123	-0.0068	-0.0014	-0.0012	0.6014	-0.0285	-0.0648
var20	-0.0867	-0.0064	-0.0013	-0.0011	0.5663	-0.0268	-0.061
var21	-0.0897	-0.0102	-0.0021	-0.0017	0.2859	0.0587	-0.0968
var22	-0.159	-0.0337	-0.0069	-0.0057	-0.0144	0.3491	-0.3167
var23	-0.0617	-0.0631	-0.0129	-0.0107	-0.0313	0.5904	-0.5314
var24	0.5172	-0.2824	-0.058	-0.0478	-0.1404	-0.6266	0.7071
var26	-0.0298	0.0703	0.0199	-0.0133	-0.0567	-0.0029	-0.0274

var27	0.1882	-0.1619	-0.0332	-0.0274	0.0246	0.0254	0.0537
var28	0.006	-0.0661	-0.0047	-0.0119	-0.0107	0.1084	-0.069
var29	0.1868	-0.2144	-0.0361	-0.0363	0.0222	0.1567	-0.0462
var30	0.1471	-0.092	-0.0189	-0.0156	-0.0457	-0.1238	0.1687
var31	0.0817	-0.0471	-0.0135	-0.0111	-0.0312	-0.1763	0.1776
var32	-0.1884	0.132	0.03	0.0127	0.0706	0.1566	-0.1969
var33	0.001	-0.0333	-0.0068	-0.0056	-0.0141	0.1723	-0.1723
var34	0.0635	-0.0517	-0.0106	-0.0087	-0.0257	0.0453	-0.0133
var35	0.1632	-0.0842	-0.0173	-0.0142	-0.0418	-0.264	0.2862
var36	0.0252	-0.0227	-0.0047	-0.0038	-0.0113	-0.0339	0.0459
var37	-0.0451	-0.056	0.0791	0.0077	0.0251	0.3188	-0.2889
var38	-0.2466	0.2095	-0.0206	0.0091	0.0705	0.1399	-0.194
var39	0.0429	-0.0283	-0.0061	-0.005	-0.0148	-0.1073	0.1203
var40	0.0841	-0.0481	-0.0099	-0.0081	-0.0239	-0.1111	0.0881
var41	0.0536	-0.0284	-0.0058	-0.0048	-0.0141	-0.0682	0.0698
var42	0.0367	-0.0194	-0.004	-0.0033	-0.0096	-0.0704	0.0759
var43	0.0196	-0.0072	-0.0015	-0.0012	-0.0036	-0.03	-0.0064
var44	0.0187	-0.0079	-0.0016	-0.0013	-0.0039	-0.0332	0.0366
var45	0.0095	-0.0048	-0.001	-0.0008	-0.0024	-0.0199	0.022
var46	0.1125	-0.1307	0.0316	-0.013	-0.0272	0.0791	-0.0218
var47	-0.7314	0.7484	-0.0056	0.072	0.1028	-0.0506	-0.202
var48	-0.1298	-0.0337	0.0664	0.0077	0.0496	0.4953	-0.467
var49	0.1943	-0.1277	-0.0262	-0.0216	-0.0635	-0.2209	0.2874
var50	-0.0422	-0.0496	-0.0102	-0.0033	0.0499	0.3141	-0.2855
var51	-0.0769	0.0249	-0.0044	0.0393	-0.007	0.1186	-0.1191
var52	-0.0001	-0.0113	-0.0023	-0.0019	0.0082	0.0107	-0.0058

var53	0.2451	-0.1471	-0.0303	-0.025	-0.0672	-0.3025	0.3254
var54	-0.1979	0.1277	0.0227	-0.0022	0.0628	0.2858	-0.3004
var55	0.0488	-0.0508	-0.0104	-0.0086	0.046	0.0465	-0.0263
var56	0.0558	-0.0349	0.0098	-0.0059	-0.0103	-0.0764	0.0918
var57	0.0292	-0.0333	-0.0068	-0.0056	-0.0068	-0.077	0.0921
var58	-0.0257	-0.0217	-0.0045	-0.0037	-0.0035	0.1489	-0.1318
var59	0.0412	-0.0406	-0.0083	-0.0009	-0.0059	-0.0053	0.0263
var60	0.0044	-0.0063	-0.0013	-0.0011	-0.0032	0.0241	-0.0194
var61	0.0591	-0.0346	-0.0071	-0.0058	0.0253	-0.1029	0.1126
var62	0.0107	-0.0086	-0.0018	-0.0015	-0.0043	0.0786	-0.0706
var63	0.0831	-0.0562	-0.0115	-0.0095	-0.0264	-0.2001	0.1473
var64	0.0033	-0.0026	-0.0005	-0.0004	-0.0013	-0.0062	0.0075
var65	-0.1267	0.1331	-0.0025	0.1099	-0.0061	0.0312	-0.0757
var66	-0.0224	-0.011	-0.004	-0.0033	0.0272	0.1759	-0.1665
var67	0.0356	-0.0294	-0.006	-0.005	-0.0119	0.0048	0.0122
var68	0.0471	-0.0316	-0.0065	-0.0053	-0.0106	-0.0965	0.1105
var69	-0.0248	-0.0297	-0.0061	-0.005	0.0475	0.2526	-0.2357
var70	0.0101	-0.0172	0.0075	0.0105	0.0143	-0.0341	0.0378
var71	-0.0043	-0.0048	-0.001	-0.0008	0.0139	0.0097	-0.0091
var72	-0.0727	-0.03	-0.0061	-0.0051	-0.0149	0.31	-0.2809
var73	0.0258	-0.0198	-0.0041	-0.0033	0.018	-0.0592	0.0641
var74	0.01	-0.0354	-0.0073	-0.006	0.0032	0.0491	-0.0299
var75	0.0116	-0.018	-0.0037	-0.0031	0.0215	-0.0122	0.0174
var76	-0.0141	-0.0068	-0.0014	-0.0012	0.008	0.0432	-0.0394
var77	0.0097	-0.0068	-0.0014	-0.0012	-0.0034	-0.004	0.0078
var78	0.1359	-0.0838	-0.0172	-0.0142	-0.0405	-0.0425	0.0899

	var9	var10	var11	var12	var13	var14	var15
var9	1						
var10	-0.0014	1					
var11	-0.004	0.2533	1				
var12	-0.0034	-0.0004	-0.0011	1			
var13	-0.0151	-0.0017	-0.005	-0.0043	1		
var14	-0.0055	-0.0006	-0.0018	-0.0016	0.1458	1	
var15	-0.0014	-0.0002	-0.0005	-0.0004	-0.0017	-0.0006	1
var16	-0.003	-0.0003	-0.001	-0.0008	-0.0037	-0.0014	-0.0003
var17	-0.0015	-0.0002	-0.0005	-0.0004	-0.0019	-0.0007	-0.0002
var18	-0.0031	-0.0003	-0.001	-0.0009	-0.0038	-0.0014	-0.0003
var19	-0.005	-0.0006	-0.0017	-0.0014	-0.0062	-0.0023	-0.0006
var20	-0.0047	-0.0005	-0.0016	-0.0013	-0.0058	-0.0021	-0.0005
var21	-0.0074	-0.0008	-0.0025	-0.0021	-0.0093	-0.0034	-0.0008
var22	-0.0246	-0.0028	-0.0082	-0.0069	-0.0307	-0.0113	-0.0028
var23	-0.046	-0.0052	-0.0153	-0.0129	-0.0574	-0.021	-0.0052
var24	0.0588	-0.0232	-0.0686	-0.058	-0.2573	-0.0942	-0.0232
var26	0.0709	0.008	0.0144	0.0199	0.0716	-0.0447	0.008
var27	-0.1182	-0.0133	-0.0393	-0.0332	-0.1475	-0.054	-0.0133
var28	-0.0512	-0.0058	-0.0006	-0.0144	-0.0639	-0.0234	-0.0058
var29	-0.1566	-0.0176	-0.0521	-0.044	-0.1953	-0.0715	-0.0176
var30	-0.0482	-0.0075	-0.0223	-0.0189	-0.0838	-0.0307	-0.0075
var31	0.058	-0.0054	0.007	0.0306	-0.0559	-0.0219	-0.0054
var32	-0.0398	0.012	0.0187	-0.0047	0.1302	0.0487	0.012
var33	0.0859	-0.0027	-0.0081	-0.0068	-0.0304	-0.0111	-0.0027

var34	-0.0378	-0.0042	-0.0126	-0.0106	-0.0471	-0.0173	-0.0042
var35	0.013	-0.0069	-0.0204	-0.0173	-0.0767	-0.0281	-0.0069
var36	-0.0166	-0.0019	-0.0055	-0.0047	-0.0207	-0.0076	-0.0019
var37	-0.0431	-0.0048	-0.002	-0.0121	-0.0538	-0.0197	0.0316
var38	-0.0733	0.0186	0.0301	0.0063	0.2037	0.0757	-0.0082
var39	-0.0217	-0.0024	-0.0072	0.0004	-0.0271	-0.0099	-0.0024
var40	0.1679	-0.0039	-0.0117	-0.0099	-0.0438	-0.0161	-0.0039
var41	0.0334	-0.0023	-0.0069	-0.0058	-0.0259	-0.0095	-0.0023
var42	-0.0002	-0.0016	-0.0047	-0.004	-0.0177	-0.0065	-0.0016
var43	0.1652	-0.0006	-0.0017	-0.0015	-0.0065	-0.0024	-0.0006
var44	-0.0058	-0.0007	-0.0019	-0.0016	-0.0072	-0.0026	-0.0007
var45	-0.0035	-0.0004	-0.0012	-0.001	-0.0043	-0.0016	-0.0004
var46	-0.0446	-0.0121	-0.0066	0.0019	-0.1318	-0.0478	0.0126
var47	-0.0201	0.0679	0.0646	0.0014	0.743	0.2763	-0.0023
var48	-0.0513	-0.0058	0.0458	0.0632	-0.0589	-0.0235	0.0266
var49	-0.0932	-0.0105	-0.031	-0.0262	-0.1163	-0.0426	-0.0105
var50	-0.0362	-0.0041	-0.012	-0.0102	-0.0451	-0.0165	-0.0041
var51	-0.0157	-0.0018	0.0472	0.1107	-0.0095	-0.0072	-0.0018
var52	-0.0083	-0.0009	-0.0027	-0.0023	-0.0103	-0.0038	-0.0009
var53	0.1126	-0.0121	-0.0359	-0.0278	-0.1345	-0.0493	-0.0121
var54	-0.1131	0.0121	0.0001	-0.007	0.131	0.049	0.0121
var55	-0.0371	-0.0042	-0.0123	-0.0104	-0.0463	-0.017	-0.0042
var56	-0.0255	-0.0029	-0.0085	-0.0072	-0.0318	-0.0116	-0.0029
var57	-0.0243	-0.0027	-0.0081	-0.0068	-0.0304	-0.0111	-0.0027
var58	-0.0158	-0.0018	-0.0053	-0.0045	-0.0198	-0.0072	-0.0018
var59	-0.0297	-0.0033	-0.0099	-0.0083	-0.037	-0.0136	-0.0033

var60	-0.0046	-0.0005	-0.0015	-0.0013	-0.0058	-0.0021	-0.0005
var61	-0.0252	-0.0028	-0.0084	-0.0071	-0.0315	-0.0115	-0.0028
var62	-0.0063	-0.0007	-0.0021	-0.0018	-0.0079	-0.0029	-0.0007
var63	0.2948	-0.0046	-0.0136	-0.0115	-0.0512	-0.0187	-0.0046
var64	-0.0019	-0.0002	-0.0006	-0.0005	-0.0024	-0.0009	-0.0002
var65	-0.0045	-0.001	-0.003	0.0129	0.0842	0.4132	-0.001
var66	-0.0141	-0.0016	0.0286	-0.004	-0.0176	-0.0064	-0.0016
var67	-0.0215	-0.0024	-0.0071	-0.006	-0.0268	-0.0098	-0.0024
var68	-0.023	-0.0026	-0.0077	-0.0065	-0.0287	-0.0105	-0.0026
var69	-0.0217	-0.0024	-0.0072	-0.0061	-0.0271	-0.0099	-0.0024
var70	-0.0125	-0.0014	-0.0042	-0.0035	-0.0156	0.0146	0.0261
var71	-0.0035	-0.0004	-0.0012	-0.001	-0.0043	-0.0016	-0.0004
var72	-0.0219	-0.0025	-0.0073	-0.0061	-0.0273	-0.01	-0.0025
var73	-0.0145	-0.0016	-0.0048	-0.0041	-0.018	-0.0066	-0.0016
var74	-0.0258	-0.0029	-0.0086	-0.0073	-0.0322	-0.0118	-0.0029
var75	-0.0132	-0.0015	-0.0044	-0.0037	-0.0164	-0.006	-0.0015
var76	-0.005	-0.0006	-0.0017	-0.0014	-0.0062	-0.0023	-0.0006
var77	-0.005	-0.0006	-0.0017	-0.0014	-0.0062	-0.0023	-0.0006
var78	-0.0612	-0.0069	-0.0204	-0.0172	-0.0764	-0.028	-0.0069

	var16	var17	var18	var19	var20	var21	var22
var16	1						
var17	0.1023	1					
var18	-0.0007	-0.0004	1				
var19	-0.0012	-0.0006	-0.0012	1			
var20	-0.0011	-0.0006	-0.0012	-0.0019	1		

var21	-0.0018	-0.0009	-0.0019	-0.003	0.0106	1	
var22	-0.006	-0.0031	-0.0062	-0.0101	-0.0095	-0.0097	1
var23	-0.0113	-0.0058	-0.0116	-0.0188	-0.0177	-0.0282	-0.0819
var24	-0.0505	-0.0259	-0.0518	-0.0844	-0.0795	-0.1261	-0.4187
var26	0.0174	0.0089	-0.0187	-0.0383	-0.0302	-0.0206	-0.074
var27	-0.029	-0.0149	-0.0214	0.0062	0.016	0.0158	-0.0814
var28	-0.0014	-0.0064	-0.0093	-0.0009	-0.0056	-0.0269	0.1763
var29	-0.0293	-0.0197	-0.0276	0.0064	0.0164	-0.0096	0.0642
var30	-0.0165	-0.0084	-0.0169	-0.0275	-0.0259	-0.0411	-0.1364
var31	-0.0117	-0.006	-0.012	-0.0196	-0.016	0.0238	-0.0235
var32	0.0261	0.0023	0.0213	0.0437	0.0393	0.023	0.1065
var33	-0.006	-0.0031	-0.0061	-0.01	-0.0094	-0.0068	0.0633
var34	-0.0093	-0.0047	-0.0095	-0.0155	-0.0146	-0.0231	-0.0767
var35	-0.0151	-0.0077	-0.0154	-0.0252	-0.0237	-0.0376	-0.1248
var36	-0.0041	-0.0021	-0.0042	-0.0068	-0.0064	-0.0101	-0.0288
var37	0.069	0.0191	0.0096	0.0074	0.01	0.0207	0.1843
var38	-0.0179	-0.0092	0.0176	0.0494	0.0423	0.0208	0.083
var39	-0.0053	-0.0027	-0.0055	-0.0089	-0.0084	-0.0133	-0.0412
var40	-0.0086	-0.0044	-0.0088	-0.0144	-0.0135	-0.0215	-0.0664
var41	-0.0051	-0.0026	-0.0052	-0.0085	-0.008	-0.0127	-0.0422
var42	-0.0035	-0.0018	-0.0036	-0.0058	-0.0055	-0.0087	-0.0287
var43	-0.0013	-0.0007	-0.0013	-0.0021	-0.002	-0.0032	-0.0106
var44	-0.0014	-0.0007	-0.0015	-0.0024	-0.0022	-0.0035	-0.0118
var45	-0.0009	-0.0004	-0.0009	-0.0014	-0.0013	-0.0021	-0.0071
var46	0.0275	0.0031	-0.0133	-0.0238	-0.0217	0.0174	0.0341
var47	-0.0049	-0.0025	0.0892	0.0738	0.0537	0.0169	0.0377

var48	0.0579	0.0152	0.0088	0.0368	0.0274	0.0476	0.2705
var49	-0.0228	-0.0117	-0.0234	-0.0382	-0.0359	-0.057	-0.1718
var50	-0.0089	-0.0045	0.0002	0.0139	0.0318	0.0857	0.1212
var51	-0.0039	0.0376	0.0158	-0.0064	0.0004	0.1292	0.1327
var52	-0.002	-0.001	-0.0021	0.008	-0.0032	0.0103	0.0411
var53	-0.0264	-0.0135	-0.0271	-0.0407	-0.0379	-0.0602	-0.1919
var54	0.0178	0.0024	0.0076	0.0388	0.0359	0.0154	0.1103
var55	-0.0091	-0.0047	-0.0093	0.0073	0.0633	0.0226	-0.0635
var56	0.0132	-0.0032	-0.0064	0.0012	-0.0098	-0.0104	-0.0288
var57	-0.006	-0.0031	-0.0061	0.0062	-0.0094	-0.0149	-0.0229
var58	-0.0039	-0.002	-0.004	-0.0004	0.0003	-0.0097	0.1006
var59	-0.0073	-0.0037	-0.0019	0.0048	-0.0042	-0.0136	-0.0237
var60	-0.0011	-0.0006	-0.0012	-0.0019	-0.0018	-0.0028	-0.0008
var61	-0.0062	-0.0032	0.0064	0.0209	-0.0056	0.0082	-0.0372
var62	-0.0015	-0.0008	-0.0016	-0.0026	-0.0024	-0.0039	-0.0128
var63	-0.01	-0.0052	-0.0103	-0.0142	-0.0158	0.029	-0.0377
var64	-0.0005	-0.0002	-0.0005	-0.0008	-0.0007	-0.0012	-0.0039
var65	-0.0022	-0.0011	0.101	-0.0037	-0.0034	-0.0055	0.002
var66	-0.0034	-0.0018	-0.0035	0.0213	0.0233	-0.0041	-0.0057
var67	-0.0053	-0.0027	-0.0054	-0.0043	-0.0083	-0.0131	-0.0216
var68	-0.0056	-0.0029	-0.0058	-0.0009	-0.0089	0.0116	-0.0145
var69	-0.0053	-0.0027	-0.0055	0.0046	0.0154	0.077	0.0924
var70	-0.0031	-0.0016	0.0092	0.0024	0.0032	-0.0077	0.0161
var71	-0.0009	-0.0004	-0.0009	-0.0014	0.0273	-0.0021	0.0214
var72	-0.0054	-0.0027	-0.0055	-0.009	-0.0084	-0.0134	0.3246
var73	-0.0035	-0.0018	0.0071	0.0007	0.0154	-0.0044	-0.0029

var74	-0.0063	-0.0032	-0.0065	0.0162	-0.0059	-0.0081	0.0688
var75	-0.0032	-0.0017	0.0084	0.0235	0.0026	-0.0032	0.0205
var76	-0.0012	-0.0006	-0.0012	-0.002	0.0182	-0.003	0.0578
var77	-0.0012	-0.0006	-0.0012	-0.002	-0.0019	-0.003	-0.0101
var78	-0.015	-0.0077	-0.0154	-0.0251	-0.0236	-0.0361	-0.1077

	var23	var24	var26	var27	var28	var29	var30
var23	1						
var24	-0.7427	1					
var26	-0.0311	0.0562	1				
var27	-0.0716	0.1597	0.1301	1			
var28	0.1616	-0.1993	0.0414	-0.499	1		
var29	0.0859	-0.0255	0.2054	0.5763	0.3146	1	
var30	-0.0647	0.1706	0.3524	0.2697	-0.0135	0.3244	1
var31	-0.1181	0.1289	0.2327	-0.1072	0.0162	-0.1475	-0.2651
var32	0.0621	-0.1685	-0.5181	-0.1304	-0.031	-0.1658	-0.6297
var33	0.1637	-0.1515	0.1047	-0.0986	0.0866	-0.0474	-0.1347
var34	0.1224	-0.0374	0.2207	0.0122	0.1555	0.1714	0.5622
var35	-0.2189	0.2941	0.3342	0.1675	-0.1176	0.094	0.2115
var36	0.0725	-0.0374	0.0946	-0.0383	0.0546	-0.049	-0.0783
var37	0.2482	-0.292	0.252	-0.2301	0.2178	-0.048	-0.2175
var38	0.0416	-0.165	-0.725	-0.015	-0.0919	-0.122	-0.3989
var39	-0.0703	0.093	-0.2838	-0.1458	-0.0868	-0.2065	-0.1139
var40	-0.0675	0.1134	0.1772	0.0834	-0.031	0.04	-0.1698
var41	-0.0735	0.0982	0.0373	0.0356	0.002	0.0473	0.3026
var42	-0.0537	0.0686	0.0827	0.1167	-0.0597	0.0872	0.2101

var43	-0.0199	0.0254	0.0306	0.0071	-0.0221	-0.0059	0.0363
var44	-0.022	0.0281	0.0339	0.0329	-0.0245	0.0199	0.0074
var45	-0.0132	0.0169	0.0203	0.0246	-0.0147	0.0171	0.0463
var46	0.0383	0.0025	0.5279	-0.0355	0.1407	0.1116	0.1974
var47	-0.0456	-0.2716	-0.0416	-0.1059	-0.0512	-0.1418	-0.1067
var48	0.4359	-0.5119	-0.0467	-0.1315	0.142	0.001	-0.2587
var49	-0.2823	0.3918	-0.0563	0.1851	-0.2182	-0.016	0.1599
var50	0.3203	-0.3226	0.1311	-0.0255	0.1102	0.0683	0.0715
var51	0.0443	-0.1195	0.0774	-0.0691	0.0175	-0.0468	-0.0827
var52	0.0004	-0.0205	-0.0804	0.0287	-0.0013	0.0309	-0.033
var53	-0.1673	0.3087	0.5233	0.2531	-0.0215	0.2708	0.5772
var54	0.1895	-0.2728	-0.4633	-0.1605	-0.0192	-0.202	-0.4165
var55	0.0384	0.0074	0.1611	0.314	-0.1567	0.2371	0.1413
var56	-0.0275	0.0505	-0.093	-0.2482	0.4973	0.1627	0.0549
var57	0.0452	-0.0107	0.0894	-0.237	0.4749	0.1554	0.0634
var58	0.1554	-0.1737	-0.0537	-0.1543	0.3093	0.1012	-0.0406
var59	0.0299	0.0127	-0.0711	-0.2889	-0.1252	-0.3826	-0.0646
var60	0.0055	0.0005	-0.0131	0.0391	-0.0195	0.0296	0.0052
var61	-0.0582	0.0745	0.0617	0.2135	-0.1065	0.1612	-0.0138
var62	0.0253	-0.0099	0.0265	-0.0613	-0.0266	-0.0812	-0.0348
var63	-0.1487	0.1611	-0.1746	-0.3996	-0.1731	-0.5292	-0.168
var64	-0.0012	0.0041	-0.0272	-0.0188	-0.0081	-0.0249	-0.0107
var65	-0.0097	-0.0404	-0.0452	-0.0869	-0.0376	-0.1151	-0.0494
var66	0.1891	-0.1555	0.0427	-0.1371	-0.0594	-0.1815	-0.0751
var67	0.0211	0.0055	-0.0998	-0.2092	-0.0907	-0.2771	-0.1152
var68	-0.0681	0.074	-0.0737	0.1949	-0.0972	-0.2972	-0.1094

var69	0.1469	-0.1741	-0.2812	0.1836	-0.0916	0.1387	-0.1202
var70	-0.0409	0.0288	-0.0263	-0.1222	-0.0529	-0.1618	-0.0671
var71	0.0073	-0.0182	-0.041	-0.0339	0.0679	0.0222	-0.0193
var72	0.2174	-0.335	0.1203	-0.2131	0.427	0.1397	-0.121
var73	-0.0448	0.0437	0.0454	-0.1408	0.2822	0.0923	0.0122
var74	0.0806	-0.0906	-0.235	0.2186	-0.1091	0.1651	-0.143
var75	-0.0025	-0.001	-0.0615	0.1114	-0.0556	0.0841	-0.0429
var76	0.0266	-0.0517	-0.027	-0.0484	0.097	0.0317	-0.0275
var77	-0.0141	0.0241	-0.0214	-0.0484	0.097	-0.0641	-0.0275
var78	-0.1571	0.2347	0.3091	0.5177	-0.2583	0.3909	0.4152

	var31	var32	var33	var34	var35	var36	var37
var31	1						
var32	-0.449	1					
var33	-0.096	-0.2282	1				
var34	-0.149	-0.354	-0.0757	1			
var35	0.4295	-0.4716	-0.0711	-0.1912	1		
var36	0.3212	-0.1492	-0.0332	-0.0516	-0.0839	1	
var37	-0.1596	0.1573	0.3765	-0.1341	-0.2183	-0.0589	1
var38	-0.2771	0.5939	-0.1102	-0.2272	-0.371	-0.1001	-0.2603
var39	-0.0673	0.1694	-0.0377	-0.0673	-0.1098	-0.0296	-0.077
var40	0.0549	0.1084	0.0018	-0.1024	-0.1779	-0.048	-0.1248
var41	-0.0802	-0.1901	-0.0417	-0.0646	-0.1052	-0.0284	-0.0738
var42	-0.0559	-0.1321	-0.0284	-0.044	-0.0717	-0.0193	-0.0503
var43	-0.0207	-0.033	0.0278	-0.0163	-0.0265	-0.0072	-0.0186
var44	-0.0229	0.0158	-0.0116	-0.018	-0.0293	-0.0079	-0.0206

var45	-0.0137	-0.0278	-0.007	-0.0108	-0.0176	-0.0048	-0.0124
var46	0.2437	-0.433	0.1695	0.1083	0.5694	-0.0313	0.3995
var47	-0.065	0.1612	-0.0382	-0.0561	-0.1016	-0.0274	-0.0713
var48	-0.1892	0.2825	0.2038	-0.1457	-0.26	-0.0701	0.6672
var49	-0.0387	-0.0662	-0.1228	-0.0546	0.2221	-0.1268	-0.325
var50	0.1169	-0.167	0.0495	0.2733	-0.1616	0.3668	-0.0429
var51	0.2091	-0.0904	0.0179	-0.0462	0.0189	0.1442	-0.0405
var52	0.0194	0.012	0.0078	-0.0257	-0.0418	-0.0078	-0.0218
var53	0.2416	-0.6298	-0.1344	0.3405	0.5089	-0.0462	-0.3811
var54	-0.328	0.5603	0.1151	-0.1014	-0.5392	-0.0014	0.3719
var55	-0.0043	-0.1159	-0.0072	0.3507	-0.0937	-0.024	0.0389
var56	0.0207	-0.0391	-0.0511	0.0721	-0.0158	0.0636	-0.0648
var57	0.0562	-0.0879	-0.016	0.2113	-0.0304	0.0743	-0.028
var58	-0.0581	0.006	0.1708	0.0181	-0.0777	-0.0216	0.0743
var59	0.0624	0.0005	0.0354	0.0261	-0.0067	0.1047	0.0093
var60	-0.0058	0.0041	-0.0093	0.0303	-0.0148	-0.0063	-0.0164
var61	0.0717	-0.0176	-0.0473	0.0563	0.0331	0.0158	-0.0254
var62	-0.0248	-0.0483	0.2332	-0.0196	-0.0319	-0.0086	0.1302
var63	0.1591	0.0542	-0.0417	-0.1196	0.0288	-0.0497	-0.1423
var64	-0.0076	0.017	-0.0039	-0.006	-0.0098	-0.0026	-0.0069
var65	-0.0222	0.0422	0.0454	-0.0278	-0.0396	-0.0057	0.0539
var66	-0.053	0.1188	-0.0268	-0.0418	-0.0705	-0.0151	0.2473
var67	-0.0675	0.1267	0.0663	-0.0655	-0.0982	-0.0224	0.1869
var68	0.1156	0.0047	0.0101	-0.0717	-0.0218	0.1257	-0.0548
var69	-0.0785	0.1799	-0.0311	-0.0676	-0.108	-0.0255	-0.0533
var70	0.0791	0.0045	-0.0025	-0.039	-0.0138	-0.0125	0.0258

var71	-0.0137	0.0306	-0.007	-0.0108	-0.0176	-0.0048	-0.0124
var72	-0.0863	0.1212	0.1246	-0.0681	-0.1107	-0.0299	0.4955
var73	0.1208	-0.0856	-0.029	0.0886	-0.0013	-0.0036	-0.026
var74	0.0031	0.1075	0.0177	-0.0804	-0.0883	-0.0271	-0.0253
var75	0.0431	0.0143	-0.0141	-0.0209	-0.0636	0.0527	-0.0152
var76	0.0037	0.0266	-0.01	-0.0155	-0.0212	0.0221	-0.0001
var77	-0.0196	-0.0006	0.0951	-0.0155	-0.0252	-0.0068	0.0475
var78	-0.1924	-0.2049	-0.0816	-0.1554	0.3709	-0.0836	-0.2161

	var38	var39	var40	var41	var42	var43	var44
var38	1						
var39	-0.1309	1					
var40	-0.2114	-0.0626	1				
var41	-0.1254	-0.0371	-0.0601	1			
var42	-0.0855	-0.0253	-0.041	-0.0242	1		
var43	-0.0317	-0.0094	-0.0152	-0.009	-0.0061	1	
var44	-0.035	-0.0104	-0.0168	-0.0099	-0.0068	-0.0025	1
var45	-0.021	-0.0062	-0.0101	-0.006	-0.0041	-0.0015	-0.0017
var46	-0.5066	-0.1846	-0.3043	-0.1826	-0.1259	-0.0466	-0.0515
var47	0.268	-0.0336	-0.0581	-0.0344	-0.0234	-0.0087	-0.0096
var48	0.0481	-0.0648	-0.148	-0.0879	-0.0599	-0.0222	-0.0245
var49	0.0723	0.1545	-0.0462	0.0086	0.0381	-0.0174	-0.0253
var50	-0.1604	0.0104	0.0595	-0.0584	-0.0422	-0.0156	-0.0173
var51	-0.0937	0.0066	-0.019	-0.0239	-0.0183	-0.0068	-0.0075
var52	0.0114	0.1886	-0.0239	-0.0141	-0.0096	-0.0036	-0.0039
var53	-0.6103	-0.1763	0.2931	0.1569	0.1313	0.0486	0.0537

var54	0.5598	0.1353	-0.3021	-0.1586	-0.1319	-0.0489	-0.054
var55	-0.1055	-0.0664	0.0166	-0.0635	-0.0433	-0.016	-0.0177
var56	0.0015	-0.0455	-0.0352	0.1127	-0.0297	-0.011	-0.0122
var57	-0.0916	-0.0435	0.037	-0.0416	-0.0284	-0.0105	-0.0116
var58	0.0654	-0.0154	-0.0431	-0.0271	-0.0185	-0.0068	-0.0076
var59	0.0296	-0.024	-0.0637	-0.0432	-0.0346	-0.0128	-0.0142
var60	0.0157	-0.0034	-0.0039	-0.0029	-0.0054	-0.002	-0.0022
var61	-0.0623	-0.0414	0.0764	-0.0413	-0.0294	-0.0109	-0.012
var62	-0.0263	-0.0113	-0.0182	-0.0108	-0.0073	-0.0027	-0.003
var63	-0.0288	0.3998	0.0244	0.0276	-0.0432	0.039	0.005
var64	0.0263	-0.0034	-0.0056	-0.0033	-0.0022	-0.0008	-0.0009
var65	0.0464	-0.0109	-0.0242	-0.0153	-0.0104	-0.0039	-0.0043
var66	-0.0314	-0.0251	-0.0407	-0.0207	-0.0164	-0.0061	-0.0067
var67	0.0796	-0.0384	-0.0558	-0.03	-0.0251	-0.0093	-0.0103
var68	0.0679	-0.0412	0.0581	-0.0163	-0.0269	-0.01	-0.011
var69	0.2693	-0.0335	-0.0601	-0.036	-0.0253	-0.0094	-0.0104
var70	0.0263	-0.0224	0.0343	-0.0215	-0.0146	-0.0054	-0.006
var71	0.0475	-0.0062	-0.0101	-0.006	-0.0041	-0.0015	-0.0017
var72	-0.1233	-0.0391	-0.0633	-0.0374	-0.0255	-0.0094	-0.0104
var73	-0.0506	-0.0258	0.0617	-0.0247	-0.0169	-0.0062	-0.0069
var74	0.2162	-0.0244	-0.0165	-0.0442	-0.0301	-0.0112	-0.0123
var75	-0.0097	0.172	-0.0213	-0.0136	-0.0154	-0.0057	-0.0063
var76	0.0402	-0.0089	-0.0144	-0.0085	-0.0058	-0.0021	-0.0024
var77	0.0199	-0.0089	-0.0144	-0.0085	-0.0058	-0.0021	-0.0024
var78	-0.1759	-0.103	0.0615	0.1594	0.2277	0.042	0.0757

	var45	var46	var47	var48	var49	var50	var51
var45	1						
var46	-0.0309	1					
var47	-0.0058	-0.1703	1				
var48	-0.0147	0.1622	-0.0849	1			
var49	0.0028	-0.0244	-0.1542	-0.3945	1		
var50	-0.0104	-0.016	-0.0598	-0.1531	-0.278	1	
var51	-0.0045	0.0706	-0.0244	-0.0443	-0.0497	0.2423	1
var52	-0.0024	-0.0467	-0.0137	-0.0121	-0.0312	0.1452	-0.0107
var53	0.0323	0.2146	-0.164	-0.4329	0.1498	0.0606	-0.1396
var54	-0.0324	-0.2872	0.1549	0.3977	-0.1512	-0.0524	-0.1465
var55	-0.0106	-0.0818	-0.0392	-0.0116	-0.0563	0.2411	0.0352
var56	-0.0073	-0.0153	-0.0214	-0.0936	-0.1196	0.0135	0.088
var57	-0.007	0.0813	-0.0299	-0.053	-0.0733	0.1336	-0.0224
var58	-0.0045	-0.0011	-0.0185	0.1801	-0.0892	0.0105	-0.0127
var59	-0.0085	0.0413	-0.0456	0.0013	0.0055	0.0809	0.0805
var60	-0.0013	0.0027	-0.0025	-0.0172	0.0274	0.017	0.0201
var61	-0.0072	0.067	-0.0168	-0.03	-0.0976	-0.0402	-0.0302
var62	-0.0018	0.0476	-0.0066	0.077	-0.0416	-0.0188	-0.0082
var63	-0.0043	-0.1225	-0.0665	-0.1381	0.178	-0.0721	0.0281
var64	-0.0006	-0.0172	0.0092	-0.0024	0.0029	-0.0058	-0.0025
var65	-0.0026	-0.0126	0.123	0.0593	-0.0463	-0.0202	-0.0013
var66	-0.004	0.0865	-0.0094	0.239	-0.0988	-0.0286	-0.0051
var67	-0.0062	0.0028	-0.0251	0.0918	-0.158	-0.0503	-0.0264
var68	-0.0066	-0.0821	-0.0284	-0.069	0.0831	-0.01	-0.0271

var69	-0.0062	-0.1648	-0.0279	0.2325	-0.1033	-0.0239	-0.0209
var70	-0.0036	-0.0188	-0.0034	0.0199	-0.0169	-0.0282	-0.0065
var71	-0.001	-0.0309	0.0149	0.0075	0.0004	0.0019	-0.0045
var72	-0.0063	0.1946	-0.035	0.3244	-0.166	0.0593	-0.0283
var73	-0.0041	0.0383	-0.0037	-0.0371	0.0316	-0.0221	-0.006
var74	-0.0074	-0.0803	0.0754	0.1075	-0.0917	-0.0544	-0.0322
var75	-0.0038	-0.0632	-0.0052	-0.026	-0.0248	0.146	0.0875
var76	-0.0014	-0.0186	0.0111	0.0279	-0.0313	0.0397	0.0118
var77	-0.0014	0.0001	-0.0034	0.0368	-0.0002	-0.0148	-0.0064
var78	0.0511	0.1543	-0.1007	-0.2493	0.3669	-0.1797	-0.078

	var52	var53	var54	var55	var56	var57	var58
var52	1						
var53	-0.0734	1					
var54	-0.077	-0.8565	1				
var55	-0.0202	0.0735	0.1437	1			
var56	-0.015	0.0422	-0.0813	-0.0779	1		
var57	-0.0141	0.1314	-0.1358	-0.0744	-0.0511	1	
var58	0.0439	-0.0907	0.0699	-0.0485	-0.0333	-0.0318	1
var59	-0.01	-0.0348	-0.0208	-0.0907	-0.0622	-0.0594	-0.0387
var60	0.0213	-0.0046	-0.0102	-0.0142	-0.0097	-0.0093	-0.006
var61	-0.0148	0.0901	-0.0944	-0.0772	-0.053	-0.0506	-0.0329
var62	-0.0043	-0.0559	0.0557	-0.0193	-0.0132	-0.0126	-0.0082
var63	-0.0169	-0.0855	0.0592	-0.1255	-0.0861	-0.0822	-0.0535
var64	-0.0013	-0.0171	0.0127	-0.0059	-0.004	-0.0039	-0.0025
var65	-0.0061	-0.0707	0.0598	-0.0273	-0.0187	-0.0179	-0.0116

var66	-0.0055	-0.1195	0.1085	-0.043	-0.0295	-0.0282	-0.0184
var67	-0.0146	-0.1716	0.1646	-0.0657	-0.0451	-0.0431	-0.028
var68	-0.0029	-0.036	0.0289	-0.0705	-0.0484	-0.0462	-0.0301
var69	0.0231	-0.1876	0.175	-0.0664	-0.0456	-0.0435	-0.0283
var70	-0.0085	-0.0289	0.0181	-0.0384	-0.0263	-0.0251	-0.0164
var71	0.0139	-0.026	0.0137	-0.0106	-0.0073	-0.007	-0.0045
var72	-0.0122	-0.1935	0.1918	-0.0669	-0.0459	-0.0438	-0.0286
var73	0.0021	0.0735	-0.0831	-0.0442	-0.0303	-0.029	-0.0189
var74	-0.0176	-0.1465	0.1372	-0.0791	-0.0542	-0.0518	-0.0337
var75	0.3265	-0.0455	-0.0396	-0.0403	-0.0276	-0.0264	-0.0172
var76	0.008	-0.039	0.0235	-0.0152	-0.0104	-0.01	-0.0065
var77	-0.0034	-0.0441	0.0439	-0.0152	-0.0104	-0.01	-0.0065
var78	-0.0392	0.3897	-0.3942	-0.1872	-0.1285	-0.1227	-0.0799

	var59	var60	var61	var62	var63	var64	var65
var59	1						
var60	-0.0113	1					
var61	-0.0617	-0.0096	1				
var62	-0.0154	-0.0024	-0.0131	1			
var63	-0.1002	-0.0156	-0.0853	-0.0213	1		
var64	-0.0047	-0.0007	-0.004	-0.001	-0.0065	1	
var65	-0.0218	-0.0034	-0.0185	-0.0046	-0.0301	-0.0014	1
var66	-0.0344	-0.0054	-0.0293	-0.0073	-0.0476	-0.0022	-0.0103
var67	-0.0525	-0.0082	-0.0447	-0.0111	-0.0726	-0.0034	-0.0158
var68	-0.0563	-0.0088	-0.0479	-0.012	-0.0779	-0.0037	-0.0169
var69	-0.053	-0.0083	-0.0451	-0.0113	-0.0734	-0.0035	-0.016

var70	-0.0306	-0.0048	-0.0261	-0.0065	-0.0424	-0.002	-0.0092
var71	-0.0085	-0.0013	-0.0072	-0.0018	-0.0118	-0.0006	-0.0026
var72	-0.0534	-0.0083	-0.0455	-0.0113	-0.0739	-0.0035	-0.0161
var73	-0.0353	-0.0055	-0.0301	-0.0075	-0.0489	-0.0023	-0.0106
var74	-0.0632	-0.0099	-0.0538	-0.0134	-0.0874	-0.0041	-0.019
var75	-0.0322	-0.005	-0.0274	-0.0068	-0.0445	-0.0021	-0.0097
var76	-0.0121	-0.0019	-0.0103	-0.0026	-0.0168	-0.0008	-0.0037
var77	-0.0121	-0.0019	-0.0103	-0.0026	-0.0168	-0.0008	-0.0037
var78	-0.1495	-0.0233	-0.1273	-0.0318	-0.2069	-0.0097	-0.045

	var66	var67	var68	var69	var70	var71	var72
var66	1						
var67	-0.0249	1					
var68	-0.0267	-0.0408	1				
var69	-0.0252	-0.0384	-0.0412	1			
var70	-0.0145	-0.0222	-0.0238	-0.0224	1		
var71	-0.004	-0.0062	-0.0066	-0.0062	-0.0036	1	
var72	-0.0254	-0.0387	-0.0415	-0.0391	-0.0226	-0.0063	1
var73	-0.0168	-0.0256	-0.0274	-0.0259	-0.0149	-0.0041	-0.0261
var74	-0.03	-0.0457	-0.0491	-0.0462	-0.0267	-0.0074	-0.0466
var75	-0.0153	-0.0233	-0.025	-0.0236	-0.0136	-0.0038	-0.0237
var76	-0.0058	-0.0088	-0.0094	-0.0089	-0.0051	-0.0014	-0.009
var77	-0.0058	-0.0088	-0.0094	-0.0089	-0.0051	-0.0014	-0.009
var78	-0.071	-0.1083	-0.1162	-0.1095	-0.0632	-0.0175	-0.1103

	var73	var74	var75	var76	var77	var78

var73	1					
var74	-0.0308	1				
var75	-0.0157	-0.0281	1			
var76	-0.0059	-0.0106	-0.0054	1		
var77	-0.0059	-0.0106	-0.0054	-0.002	1	
var78	-0.0729	-0.1303	-0.0664	-0.0251	-0.0251	1

Appendix 7 Regression Coefficient Index of Dynastic Dummy

	coefficien	index
the 6th C.	-0.37	100.00
the 7th C.	1.83	792.23
the 8th C.	2.58	1034.25
the 9th C.	0.75	441.33
the 10th C.	0.41	331.89
the 11th C.	0.18	258.88
the 12th C.	0.84	473.52
the 13th C.	1.75	766.31
the 14th C.	1.83	793.73
the 15th C.	1.59	715.68
the 16th C.	1.15	572.95
the 17th C.	1.24	600.04
the 18th C.	1.19	585.78
the 19th C.	0.95	507.36
the 20th C.	1.03	533.82

	coefficien	index
Tang	3.30	100.00
Song	3.13	94.85
Yuan	3.89	117.88
Ming	3.68	111.52
Qing	3.42	103.64
Republica	3.31	100.30
P.R.C.	2.64	80.00

Data source: own dataset of 26,107 entries containing transactional details or attributes of interest rates.

Appendix 8 Market Integration Methodology in Literature

Early research on market integration defines integrated markets as locations with high price correlations.[300] The Correlation Coefficient[301] is an indicator commonly used to tell how closely price movements of an identical commodity on a pair of markets are interconnected. Nevertheless, many scholars have come to find this measure statistically problematic.[302] Moreover, historical interpretation of the results requires a benchmark to define integration, which seems not so easy to find.[303] Then the methodology of integration estimating is further modified and developed.

If a linear relationship between two non-stationary price series is stationary,[304] the two series are statistically defined as "co-integrated", maintaining an interdependent relationship in the long run. From a historical point of view, this means if there was a shock that made the two markets' prices walk away from each other, the shock could be only temporary and the two markets would converge sooner or later. It allows inference about questions like: Was there a long-run connection between two markets' interest rate levels? And what factors were pulling one market towards the other? The underlying logic is: price changes in one of the two markets will spread to the other instantaneously (as in perfect integration) or over a time lag.[305] The method of co-integration has been

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[300] B. Harris, "There Is Method In My Madness: Or Is It Vice Versa? Measuring Agricultural Market Performance," *Food Research Institute Studies* 17 (1979): 197–218.

[301] It is a statistic measure defined as $\frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N})(\sum Y^2 - \frac{(\sum Y)^2}{N})}}$, where x is price series of Locality 1 and y that of Locality 2.

[302] See Heytens (1986), Trotter (1991), Timmer (1974) for the bias of coefficient of correlation. Firstly, the bias may result from serial correlation or omitted variables (Ravallion 1986, Blyn 1973, Hariss 1979). Secondly, if the time series are not stationary, the results can also be biased, because the two series of the markets would be linked to the variable of time, thus appeared to be correlated with each other but actually not. The second problem may be solved by de-trending or differentiating. For details about this econometric issue, please see Barry K. Goodwin and Ted C. Schroeder, "Testing Perfect Spatial Market Integration: An Application to Regional U.S. Cattle Markets," *North Central Journal of Agricultural Economics* 12, no. 2 (1990): 176.

[303] Giovanni Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870," *Working Papers HEC, of Department of History and Civilization, European University Institute* 1 (2008), 7.

[304] Being non-stationary means the residuals of the linear relation between the two series follow a random walk, whereas being stationary means the residuals follow not a random walk but a trend in time. An ADF test (augmented Dickey-Fuller, 1979) can test for the unit root.

[305] Barry K. Goodwin and Ted.C. Schroeder, "Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets," *American Journal of Agricultural Economics* 73 (1991): 452–64.

widely adopted.[306] For example, Shiue and Keller[307] applied the method on 250 grain markets of China from 17th to 19th century:

$$p_{1t} = \beta_0 + \beta_1 p_{2t} + e_t$$

p_{1t} and p_{2t} are the price series of the two markets under study, and β_0 is the constant. If the residual term e_t is stationary and the estimated parameter β_1 is statistically significant, a long-run relationship exists between the markets under study. As a result, they find in the late 18th century market performance in China was comparable with that of Western Europe overall, but that of England was better than both that of the continental European and Lower Yangzi Delta area of China.[308]

However, this co-integration approach models answers only the question of "yes or no", confirming if there is long-term relationship between two markets. It does not answer the question of "more or less" and "fast or slow". How closely interrelated are the two markets? How fast can they adjust to each other's price level? In other words, it does not allow for the observation of short-run dynamics between the two markets. To capture such an adjustment process between two markets, many researchers[309] in this field of

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[306] See: I Horowitz, "Market Definition in Antitrust Analysis: A Regression Based Approach," *Southern Economic Journal* 48 (1981): 1–16.
J. Howell, Uri, N. and E. Rifkin, "On Defining Geographic Markets," *Applied Economics* 17 (1985): 959–97.
R. F. Engle and C. W Granger, "Co-Integration and Error Correction: Representation, Estimation, and Testing," *Econometrica* 55, no. 2 (1987): 252–76.
Trotter, *Applying Price Analysis to Marketing Systems: Methods and Examples from the Indonesian Rice Market*.
Goodwin and Schroeder, "Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets."
T. B. Palaskas and B. Harriss-White, "Testing Market Integration: New Approaches with Case Material from the West Bengal Food Economy," *Journal of Development Studies* 30, no. 1 (1993): 1–57.
C. Alexander and J. Wyeth, "Cointegration and Market Integration: An Application to the Indonesian Rice Market," *Journal of Development Studies* 30, no. 2 (1994): 303–28.
[307] Shiue and Keller, "Markets in China and Europe on the Eve of the Industrial Revolution."
[308] Ibid.
[309] Federico, "The First European Grain Invasion: A Study in the Integration of the European Market 1750-1870.", 7.
Persson, *Grain Markets in Europe, 1500–1900 Integration and Deregulation*.
Kopsidis, "The Creation of a Westphalian Rye Market 1820-1870: Leading and Following Regions, a Cointegration Analysis."
Jan Tore Klovland, "Commondity Market Integration 1850-1913: Evidence from Britain and Germany," *European Review of Economic History* 9 (2005): 163–97.
Trenkler and Wolf, "Economic Integration across Borders: The Polish Interwar Economy."
Bateman, "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Grain Price."
Richard and Henry, "The Econometric Analysis of Economic Time Series."
Hendry, Pagan, and Sargan, "Dynamic Specification."
Thirtle and Schimmelpfennig, "Cointegration and Causality: Exploring the Relationship Between Agricultural R& D and Productivity."

research consider an Error Correction component in their integration model. For example, Roman Studer [310] also applied the method in comparing grain market integration of India and Europe from 1700-1900:

$$\Delta \log P_{1,t} = \theta_1 (\log P_1 - \log P_2)_{t-1} + c_1 + \varepsilon_{1,t} \quad (1)$$

$$\Delta \log P_{2,t} = \theta_2 (\log P_2 - \log P_1)_{t-1} + c_2 + \varepsilon_{2,t} \quad (2)$$

P1 and P2 are the prices of the two markets. θ1 and θ2 are the regression coefficients, indicating how fast each market adjusts back to the equilibrium point after the shocks. The correlation ρ between ε_1 and ε_2, measures the co-movement degree between the two markets.

This study adopts a similar ECM strategy as above; just the new contribution is to extend its application from grain (commodity) markets to financial markets. For more details on the methodologies adopted by Part II, please refer to Section 2.1.

Trotter, *Applying Price Analysis to Marketing Systems: Methods and Examples from the Indonesian Rice Market*.
Studer, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900."
[310] Studer, Roman, "Market Integration and Economic Development: A Comparative Study of India and Europe, 1700-1900".
Shiue and Keller, "Markets in China and Europe on the Eve of the Industrial Revolution."

Appendix 9 Geographic Coordinates of Provinces

Province/region	longitude	latitude
Xinjiang	83.07536	42.11380
Liaoning	122.65564	40.84202
Yunnan	101.77803	25.17224
Heilongjiagn	125.29645	50.80618
Jilin	134.44638	47.98264
Qinghai	95.97999	35.26864
Shannxi	109.58463	35.54087
Anhui	117.25979	31.55435
Hubei	112.26328	31.15641
Hunan	111.51873	27.38116
Canton	112.33343	21.84060
Zhejiang	120.23102	29.19472
Zhili	117.64316	39.89394
Henan	113.44322	34.08063
InnerMogolia	111.24356	42.39682
Shanxi	112.24277	38.07427
Gansu	102.33739	37.65251
Sichuan	103.78422	30.19001
Guizhou	106.55260	26.92137
Jiangxi	116.02689	27.28384
Guangxi	108.50459	23.99070
Shandong	118.88338	36.36130
Jiangsu	119.49252	32.88607
Fujian	117.97560	26.07560
Taiwan	120.96520	23.74810

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