

ESSAYS ON MACROECONOMICS

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This dissertation consists of two chapters on different topics in macroeconomics. The first chapter studies the economic effect of privately-issued banking notes (private money). I build a model in which money is divisible and price is endogenous. The model is based on Lagos and Wright's model (Lagos and Wright, 2005). The analysis shows that the private banknotes serve as short term credit for bankers. Given that the Friedman rule, which suggests a deflationary monetary policy, is not available, privately-issued banking notes improve resource allocation in the economy. The welfare improvement is not restricted to bankers. Nonbankers also enjoy welfare improvement. The paper offers new insight into the historical role of privately-issued banknotes. The second chapter is based on a paper co-authored with Ying Fang, who was my fellow graduate student at the University of Pittsburgh and now is a professor at Xiamen University. In this chapter we use crossing-city data to estimate the effect of property rights protection on China's economic performance. We adopt the historical enrollments of Protestant lower primary schools in the early 20th century as the instrumental variable for current property rights protection in China. Our findings about property rights protection in China resemble the cross-country research by Paulo Mauro (1995), Hall and Jones (1999), and Acemoglu et al (2001). We find that property rights protection dominates others potential determinants of economic performance, such as geography or government policy.

TABLE OF CONTENTS

1.0 INTRODUCTION	1
2.0 DIVISIBLE PRIVATE MONEY WITH ENDOGENOUS PRICES IN A RANDOM MATCHING MODEL	3
2.1 Introduction	3
2.2 The Environment	5
2.2.1 Dual Markets	5
2.2.2 Money and Banking	6
2.3 The Model	7
2.3.1 Nonbankers	7
2.3.2 Bankers	9
2.3.3 The Bargaining Problem	13
2.4 Equilibrium	14
2.4.1 Definition of Equilibrium	14
2.4.2 Characterizing the Equilibrium	15
2.4.3 The Steady State	19
2.5 Welfare Analysis	20
2.6 Concluding Remarks	22
BIBLIOGRAPHY	24
3.0 DO INSTITUTIONS MATTER? ESTIMATING THE EFFECTS OF INSTITUTIONS ON ECONOMIC PERFORMANCE IN CHINA	26
3.1 Introduction	26
3.2 Institutional Change in China: A Brief Review of Historical Background	29

3.3	The Instrument for China's Institutions	31
3.4	Measurements and Data	35
3.5	Estimates	37
3.5.1	The Model	37
3.5.2	Main Results	38
3.6	Robustness	39
3.6.1	Possible Violations of the Exclusion Condition	39
3.6.2	Different Measurements of Institutions	40
3.7	Institutions, Geography and Policy	41
3.7.1	Institutions versus Geography	41
3.7.2	Institutions versus Policies	42
3.8	Conclusion	45
	BIBLIOGRAPHY	57

LIST OF TABLES

1	Descriptive Statistics	47
2	Instrument the Institutions in China	48
3	The Effects of Institutions on Economic Performance	49
4	Robustness Test with Additional Controls	50
5	Robustness Test with Different Measurements of Institutions	51
6	Geography versus Institutions	52
7	Policy versus Insitutions (2SLS)	53
8	A1: Data Sources	54
9	A2: Main Data Used in the Paper	55
10	A2: Continue	56

1.0 INTRODUCTION

Money is at the core of modern macroeconomics. Many research efforts have been devoted to modelling the economy with money as the medium of exchange. However, an analytical model of private money with both endogenous prices and divisibility is still in lack. The first of the two chapters in this dissertation fills this gap. I build a model of privately-issued money in which money is divisible and price is endogenous. The model is based on Lagos and Wright's model (Lagos and Wright, 2005). The analysis shows that the private banknotes serve as short term credit for bankers. Given that the Friedman rule, which suggests a deflationary monetary policy, is not available, privately-issued banking notes improve resource allocation in the economy. The welfare improvement is not restricted to bankers. Nonbankers also enjoy welfare improvement. The paper offers new insight into the historical role of privately-issued banknotes.

The second chapter is based on a paper co-authored with Ying Fang, who was my fellow graduate student at the University of Pittsburgh and now is a professor at Xiamen University. In this chapter we use crossing-city data to estimate the effect of property rights protection on China's economic performance. We adopt the historical enrollments of Protestant lower primary schools in the early 20th century as the instrumental variable for current property rights protection in China. Our findings about property rights protection in China resemble the cross-country research by Paulo Mauro (1995), Hall and Jones (1999), and Acemoglu et al (2001). We find that property rights protection dominates others potential determinants of economic performance, such as geography or government policy.

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sertation would have been less interesting, less precise and much less readable. I also thank Professor Marla Ripoll, Professor John Duffy and Professor David DeJong for their warm-hearted encouragement and invaluable advice on my research. Professor Esther Gal-Or and Professor James Feigenbaum have provided very helpful comments on both chapters. I also want to thank Professor Ying Fang, who is my coauthor and my friend. My old friend from Fudan University, Professor Zheng Song has provided insightful comments on both chapters and pointed out one error in the earlier draft of the first chapter. I want to also thank Professor Daniel Berkowitz, Professor Mehmet Caner, Professor Alexis Leon and Professor Mark L. Hoekstra for helpful comments on the chapter on China's institutions.

I am responsible for all the errors in this dissertation.

2.0 DIVISIBLE PRIVATE MONEY WITH ENDOGENOUS PRICES IN A RANDOM MATCHING MODEL

2.1 INTRODUCTION

When memory, or a record of every agent's trading history is absent, money can be seen as a substitute for memory (Kocherlakota, 1996). However, it is not a perfect substitute for memory. Typically, in the random matching model, where money is essential for its function as medium of exchange, the monetary equilibrium is inefficient. The inefficiency is mainly due to the discount factor. When a seller (producer) accepts money in exchange, he is essentially holding money for future consumption. The optimization of the producer leads the production at the level equals today's marginal production cost with the *discounted* marginal utility from tomorrow's consumption. With positive discount rate, the seller's marginal cost is then less than the buyer's marginal utility, which means the production is lower than the efficient level. It might be more intuitive to understand this inefficiency from the seller's point of view. If the discount rate is positive, accepting and holding money means a utility discount for a producer since he is holding money for tomorrow's consumption. In order to compensate this future utility discount from holding money, the producer then would prefer to produce less than the efficient level.

Friedman (1969) suggested a policy of deflation to fix this inefficiency. When prices keep declining, the producer's future utility discount from holding money can be compensated by the higher future value of money. Thus, the producer will increase production to the efficient level. However, it might be difficult to perform the Friedman rule when the monetary authority cannot decrease the stock of money as it wishes, which was the case for the era before the government has a monopoly in money creation. In U.S. before 1914 when private

money was also used, it might be impossible for the monetary authority to decrease the stock of money in circulation. In that case, the Friedman rule might not be feasible.

Since the first best allocation is not obtainable without the Friedman rule, we ask the question: Is there any alternative to be potentially welfare improving when the Friedman rule is difficult to follow? The answer is Yes. We show that 100% backed-up bank notes can serve this purpose¹. Thus, this paper offers an explanation for the historical role of private money. In the history of banking, note issue preceded and outweighed deposit contracts as the main banking business. Walter Bagehot argued that note issue served as a subsidy for a banker to start the business (1873, Chapter III). It seems that note issue offered the earlier-day's bankers some welfare gain. However, this welfare gain has yet to be fully understood from the point of view of modern monetary and banking theory.

Recently, monetary theory has focused on a random matching model with frictions on trade, in which money is essential because of its function as a medium of exchange (Kiyotaki and Wright, 1989). To study the behavior of agents in such a model is difficult. The difficulty lies in that there is no *typical* individual in the model. Since the state of an agent (his money holdings) is a random walk in the model due to the random matching, it is hard to follow the dynamics of the distribution of money holdings among agents. This is why for a long time in this line of literature money was modeled as indivisible that people hold either one or zero unit of money (Trejos and Wright, 1995; Shi, 1995).

Several efforts have been exerted to get around the problem by introducing some mechanism to derive the degeneration of the distribution of money holdings. Shi (1997) used the redistribution of money holdings within the family to make the distribution of money holdings in the population degenerate. Recently, Lagos and Wright (2005, referred as LW hereafter) developed a model with a centralized market in addition to the decentralized market. Under quasi-linear utility, the distribution of money holdings degenerates when individuals exit the centralized market. Money is assumed to be divisible in the model, but at the end of day agents will choose the same quantity of money holding and use money as "indivisible" in the pairwise exchange : the seller will charge the entire amount of money that the buyer owns.

¹We call the bank notes private money, rather than inside money.

In this paper we introduce private money into the LW model and study its effect on the welfare. As for the behavior of bankers, we expand the analysis by Cavalcanti, Erosa and Temzelides (1999) from the indivisible case into the divisible case. Basically, the bankers are similar to those of National Banking System (referred as NBS hereafter). Bankers can issue their own money, or bank notes, under the requirement of 100% reserves. We assume that private money is divisible in the set \mathbb{R}^+ . The quasi-linear utility function will guarantee the degeneration of the distribution of money holdings among nonbankers and will lead to no excess reserves among bankers. Therefore we can solve the model analytically.

To our knowledge this is the first effort to introduce private money into the LW model. We find that, given that the Friedman rule is not attainable, the introduction of private money improves the allocation. The gain in welfare comes from the relaxed liquidity constraint of bankers due to private money. The role of private money in this model is essentially a kind of credit available only to bankers. Since nowadays the e-cash technology provides a similar monetary environment to private money, the welfare improving result of this paper could help us understand current monetary environment as well.

The rest of the paper is organized as follows. Section 2 describes the environment. Section 3 describes the problems faced by the agents in the model. In section 4 we characterize equilibrium. Section 5 analyzes the welfare effects of private money. Section 6 serves as concluding remarks.

2.2 THE ENVIRONMENT

2.2.1 Dual Markets

The economy has a continuum population normalized as having measure 1. Time is discrete. Agents live forever, with discount factor $\beta \in (0, 1)$ between two successive periods. For every period in the economy, there are two different markets successive in time: the daytime market and night market. There is no discount between day and night within one period. During the daytime, people consume and produce different types of goods. The population is equally divided into k types ($k \geq 3$). The i th type agents consume only the i th type goods

and produce only $i + 1$ th type goods. The k th type agents produce 1st type of goods. Agents are randomly matched in pairs. There is no double-coincidence. The daytime market is the decentralized one, where the individuals meet through random matching and bargain.

The night market is the competitive centralized market, where everyone consumes and produces a uniform good. We assume that the production technology is one-to-one in both markets for simplicity, i.e. one unit of labor produces one unit of goods. In order to get the degeneration of the distribution of money holdings among individuals, we need to have linearity in one market. Here we assume that utility is negatively linear in the labor supply on the night market.

As in LW, the individual preferences can be summarized by the following utility function:

$$U(x, h, X, H) = u(x) - c(h) + U(X) - H, \quad (2.1)$$

where x and h (X and H) denote the quantity of goods consumed labor provided on the daytime (night) market respectively, $u(\cdot)$ and $U(\cdot)$ denote the utility from consumption at daytime and night respectively, $c(\cdot)$ denotes the utility loss from daytime labor provision. We assume that there exists q^* such that $u'(q^*) = c'(q^*)$, X^* such that $U'(X^*) = 1$. Notice that q^* is the efficient quantity of consumption and production on the day market.

2.2.2 Money and Banking

There is fiat (outside) money in the economy without intrinsic value. The initial stock of money is M . Later we will see that the initial distribution of outside money does not matter for our result. However, here we just arbitrarily assume that outside money is initially distributed equally among all agents.

A fraction of each type of agents are bankers, denoted as α ($0 < \alpha < 1$). Like other agents, bankers consume and produce in both markets. Bankers can issue their own banking notes as *private money*. We assume that note issue belongs to the set of non-negative real numbers \mathbb{R}^+ in both markets. There is a 100% reserve condition stated as: Every banker's reserves should be no less than his out-floating notes in circulation when he exits the night market. The reserves could be in the form of outside money or notes issued by

other bankers. We use this condition to mimic the 100% collateral requirement during the NBS. NBS required the 100% collateral to be built in advance to note issuing. Our bankers are temporarily allowed to hold a negative net assets during the interval between the day market and the night market, as long as they rebuild their reserve to meet the 100% reserve at the end of the period. For the sake of simplicity, we assume that the cost for bankers to issue notes is zero and that reserves bear no interest. There is a clearing house which serves as a book-keeper only for its members (bankers). The clearing house tracks each banker's reserves, r , and her floating notes in circulation, n . Since the goal of the model is not to study individual's different preferences between outside money and inside money, we simply assume that nonbankers treat outside money and inside money indifferently. There are two forms of assets that can be used as reserves by a banker: outside money or notes issued by other bankers.

During the interval after the daytime market and before the night market there is a clearing process, which takes place according to following rule: First, only clearing house members, i.e., bankers, can redeem the banking notes. Second, when banker A redeems a note issued by banker B, banker A's reserve increases by 1, meanwhile, banker B's floating notes and reserves both decrease by 1. We assume that whenever a banker receives the note issued by other bankers she will redeem it as soon as possible.

For each period, events take place according to the following schedule:

period t : day market matching (decentralized market) \rightarrow redemption (clearing house) \rightarrow night market (centralized market) \rightarrow period $t+1$.

2.3 THE MODEL

2.3.1 Nonbankers

A banker's state can be summarized by her account with the clearing house (r, n) , where r is his reserves and n is his outside floating notes. A nonbanker's state is her money holdings m (including both outside and inside money). In the decentralized market, agents bargain over the quantity and the nominal price of the goods during exchange. The bargaining problem

is solved by studying the Nash solution. In the centralized market nonbankers decide on consumption, labor supply and money to bring into the next day market, taking the price as given. The bankers, in addition to labor supply and consumption, choose reserves and note issuing for the next day, so as to maximize utility subject to the budget constraint and the reserve ratio requirement, taking as given the same price in the centralized market.

On the day time market, each individual is with probability $\frac{1}{k}$ in a meeting with a person who can produce the good he needs, and with probability $\frac{1}{k}$ meeting with a person who can consume the good he produces. Finally, with probability $1 - \frac{2}{k}$ he is in a no-single-coincidence meeting. At the beginning of bargaining, agents know whether their opponent is a banker or a nonbanker and the state of their opponent.

Let $F_t(m)$ denote the distribution of money holdings (both outside and inside money) among nonbankers before trade in the decentralized market. Let $J_t(r, n)$ denote the joint distribution of reserves and notes floating in the circulation for a banker when he enters the decentralized market. Let $V_t^N(m)$ and $W_t^N(m)$ denote the value functions for a nonbanker who holds money m in the day and night markets respectively. The value function for a nonbanker when he enters the day market can be written as follows:

$$\begin{aligned}
V_t^N(m) &= \frac{1}{k}(1 - \alpha) \int \{u[q_t^{NN}(m, \tilde{m})] + W_t^N[m - d_t^{NN}(m, \tilde{m})]\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k}\alpha \int \{u[q_t^{NB}(m; \tilde{r}, \tilde{n})] + W_t^N[m - d_t^{NB}(m; \tilde{r}, \tilde{n})]\} dJ_t(\tilde{r}, \tilde{n}) \\
&\quad + \frac{1}{k}(1 - \alpha) \int \{-c[q_t^{NN}(\tilde{m}, m)] + W_t^N[m + d_t^{NN}(\tilde{m}, m)]\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k}\alpha \int \{-c[q_t^{BN}(m; \tilde{r}, \tilde{n})] + W_t^N[m + d_t^{BN}(m; \tilde{r}, \tilde{n})]\} dJ_t(\tilde{r}, \tilde{n}) \\
&\quad + (1 - \frac{2}{k})W_t^N(m), \tag{2.2}
\end{aligned}$$

where q^{ij} ($i, j \in \{N, B\}$) and d^{ij} ($i, j \in \{N, B\}$) stand for the quantity of goods and money exchanged, respectively, when the buyer is i and seller is j . N denotes a nonbanker and B denotes a banker. In our model, q^{ij} ($i, j \in \{N, B\}$) and d^{ij} ($i, j \in \{N, B\}$) are determined by bargaining and in general are functions of the states of the two parties in the meeting. However, we will show in Lemma 2 that they are only determined by the buyer's state. For a

nonbanker, there could be five possible cases. The first line of the right hand side of equation (2.2) describes the case of meeting a nonbanker seller, the second line of meeting a banker seller, the third line is the case of meeting a nonbanker buyer, the fourth line is the case to meet a banker buyer, and the last line describes the case of no coincidence.

On the night market, a nonbanker faces the following problem:

$$\begin{aligned} W_t^N(m) &= \max_{\{X, H, m'\}} \{U(X) - H + \beta V_{t+1}^N(m')\} \\ \text{s.t. } X &= H + \phi_t(m - m'), \end{aligned} \quad (2.3)$$

where ϕ_t is the price of money/banking note in the night market. Substitute H using the budget constraint into the objective function in (2.3) and apply the first order condition with respect to X . We then obtain:

$$W_t^N(m) = U(X^*) - X^* + \phi_t m + \max_{\{m'\}} \{-\phi_t m' + \beta V_{t+1}^N(m')\}. \quad (2.4)$$

Notice that the value function is linear in money holdings.

2.3.2 Bankers

Let $D_t(r, n)$, $S_t(r, n)$ and $L_t(r, n)$ denote the value function for the bankers while entering the daytime market, the clearing house and the night market respectively. The value function of a banker entering the daytime market is

$$\begin{aligned} D_t(r, n) &= \frac{1}{k}(1 - \alpha) \int \{u[q_t^{BN}(\tilde{m}; r, n)] + S_t[r, n + d_t^{BN}(\tilde{m}; r, n)]\} dF_t(\tilde{m}) \\ &\quad + \frac{1}{k} \alpha \int \{u[q_t^{BB}(r, n; \tilde{r}, \tilde{n})] + S_t[r - d_t^{BB}(r, n; \tilde{r}, \tilde{n}), n]\} dJ_t(\tilde{r}, \tilde{n}) \\ &\quad + \frac{1}{k}(1 - \alpha) \int \{-c[q_t^{NB}(\tilde{m}; r, n)] + S_t[r + d_t^{NB}(\tilde{m}; r, n), n]\} dF_t(\tilde{m}) \\ &\quad + \frac{1}{k} \alpha \int \{-c[q_t^{BB}(\tilde{r}, \tilde{n}; r, n)] + S_t[r + d_t^{BB}(\tilde{r}, \tilde{n}; r, n), n]\} dJ_t(\tilde{r}, \tilde{n}) \\ &\quad + (1 - \frac{2}{k}) S_t(r, n). \end{aligned} \quad (2.5)$$

There are also five possible cases for a banker on the daytime market match: meet a non-banker seller, which is described by the first line on the right hand side of equation (2.5), a banker seller by the second line, a nonbanker buyer by the third line, a banker buyer by the

fourth line, and no coincidence by the last line. $S_t(r, n)$ is the value function for a banker entering the clearing process:

$$S_t(r, n) = \int_0^n L_t(r - x, n - x) d\Pi_t(x), \quad (2.6)$$

where $\Pi_t(x)$ is the probability distribution function of the banker's notes that is to be redeemed during the coming-up redemption process. This distribution is endogenously determined by the model. However, later we will find that it is not necessary to know the specific form of this distribution to characterize the equilibrium. In Lemma 1 we show that the equilibrium for the banker only depends on her excess reserves. Since when a note is redeemed, both reserves and notes are decreased by the same amount, the excess reserves of a banker are not affected by the redemptions. Also, since we assume that bankers must meet the 100% reserve requirement, the number of notes redeemed will not affect the banker's status to satisfy this requirement. Hence, the unknown distribution function $\Pi_t(x)$ does not matter when we characterize the equilibrium.

The value function for a banker who enters the night market can be written as follows:

$$\begin{aligned} L_t(r, n) &= \max_{\{X, H, r', n'\}} \{U(X) - H + \beta V_{t+1}^B(r', n')\} \\ \text{s.t. } X &= H + \phi_t(n' - n + r - r') \\ r' &\geq n'. \end{aligned} \quad (2.7)$$

Notice that bankers are allowed to hold negative reserves during the interval between redemption and the night market. However, they must rebuild their reserves to meet the reserve ratio requirement of $r' \geq n'$ when they exit the night market.

Lemma 1. *The bankers' value function can be written as a function of his excess reserves only, r^e , where $r^e \equiv r - n$.*

Proof. We first prove that the value function in the night market is a function of excess reserves. Then we prove the value function for entering the clearing house is a function of excess reserves. Finally, we show that the day market value function is only related excess reserves.

In the night market, the first order conditions imply that $X = X^*$. Substituting the budget constraint into object function for (2.7), we have

$$L_t(r, n) = U(X^*) - X^* + \phi_t(r - n) + \max_{\{r', n'\}} \{-\phi_t(r' - n') + \beta D_{t+1}(r', n')\}. \quad (2.8)$$

Notice that the value function is a linear function of the excess reserves, $r - n$, and the decision of $\{r', n'\}$ does not depend on current state. We then can rewrite the value function as:

$$\begin{aligned} W_t^B(r^e) &\equiv L_t(r, n) \\ &= U(X^*) - X^* + \phi_t(r - n) + \max_{\{r', n'\}} \{-\phi_t(r' - n') + \beta D_{t+1}(r', n')\} \\ &= U(X^*) - X^* + \phi_t(r^e) + \max_{\{r', n'\}} \{-\phi_t(r^{e'}) + \beta D_{t+1}(r', n')\}. \end{aligned} \quad (2.9)$$

Then S_t can be written as

$$\begin{aligned} S_t(r, n) &= \int_0^n L_t(r - x, n - x) d\Pi_t(x) \\ &= \int_0^n W_t^B(r^e) d\Pi_t(x) \\ &= W_t^B(r^e). \end{aligned} \quad (2.10)$$

Notice that the distribution of redeemed note does not enter the value function. Substituting the $S_t(r, n)$ into the day market value function, we obtain

$$\begin{aligned} D_t(r, n) &= \frac{1}{k}(1 - \alpha) \int \{u[q_t^{BN}(\tilde{m}; r, n)] + W_t^B[r^e - d_t^{BN}(\tilde{m}; r, n)]\} dF_t(\tilde{m}) \\ &\quad + \frac{1}{k}\alpha \int \{u[q_t^{BB}(r, n; \tilde{r}, \tilde{n})] + W_t^B[r^e - d_t^{BB}(r, n; \tilde{r}, \tilde{n})]\} dJ_t(\tilde{r}, \tilde{n}) \\ &\quad + \frac{1}{k}(1 - \alpha) \int \{-c[q_t^{NB}(\tilde{m}; r, n)] + W_t^B[r^e + d_t^{NB}(\tilde{m}; r, n)]\} dF_t(\tilde{m}) \\ &\quad + \frac{1}{k}\alpha \int \{-c[q_t^{BB}(\tilde{r}, \tilde{n}; r, n)] + W_t^B[r^e + d_t^{BB}(\tilde{r}, \tilde{n}; r, n)]\} dJ_t(\tilde{r}, \tilde{n}) \\ &\quad + (1 - \frac{2}{k})W_t^B(r^e). \end{aligned} \quad (2.11)$$

We will show in Lemma 2 that $\{q_t^{IJ}, d_t^{IJ}\}$ depends only on buyer's money holdings, m , or excess reserves, r^e , so we can rewrite the banker's day market value function as

$$D_t(r, n) \equiv V_t^B(r^e). \quad (2.12)$$

Thus, the banker's problem can be written as

$$\begin{aligned}
V_t^B(r^e) &= \frac{1}{k}(1-\alpha) \int \{u[q_t^{BN}(\tilde{m}; r, n)] + W_t^B[r^e - d_t^{BN}(\tilde{m}; r, n)]\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k}\alpha \int \{u[q_t^{BB}(r, n; \tilde{r}, \tilde{n})] + W_t^B[r^e - d_t^{BB}(r, n; \tilde{r}, \tilde{n})]\} dJ_t(\tilde{r}, \tilde{n}) \\
&\quad + \frac{1}{k}(1-\alpha) \int \{-c[q_t^{NB}(\tilde{m}; r, n)] + W_t^B[r^e + d_t^{NB}(\tilde{m}; r, n)]\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k}\alpha \int \{-c[q_t^{BB}(\tilde{r}, \tilde{n}; r, n)] + W_t^B[r^e + d_t^{BB}(\tilde{r}, \tilde{n}; r, n)]\} dJ_t(\tilde{r}, \tilde{n}) \\
&\quad + (1 - \frac{2}{k})W_t^B(r^e)
\end{aligned} \tag{2.13}$$

and

$$\begin{aligned}
W_t^B(r^e) &= U(X^*) - X^* + \phi_t r^e \max_{\{r^{e'}\}} \{-\phi_t r^{e'} + \beta V_{t+1}^B(r^{e'})\} \\
\text{s.t. } r^{e'} &\geq 0.
\end{aligned} \tag{2.14}$$

Since q and d are functions of only buyer's money holding or excess reserves as shown in Lemma 2, the bankers' value functions are reduced to functions of r^e . \square

The result can greatly simplify our analysis of the equilibrium of the model. The intuition for the lemma is quite direct. The value of being a banker is determined by how many assets (reserves) the banker has in his account in the clearing house and how many liabilities (notes) he has in circulation. More reserves means a higher value for the banker, while more notes in circulation means a lower value for the banker. Since we assume that there is no interest return on reserves and no cost to issue the notes, it is not the absolute level of assets and liabilities but the net assets that really counts.

2.3.3 The Bargaining Problem

There are four cases for bargaining: a) nonbanker buyer vs. nonbanker seller; b) nonbanker buyer vs. banker seller; c) banker buyer vs. nonbanker seller; d) banker buy vs. banker seller. The bargaining terms are determined as the Nash solution to the following problems:

$$\begin{aligned} & \max_{\{q_t^{NN}, d_t^{NN}\}} \{u(q_t^{NN}) + W_t^N(m - d_t^{NN}) - W_t^N(m)\}^\theta & (2.15) \\ & \cdot \{-c(q_t) + W_t^N(\tilde{m} + d_t^{NN}) - W_t(\tilde{m})\}^{1-\theta} \end{aligned}$$

$$\begin{aligned} & \max_{\{q_t^{NB}, d_t^{NB}\}} \{u(q_t^{NB}) + W_t^N(m - d_t^{NB}) - W_t^N(m)\}^\theta & (2.16) \\ & \cdot \{-c(q_t^{NB}) + W_t^B(\tilde{r}^e + d_t^{NB}) - W_t^B(\tilde{r}^e)\}^{1-\theta} \end{aligned}$$

$$\begin{aligned} & \max_{\{q_t^{BN}, d_t^{BN}\}} \{u(q_t^{BN}) + W_t^B(r^e - d_t^{BN}) - W_t^B(r^e)\}^\theta & (2.17) \\ & \cdot \{-c(q_t^{BN}) + W_t^N(\tilde{m} + d_t^{BN}) - W_t^N(\tilde{m})\}^{1-\theta} \end{aligned}$$

$$\begin{aligned} & \max_{\{q_t^{BB}, d_t^{BB}\}} \{u(q_t^{BB}) + W_t^B(r^e - d_t^{BB}) - W_t^B(r^e)\}^\theta & (2.18) \\ & \cdot \{-c(q_t^{BB}) + W_t^B(\tilde{r}^e + d_t^{BB}) - W_t^B(\tilde{r}^e)\}^{1-\theta} \end{aligned}$$

where θ is the bargaining power of the buyers.

The difficulty in solving the model lies in that the state of each agent could be variant. Since whether an agent is a producer or a consumer or a nobody in the meeting is entirely random, the money holdings of nonbankers or the excess reserves of bankers could change following a random walk. This makes the bargaining problem (2.15)-(2.18) intractable. However, if both the distribution of nonbanker's money holdings and that of banker's excess reserves are degenerate, then we can solve the bargaining problem. Linearity of preferences and linearity of the technology in the night market leads these distributions to be degenerate.

2.4 EQUILIBRIUM

2.4.1 Definition of Equilibrium

Definition 2. *The equilibrium of the model is defined by a path of*

$$\{V_t^N(m), W_t^N(m), V_t^B(r^e), W_t^B(r^e), X_t, H_t, m'_t, r_t^e, q_t^{ij}, d_t^{ij}, \phi_t, F_t, J_t\}_{t=0}^\infty,$$

where $V_t^N(m)$ is the value function for a nonbanker in the day market, $W_t^N(m)$ is the value function for a nonbanker in the night market, $V_t^B(r^e)$ is the value function for a banker in the day market, and $W_t^B(r^e)$ is the function for a banker in the night market, X_t and H_t are the individual's decision on consumption and production in the night market, m'_t and r_t^e are nonbankers' decision on money holdings and bankers' decision on reserve management when they exit the night market, q_t^{ij} and d_t^{ij} describe for terms of the trade in the day market, ϕ_t is the price of money (hence $1/\phi_t$ is the price of general goods) in the night market, F_t and J_t are the distribution of money holdings and the joint distribution of reserves and notes before the matching.

The conditions for equilibrium in such an economy are as follows. For each period t :

- (i) $V_t^N(m), W_t^N(m), V_t^B(r^e), W_t^B(r^e)$ satisfy (2.2),(2.3),(2.13) and (2.14);
- (ii) given results of bargaining in the day market $\{q_t^{ij}, d_t^{ij}\}$, the price in the night market ϕ_t , and the distributions F_t and J_t , individuals solve their dynamic problems (2.2-2.4 for nonbankers and (2.13)-(2.14) for bankers), determining the money holding m_t , excess reserve management r_t^e , and setting night consumption $X = X^*$, production H subject to budget constraint;
- (iii) given the path of prices in the night market ϕ_t and individual's state m_t, r_t^e , the path of q_t^{ij}, d_t^{ij} solve the bargaining problem (2.15)-(2.18) in each period;
- (iv) $\phi_t > 0$; i.e., we focus on monetary equilibrium;
- (v) at the end of every period, the total financial assets equal the original stock of money $\int m dF_t(m) + \int r^e dJ_t(r, n) = M$;
- (vi) the distributions F_t, J_t are consistent with the evolution of money holdings and reserves and notes implied by trade in both markets and the random redemption process.

2.4.2 Characterizing the Equilibrium

With the result in Lemma 1, the bargaining problem can be greatly simplified. Substitute (2.4) and (2.14) into the bargaining problem, to get:

$$\begin{aligned}
& \max_{\{q_t^{NN}, d_t^{NN}\}} [u(q_t^{NN}) - \phi_t d_t^{NN}]^\theta \cdot [-c(q_t) + \phi_t d_t^{NN}]^{1-\theta} \\
& \max_{\{q_t^{NB}, d_t^{NB}\}} [u(q_t^{NB}) + \phi_t d_t^{NB}]^\theta \cdot [-c(q_t^{NB}) + \phi_t d_t^{NB}]^{1-\theta} \\
& \max_{\{q_t^{BN}, d_t^{BN}\}} [u(q_t^{BN}) - \phi_t d_t^{BN}]^\theta \cdot [-c(q_t^{BN}) + \phi_t d_t^{BN}]^{1-\theta} \\
& \max_{\{q_t^{BB}, d_t^{BB}\}} [u(q_t^{BB}) - \phi_t d_t^{BB}]^\theta \cdot [-c(q_t^{BB}) + \phi_t d_t^{BB}]^{1-\theta}
\end{aligned}$$

In general there are four combinations of banker-nonbanker and producer-buyer matching. However, it does not matter from the point of view of a buyer whether the seller is a bank or nonbanker. Banker and nonbanker producers are the same in regards to production technology and bargaining power. Therefore, for a seller, whether he is a banker or nonbanker does not matter for bargaining. However, from the viewpoint of a seller, whether the buyer is a banker or a nonbanker does make a difference in that the nonbanker buyer may be subject to the cash constraint while the banker is not. So we can summarize the four bargaining cases into two: i) the buyer is a nonbanker ; ii) the buyer is a banker. The bargaining problem turns to follows:

$$\max_{\{q_t^N, d_t^N\}} G^N = [u(q_t^N) - \phi_t d_t^N]^\theta \cdot [-c(q_t^N) + \phi_t d_t^N]^{1-\theta} \quad (2.19)$$

$$\max_{\{q_t^B, d_t^B\}} G^B = \{u(q_t^B) - \phi_t d_t^B\}^\theta \cdot \{-c[q_t^B] + \phi_t d_t^B\}^{1-\theta}, \quad (2.20)$$

where $\{q_t^i, d_t^i\}$ denote the quantity and the price of the exchange when buyer is a nonbanker ($i = N$) or a banker ($i = B$).

Lemma 3. *The solution of (2.19) is*

$$q_t^N = \begin{cases} \widehat{q}_t(m) & \text{if } m < m_t^* \\ q^* & \text{if } m \geq m_t^* \end{cases} \quad \text{and } d_t^N = \begin{cases} m & \text{if } m < m_t^* \\ m^* & \text{if } m \geq m_t^* \end{cases} \quad (2.21)$$

where $\widehat{q}_t(m)$ solves $\phi_t m = z(q)$ with

$$z(q) = \frac{\theta c(q)u'(q) + (1 - \theta)u(q)c'(q)}{\theta u'(q) + (1 - \theta)c'(q)} \quad (2.22)$$

and $m_t^* = z(q^*)/\phi_t$. The solution for (2.20) is

$$q_t^B = q^*; \text{ and } d_t^B = m_t^* \triangleq [\theta c(q^*) + (1 - \theta)u(q^*)] / \phi_t. \quad (2.23)$$

Proof. The first order conditions for problem (2.19) are:

$$\frac{\partial G^N}{\partial q_t} = 0 : \theta[-c(q_t) + \phi_t d_t]u'(q_t) = (1 - \theta)[u(q_t) - \phi_t d_t]c'(q_t) \quad (2.24)$$

$$\frac{\partial G^N}{\partial d_t} = 0 : \theta[-c(q_t) + \phi_t d_t] = (1 - \theta)[u(q_t) - \phi_t d_t]. \quad (2.25)$$

Immediately from above conditions we obtain $u'(q_t) = c'(q_t)$, thus $q_t = q^*$ with q^* satisfying $u'(q^*) = c'(q^*)$. Then from (2.24) we have

$$d_t = [\theta c(q^*) + (1 - \theta)u(q^*)] / \phi_t.$$

The right hand side is just m^* .

For a nonbanker buyer, there are two possible cases: his money holdings are greater than m^* or less than it. If the buyer's money holdings are greater than m^* , i.e., he is not cash constrained, then q^* and m^* are the solution. If the buyer holds less money than m^* , then the solution for q_t is given by (2.24) with d_t equals the total money holdings of the buyer.

For a banker buyer, since he can issue his own banking note, there is no cash constraint for him. Hence, the solution is just as (2.23): $q_t^B = q^*$; and $d_t^B = m_t^* = [\theta c(q^*) + (1 - \theta)u(q^*)] / \phi_t$. \square

This lemma is exactly the same as the result in LW. The results can be intuitively explained by some threshold strategy followed by the seller in bargaining. First, the seller observes the buyer's identity (nonbanker or banker) and his state (money holdings or excess reserves). If the buyer is a nonbanker, the seller will set a threshold of money holdings which equals m^* . When the buyer's money holdings are greater than m^* , the seller produces q^* and charges m^* to the buyer. When the buyer's money holdings are less than m^* , the seller will under-produce, the quantity determined by $\phi_t m = z(q_t)$, and charge all the buyer has, m . If the buyer is a banker, then the buyer will not be constrained by the threshold, since a banker can issue notes.

Notice that $\phi_t m = z(q_t(m))$ implies the following result

$$q'_t(m) = \phi_t / z'(q_t). \quad (2.26)$$

Proposition 4. *The distribution of bankers' excess reserves degenerates to 0.*

Proof. Substitute (2.23) into (2.13), we can rewrite the banker's value function in the form similar to (2.32):

$$V_t^B(r^e) = v_t^B(r^e) + \phi_t r^e + \max_{r^{e'}} \{-\phi_t r^{e'} + \beta V_{t+1}^B(r^{e'})\}, \quad (2.27)$$

where

$$\begin{aligned} v_t^B(r^e) &= \frac{1}{k} u(q^*) - \frac{1}{k} (1 - \alpha) \phi_t m^* - \frac{1}{k} \alpha c(q^*) \\ &\quad + \frac{1}{k} (1 - \alpha) \int \{-c[q_t(\tilde{m})] + \phi_t \tilde{m}\} dF_t(\tilde{m}) \\ &\quad + U(X^*) - X^*. \end{aligned} \quad (2.28)$$

By repeated substitution we have

$$V_t^B(r^e) = v_t^B(r^e) + \phi_t r^e + \sum_{j=t}^{\infty} \max_{r_{j+1}^e} \{-\phi_j r_{j+1}^e + \beta [v_{j+1}^B(r_{j+1}^e) + \phi_{j+1} r_{j+1}^e]\}. \quad (2.29)$$

Notice that $v^{B'}(r^e) = 0$, thus the necessary condition for a monetary equilibrium to exist is that $\beta \phi_{+1} \geq \phi$. As in LW, minimum inflation for a monetary equilibrium is in accordance with the Friedman rule. Under such condition, we have $r_{t+1}^e = 0$. \square

The result of this proposition is quite intuitive. The usage of holding excess reserves for a banker is only in order to prepare for the day market payment in case he meets a right exchange partner who can offer the type of good he consumes. Meanwhile, holding excess reserves implies a utility loss in the night market due to discounting. Then, consider the following strategy. The bankers hold zero excess reserves when exiting tonight's market, issue notes in tomorrow's day market when necessary, and recover the notes with tomorrow's night market production. This way bankers actually enjoy a credit from issuing notes. For bankers, this result is obviously better than holding positive excess reserves since there is no utility loss from discounting.

However, nonbankers cannot enjoy such credit and are still subject to positive money holding. Analogously to LW, we can show the following proposition.

Proposition 5. *The distribution of nonbankers' money holding degenerates to $M/(1 - \alpha)$.*

Proof. The proof of the degeneration is similar to that of LW. Substitute (2.21) and (2.2) into nonbanker's value function (1), to get

$$\begin{aligned}
V_t^N(m) &= \frac{1}{k} \{u[q_t^N(m)] - \phi_t m\} \\
&\quad + \frac{1}{k} (1 - \alpha) \int \{-c[q_t^N(\tilde{m})] + \phi_t \tilde{m}\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k} \alpha [-c(q^*) + \phi_t m^*] \\
&\quad + W_t^N(m).
\end{aligned} \tag{2.30}$$

Let

$$\begin{aligned}
v_t^N(m_t) &= \frac{1}{k} \{u[q_t^N(m)] - \phi_t d_t^N(m)\} \\
&\quad + \frac{1}{k} (1 - \alpha) \int \{-c[q_t^N(\tilde{m})] + \phi_t \tilde{m}\} dF_t(\tilde{m}) \\
&\quad + \frac{1}{k} \alpha [-c(q^*) + \phi_t m^*] + U(X^*) - X^*,
\end{aligned} \tag{2.31}$$

then

$$V_t^N(m) = v_t^N(m_t) + \phi_t m + \max_{m'} \{-\phi_t m' + \beta V_{t+1}^N(m')\}. \tag{2.32}$$

By repeated substitutions, we have

$$V_t^N(m) = v_t^N(m) + \phi_t m + \sum_{j=t}^{\infty} \max_{m_{j+1}} \{-\phi_j m_{j+1} + \beta[v_{j+1}^N(m_{j+1}) + \phi_{j+1} m_{j+1}]\}. \quad (2.33)$$

Note that $V_t^N(m)$ has exactly the same form as in LW. The distribution of money holding among nonbankers degenerates. Since bankers do not hold any excess reserves, and the total stock of money in the economy is M , the money holding of every nonbanker is $M/(1 - \alpha)$. \square

Now we can summarize the results. Every nonbanker chooses $M/(1 - \alpha)$ as his optimal money holdings when exiting the night market. In the day market, nonbankers will pay all their cash if they meet a right type of seller. Bankers all choose to hold no excess reserves when exiting the night market. When they meet the right seller in the day market, they issue m^* amount of notes and consume q^* amount of goods.

2.4.3 The Steady State

The dynamic problem for nonbankers has been described by (2.33), from which we can directly derive the first order condition for nonbankers:

$$\phi_t = \beta[v_{t+1}^{N'}(m_{t+1}) + \phi_{t+1}]. \quad (2.34)$$

Notice that the function $v_{t+1}^N(m_{t+1})$ is just one period lag of (2.31). Taking the derivative of (2.31), we have

$$v_t^{N'}(m) = \frac{1}{k} \{u'[q_t^N(m)]q_t^{N'}(m) - \phi_t\}. \quad (2.35)$$

Substituting $m_{t+1} = M/(1 - \alpha)$ and (2.35) into the first order condition (2.34), we have

$$\phi_t = \beta \left\{ \frac{1}{k} u' \left[q_{t+1}^N \left(\frac{M}{1 - \alpha} \right) \right] q_{t+1}^{N'} \left(\frac{M}{1 - \alpha} \right) + \left(1 - \frac{1}{k} \right) \phi_{t+1} \right\}. \quad (2.36)$$

This is just a first order difference equation with ϕ_t .

Recall that by the result of Lemma 2 $\phi_t = (1 - \alpha)z(q_t)/M$. From (2.26), we have $q_{t+1}'(\frac{M}{1-\alpha}) = \phi_{t+1}/z'(q_{t+1})$. Combine these results with (2.36), we obtain

$$z(q_t^N) = \beta z(q_{t+1}^N) \left[\frac{1}{k} \frac{u'(q_{t+1}^N)}{z'(q_{t+1}^N)} + 1 - \frac{1}{k} \right]. \quad (2.37)$$

Therefore the equilibrium can be summarized by the solution to this difference equation about q_t .

Definition 6. *Define a steady state as an equilibrium in which q_t is constant.*

Then, the steady state consumption of nonbankers in the decentralized market must satisfy

$$\frac{u'(q^N)}{z'(q^N)} = 1 + \frac{(1 - \beta) \cdot k}{\beta}. \quad (2.38)$$

For bankers, the steady state consumption in the day market is q^* .

2.5 WELFARE ANALYSIS

The remaining of the paper focus on steady state equilibrium. The following propositions summarize the welfare analysis in this economy.

Proposition 7. *The optimal monetary policy is the Friedman rule.*

Equation (2.38) implies that marginal utility is higher than the marginal cost for non-banker buyers. This means that the trading quantity with nonbanker buyers is lower than the efficient level. From the right hand side of (2.38), we can see that the inefficiency is caused by the discount rate. This implies that the Friedman rule is still optimal monetary policy if feasible in this economy.

Proposition 8. *The introduction of private money improves the total welfare of the economy.*

Proof. First of all, notice that in the steady state, nonbankers' consumption will not change by the introduction of private money. In the day market his consumption is determined by equation (2.38), just the same with the case without private money. And in the night market, all agents' night time consumption is X^* . Compared with the economy without private money, the only welfare change introduced by private money is in the case when a banker buyer meets a right seller. So we only need to consider this case. Let's first consider how the banker buyer's welfare will change. For the banker buyer, he will enjoy more consumption in the day market than in an economy without private money. His utility increase from more daytime consumption is $u(q^*) - u(\hat{q})$. Meanwhile, the banker buyer

have to work more in the night market to cover the more notes he issued during the day. The buyer pays M when there is only outside money. Now the bank buyer pays m^* . His utility loss from more payment is $\phi_t(m^* - M)$. Thus, the net gain for the banker buyer is $u(q^*) - u(\hat{q}) - \phi_t(m^* - M)$. Now consider how the seller's welfare will change. In the case without private money, the seller produces \hat{q} in the day market and gets M amount of money. Now if he meets a right banker buyer, he would produce q^* and get m^* amount of money. His net gain thus is $\phi_t(m^* - M) - [c(q^*) - c(\hat{q})]$. Combine the welfare change of the banker buyer and the seller, the total welfare change caused by the introduction of private money is $[u(q^*) - u(\hat{q})] - [c(q^*) - c(\hat{q})]$. It's easy to show that this welfare change is positive. Since q^* is the only q to maximize the item $u(q) - c(q)$, and since we know that \hat{q} is different from q^* , the item $[u(q^*) - c(q^*)] - [u(\hat{q}) - c(\hat{q})]$ is strictly positive. Therefore, the welfare change introduced by private money is strictly positive. \square

Proposition 9. *Both bankers and nonbankers share the welfare gain introduced by private money. The welfare gain is divided between the banker buyer and the seller according to their bargaining power.*

Proof. It is easy to see that the banker buyer will enjoy the welfare gain introduced by private money because he now has one more degree of freedom by issuing his own notes. He will not do so if his welfare decreases by doing so. For nonbankers, his welfare will also be improved by the introduction of private money. Consider a nonbanker seller meets a right banker buyer. If he accepts the deal, his welfare change will be $\phi_t(m^* - M) - [c(q^*) - c(\hat{q})]$. From equation (2.22) and (2.23), we have

$$\phi_t(m^* - M) = [\theta c(q^*) + (1 - \theta)u(q^*)] - \frac{\theta c(\hat{q})u'(\hat{q}) + (1 - \theta)u(\hat{q})c'(\hat{q})}{\theta u'(\hat{q}) + (1 - \theta)c'(\hat{q})}. \quad (2.39)$$

Notice that if $\theta = 1$, the above item is simply $[c(q^*) - c(\hat{q})]$, which means the seller's welfare gain is zero. In this case, the buyer, which is a banker, has the maximum bargaining power and will enjoy all the welfare gain introduced by private money. If $\theta = 0$, which means the seller has the maximum bargaining power, then the right hand side of equation (2.39) can be simplified as $u(q^*) - u(\hat{q})$. In this case, the welfare change for the seller is $[u(q^*) - c(q^*)] - [u(\hat{q}) - c(\hat{q})]$, which is the total welfare gain. If $0 < \theta < 1$, then the

seller has some bargaining power and will enjoy a positive welfare gain introduced by private money. □

It is interesting to realize that the nonbankers are also able to enjoy the welfare improvement in this economy with private money. In fact, this result is intuitive. Since the equilibrium of the economy is determined by the bargain between the buyer and seller, unless the seller has no bargaining power, the nonbanker, as a seller, can always get a bite on the welfare gain introduced by private money. Since all the nonbankers in this economy have the strictly positive chance to meet a banker buyer who will consume his production, the welfare of a nonbanker is thus strictly improved by introducing private money.

2.6 CONCLUDING REMARKS

In this paper we introduce divisible private money into the LW model. The note redemption of notes adds another dimension of randomness into the model, which makes it harder to solve analytically. Assuming no cost to issue note, no interest return on reserves and 100% reserve requirement, we obtain the analytical solution of the model. The distribution of note redemption does not affect bankers' value function in his optimization problem. The distribution of excess reserves among bankers degenerates, as well as the distribution of money holdings among nonbankers. The degeneration of the distributions of money holdings and excess reserves in this paper resembles the basic result in LW, except that their model has no private money and thus less complicated than the environment in this paper.

The central contribution of the paper is to study the welfare consequences of private money within the framework of the random matching model. Given that the Friedman rule is not achievable, we find that the introduction of private money improves the welfare in the economy. Both bankers and nonbankers enjoy the welfare unless their bargaining power is zero. Bankers enjoy more consumption as buyers in the day market. Nonbankers enjoy more monetary income as the seller and thus less work in the night market. The divide of the welfare gain between banker buyers and sellers is determined by their bargaining power.

We also find that the role of private money can be understood as a particular mechanism

of credit. Essentially, bankers in this model issue banknotes as if they are given a zero cost short term credit, which is similar to the credit card with zero APR within the billing cycle. Although only bankers are access to this type of credit, the whole society enjoy the welfare improvement introduced by this credit.

We set the fraction of bankers as exogenously given in the paper. One expansion for future work could be endogenizing the fraction of the population who can enjoy the credit. Another interesting expansion could be the reserve management of present banks. In our model bankers issue notes rather than attracts deposits. The modern banks do not issue money, but accept deposits. How monetary policies on inflation or reserve ratios affect bankers' reserve management and the consequent allocation in the economy? This is a natural question to be answered when we understand the case of private banking notes.

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3.0 DO INSTITUTIONS MATTER? ESTIMATING THE EFFECTS OF INSTITUTIONS ON ECONOMIC PERFORMANCE IN CHINA

3.1 INTRODUCTION

China's real GDP per capita has been growing with an average of 7.4% for almost thirty years.¹ While some suspect that China's GDP numbers has been exaggerated, the impressive economic growth of China is a widely-recognized statistical fact (Perkins & Rawski, Chapter 20). China's economic success is generally owed to the *reform and opening* policy since 1978, which has been transforming the economy toward market system step by step. However, the consequence of the reform is not evenly distributed across the country. A country of the size close to Europe with one fifth of world population, China contains more than 300 cities with substantial variations in both production and institutions existing among them. For example, in 2003 the GDP per capita in Shenzhen, one of fastest growing cities in China, was 54,545 yuan, while in Chongqing, a city located in southwest mountain area of China, that number was 8,077 yuan. Different measurements show large variation of institutions among regions. For example, in the Marketization Index constructed by Fan et al (2003), Guangdong was valued as 8.41 in 2000 while Xinjiang valued only 3.15. A research of World Bank estimates that 80 percent of productivity gap between cities within could be explained by the investment climate (World Bank Investment Climate Research Program). In this paper we try to estimate the effects of institutions on China's economy with cross-city data.

The topic of this paper relates to a general issue regarding on economic development:

¹According to the National Bureau of Statistics of China, China's GDP per capita increased from 381 yuan in 1978 to 14,040 yuan in 2005. The Consumer Price Index increase from 100 to 464 during the same period (National Bureau of Statistics of China).

how to understand the large spatial difference in economic performance? Economists have offered variant explanations. Many researchers believe that economic performance is rooted in millions of individual economic decisions. When making the economic decisions about investment, education or R&D (research and development) investment, people and firms respond to incentives, which are guided by the institutions of a society. Therefore, some believe that institutions are the most important determinant for economic development (North and Thomas, 1973; North, 1981 and 1990, Acemoglu, Johnson and Robinson, 2004). In contrast, some scholars argue that geography shapes human history and plays a fundamental role in economic growth (Diamond 1997, Sachs and Warner 1995, 1997). Others argue that human capital and government policies are the most important determinants of development (Glaeser et al., 2004). China provides a nice setting to compare the effects of institutions, geography and policies. Besides the regional variations of production and institutions, China exhibits large differences in geography and government policies across localities. Compared with the cross-country study, one merit of China case is that as an economy with uniform currency, legal system, trade regime and historic-cultural background, we could compare the effects of institutions, geography and policies with less noise from other possible influential factors.

One difficulty in estimating the effects of institutions is that institutions are endogenous. Richer economies are able to afford better education, more lawyers and prosecutors, more educated government officials, better public media and so on, thus, better institutions. Moreover, there could be other factors, such as geography, that affect both institutions and economic performance. Because of the endogeneity of institutions, the OLS estimate of the effect of institutions on economic performance is biased, making it impossible to determine the causal relationship between institutions and economic performance. In order to obtain the unbiased estimate, we need to find an instrumental variable for institutions.

Econometrically, to estimate the effects of institutions on economic performance requires that we find instruments for institutions. Mauro (1995) used ethnolinguistic fractionalization to instrument corruption and bureaucratic efficiency. Hall and Jones (1999) used the distances to the equator across countries as the instrument for social infrastructure. Acemoglu et al (2001) employed European settler mortality rates to instrument institutions. However,

there are some concerns regarding the validity of these instruments. Some authors argued that the ethnolinguistic fractionalization is influenced by economic performance (see Acemoglu et al., 2001). Distances from the equator can affect the economy through climate and geography rather than institutions (Bloom and Sachs 1998; Gallup et al., 1998). Glaeser et al. (2004) argued that historic European settler mortality was correlated with current disease environment and human capital which could influence current economic performance directly rather than through institutions.

We propose to adopt the enrollment in Protestant missionary lower primary schools in the early 20th century as an instrumental variable for China's present institutions. Our main logic can be summarized into three arguments:

1. China's present reform can be viewed as a part of longer historical movement of "modernization," which can be traced back at least one and a half centuries. The main feature of this movement is learning from the West and transforming China from pre-modern economy to modern economy.

2. Those areas that experienced deeper historical influence by the West have developed institutions more favorable to the market economy and the protection of property rights.

3. The enrollment in Protestant missionary lower primary schools in 1919 reflects the influence by the West in early 20th century China.

The sketch of our logic is: the influence of the West \Rightarrow institutions \Rightarrow economic performance. With the instrument, we perform the Two Stage Least Squares (2SLS) estimation and find that institutions are significant in explaining China's variation in economic performance across cities in our sample. The results survive various robustness tests. Our results show that institutions dominate geography and policy in explaining economic variation among China's cities.

The rest of the paper proceeds as follows. Section 2 introduces the historical background of China's institutional change. Section 3 discusses our strategy to instrument China's institutions. Section 4 describes the measurements we adopt in this paper and our data set. In section 5 we estimate the effect of institutions on economic performance and check the robustness. Section 6 compares the effect of institutions with those of geography and policy. Finally, section 7 serves as conclusion.

3.2 INSTITUTIONAL CHANGE IN CHINA: A BRIEF REVIEW OF HISTORICAL BACKGROUND

Although China's current reform started in 1978, many historians see this reform as the most recent dimension of a much longer and greater transitional process (Ray Huang, 1988; Degang Tang, 1998). This process, which dates back to 1553 when Portuguese was allowed to anchor and trade at Macau by China, accelerated in particular after China encountered a series of military defeats by the western countries during the second half of 19th century. Following the imposition of a free trade regime upon China at several port cities, Chinese local markets had become integrated with the international economy and markets at least by 1890s (Brandt, 1985). Many Chinese then realized that China had to learn from the western culture to modernize its social system and introduced modern industries into China. The process suffered many setbacks. However, after the settlement of the turmoil in 1900 that caused the occupation of Beijing by eight western countries, outside observers viewed China as having entered a new era. The following remark is not from a recent *New York Times* issue on current China, but a description by a Christian observer writing in 1919:

The two decades have been distinctly revolutionary in tendency: this not in the old sense alone which resulted in the displacement of individuals, but deeper, in that during this period ancient principles and institutions have been moved aside for something new. ... More significant than any other change has been that in the temper of the people. After all, the changes already registered are precursors of wider ones. China will not only reflect the changes going on all over the world but will materially help to change the world. Four hundred million people cannot wake up and leave the rest of the world untouched. (Frank Rawlinson, Change and progress in the Christian movement in China during the last two decades 1900-1920, The Christian Occupation of China, 1922)

In 1911 the last dynasty in China's history, Qing Dynasty, was overturned by the *Xinhai Revolution* and succeeded by the Republic of China. After the revolution and the World War I, China experienced a rapid industrial spurt. The following quote delivers a rough but impressive picture of the economy in early years of the Republic of China.

The coming of modern industry to China has been described as "a terrific invasion." This modern revolution is taking place so quietly that few people are aware that anything untoward is happening. To estimate the growth in terms of figures is not easy, since no authentic and complete list of factories has as yet been published. In the China Year Book of 1921 a list of "the more important trades" is given, showing that almost every type of

industry is to be found in China, e.g. Arsenals, Canneries, Cement Work, Confectionery, Cotton, Chemicals, Breweries, Dockyards, Shipbuilding, Engineering, Flour Mills, Furniture, Glass, ...This list does not include certain industries with which the name of China is particularly associated, e.g. Carpets, Rugs, Porcelain, etc. The above are listed under some 50 centers scattered over China. The secretary of the Chinese Maritime Customs says, "There are foreign-type articles of domestic consumption that are not now manufactured in China by factories on modern lines, the majority without foreign assistance." For proof of this mushroom-like growth, return visits to some of our factory districts after an interval of a few months will suffice, or reading the notes under "Industry in China" which appear in the Far Eastern Review or in the Weekly Review of the Far East from time to time (The Christian Occupation of China, 1922).

It seems that China was then experiencing an early phase of what Kuznets terms modern economic growth. Railroads were expanded and factories erected. Between 1913 and 1920 Chinese managers established 1,061 modern factories with capital investment totaling around 170 million Chinese dollars² and employing over a quarter million workers (Myers, 1980, pp. 126). The development continued to the World War II. According John K. Chang's index of industrial production between 1911 and 1949, from 1911 until 1936, both the gross and net value production show a rapid annual growth rate of around 9.4 percent (Chang, 1969). This growth rate is higher than that of the United Kingdom (1820-1870, 3.0 percent), the United States (1860-1914, 5.9 percent), and Japan (1906-1935, 6.4 percent) (Myers, 1980, pp.135-136).

However, the transition process was interrupted by the battle against Japanese invaders from 1937 to 1945 and the subsequent civil war between the Kuomintang government and the Chinese Communist Party (CCP) between 1946 and 1949. When the war ended in 1949, the Republic of China moved to Taiwan while on the mainland it was replaced by People's Republic of China. China kept learning from the West, however, this time from Karl Marx. The CCP copied the economic model of Soviet Union and transformed Chinese economy by embracing central planning. The CCP government promoted manufacturing through high compulsory savings and distorted low prices of inputs. China built a rather complete sector of heavy industries, such as oil, steel, ship and even airplane. However, it is believed that there existed a big gap between China's economic performance and its potential during the plan economy era (Brandt and Rawski, 2007).

²One Chinese dollar equals to US\$0.26 in 1933 (Myers, 1980, pp. 251).

In 1978, when DENG Xiaoping became the leader of the party, China began a series of reforms that gradually moved the planned economy toward a market-oriented system. In 1978 millions of farm households regained certain freedom to manage agricultural production. Thousands of Chinese students were sent to universities in western countries. State-owned enterprises began to recruit managers publicly in 1983 and began to issue stocks in 1987. In 1990 the public stock exchange was established. At the same time, private-owned enterprises and village-owned enterprises (TVEs or *Xiangzhen Qiye*) have been encouraged and then prospered. Between 1978 and 2005, China's trade volume has increased 68-fold in terms of US dollars. The FDI into China increased from 2.65 billion US dollars in 1984 to 189.06 billion US dollars in 2005 (National Bureau of Statistics of China). In 2001 China was accepted as a member of WTO.

In short, China's current reform can be viewed as a part of a long and winding road of "modernization" characterized by "learning from the West." Based on this historical view, we believe that the influence by the West during early decades of 20th century had a significant influence on China's current economic performance.

3.3 THE INSTRUMENT FOR CHINA'S INSTITUTIONS

Before we estimate the effects of institutions, we need to be aware of how to define institutions. The term "institutions" is a concept that can include many things from general law to cultural conventions. However, following North and Thomas (1973) and North (1981, 1990), our hypothesis is that the protection for property rights is the key to explain the economic performance. Thus, we consider the core of institutions as a set of social rules that protect property rights. And also following North (1981), it is the real rules embodied in the enforcement rather than the words written on paper that really count. One research report by World Bank supports this argument. "It is not just formal policies that matter. The implementation of policies is what is experienced – with 95 percent of firms reporting a gap between what is on the books and how regulations are interpreted in practice. This gap provides a key opening to corruption and by raising uncertainty lowers the probability of investment by up to a third" (World Bank Investment Climate Research Program).

Therefore, we focus on the implementation of the institution of property rights protection.

Colorful as they are, China's ongoing changes can be viewed as a transition from a planned economy to a market economy, during which the property rights get more and more respect and protection. Although different localities of China share a uniform political and legal system on paper, actual institutions – the enforcement of the market system – have large variation across regions. For example, the list of China's 100 most competitive private firms in 2005 shows that the vast majority are based in just 3 of 32 provincial administrative regions on China's mainland, 37 firms on the list are from Zhejiang province, 16 from Guangdong, and 10 from Jiangsu (Liu, Zhao and Liu, 2007).

How China, a country with strong central government and a uniform constitution and legal system, presents so large regional variation in institutions? First, although the *reform and opening* policy is adopted by central government, many specific reforms were initiated by local governments. Beneath the uniform political and legal system, the extent to which people engage with the market is largely determined by their confidence in the protection of property rights by the local administrative practice, which is highly influenced by the local conventions and understandings of institutions. These local conventions are the result of historical evolution of the local community. We believe that current conventions are related to the historical influence from the western in the local community in early 20th century. Since the modern market system and the protection of property rights are institutional establishments originating from the western countries, regions with deeper histories of influence from the West should experience greater penetration of market institutions.

We use the enrollment in Protestant missionary lower primary schools to capture the extent of the influence by the West. The earliest Christian mission in China may be traced back to 1582 when Matteo Ricci came to China. However, organized missionary activities began after 1841, just paralleling the process of China's active learning from the western countries. During the Boxer turmoil in 1900 the Christian Church was heavily destroyed in some areas. But the Church recovered rapidly after the turmoil. During the early years of the Republic of China, Christian missions in China had developed rapidly. Almost every province had Christian missionary centers and almost every mission station had a lower primary school. From the Chinese viewpoint, the Christians represented western culture.

Hence, the extent of local Christian influence can serve as a measure of how much the area was influenced by the West.

Since current institutions are related to the historical influence of the West, the early Christian influence can serve as an instrument for today's institution of property rights protection. The data of our instrument is described in the next section. In panel A of table 2, we see that institutions are significant when regressed to log GDP per capita in 2003. However, due to the endogeneity of institutions, this result should be read as a relationship of correlation rather than causality. In panel B of table 2, we see that our instrument is significant as an explanatory variable for present institutions.

The exclusion condition of the instrument assumes that the instrument affects current economic performance only through institutions. To investigate whether the condition holds, we consider two possible violations of the exclusion condition. One concern is: What if the historical enrollment of the Protestant missionary lower primary schools could affect current distribution of Christian religion in China and current Christian religion in turn affects economic performance directly rather than through institutions? Missionary schools taught not only religious subjects but also curricula about modern knowledge. Long before 1927, the number of required hours of Bible study in missionary primary schools had been reduced (Idabelle Lewis Main, 1934, pp. 270). The new curricula focused more on citizenship training and Chinese language (Howson Lee, 1934). Kiang-wen Han (1934, pp. 313) concluded that "on the whole, religion does not hold an important place in the life and thinking of the students in China." Moreover, after 1949 all religions in China declined due to the official atheist ideology and the suppression of religions during the Cultural Revolution between 1966 and 1976. The recent revival of religion including Christian missionaries in China since 1978 is difficult to measure. Besides the authorized missionary activities, there are variant forms of unauthorized missions, including overseas missionaries and underground churches. In general, we believe the historical Christian distribution has little impact on China's current Christian distribution.

More importantly, as Robert J. Barro and Rachel M. McCleary (2003, 2005) argued, it is general belief in God, heaven, hell and afterlife, hell in particular, rather than organized religious activities, that positively affect economic performance. And particularly, Barro and

McCleary (2003) found in cross-country data that after controlling for the beliefs in heaven or hell, the Protestant share of religious population actually detracts from economic growth. Chinese people have a long history of belief in heaven, hell and afterlife that dates back to the Han Dynasty (206 B.C. - 220 A.D.) or earlier (Yu, 1964, 1987). The introduction of Buddhism into China since late Han Dynasty and its subsequent popularity spread the belief in hell and the afterlife across China. Compared with the Buddhists or the mass of believers in hell and afterlife, Christians are small minority in China. We therefore believe that the enrollment in Protestant missionary primary schools in 1919 has very little influence on current Chinese beliefs about heaven or hell and could not affect current economic performance directly.

We perform an intuitive test on whether our instrument affects current log GDP per capita directly. If the historical enrollment in Protestant missionary lower primary schools (our instrument) affects current log GDP per capita only through institutions, then our instrument should be significant when explaining log GDP alone but NOT significant when explaining log GDP along with institutions. We see this exact outcome in panel A of table 2. When we regress log GDP per capita in 2003 on our instrument (historical enrollment of missionary lower primary schools) alone, the coefficient of our instrument is 0.18 and significant at 5% level. However, when we regress log GDP per capita in 2003 on both average protection of property rights and historical enrollment of missionary lower primary schools, the coefficient of our instrument is not significant while institutions remain significant at 5% level.

The other concern about the violation of exclusion condition is that the instrument is correlated with other unobserved determinants of economic performance. We test three possible underlying factors. First, if Christian missions were more prevalent in coastal areas than inland, then our instrument could be correlated with distance to the coast, which could possibly affect GDP per capita across regions through several other channels, such as the adoption of FDI and access to international trade. Thus our instrument could affect economic performance through distance to coast rather than institutions. However, the distribution of 1919 Christian missionaries does not correlate with distance to coast. The Treaty of Tientsin between China and France in 1860 allowed Christian missions to establish their missionary stations far from the coast. The Most Favored Nation Clause enabled all western countries to

locate missions in China's hinterland. As Albert Feuerwerker (1983, pp. 165-167) described, "Protected by general and specific extraterritorial provisions of treaties, they reached into nearly every corner of the country. As of 1899 all but 106 out of 1704 counties or hsien in China proper and Manchuria reported some Protestant missionary activity."

We regress our instrument on distance to the coast and report the result in panel C of table 2. We find that there is no significant correlation between the two. In panel B of table 2, we add distance to coast as an additional control in our regression of institutions, and find that our instrument is still significant in explaining the institutions when distance to the coast is controlled.

The second possible underlying factor is that the historical distribution of Protestant primary school pupils may affect the current economy through the channel of human capital. If higher enrollment means better education conditions and higher human capital in the 1920s, then our instrument could influence current economic performance through historical human capital rather than institutions. However, we believe this cannot be the case for the following reasons. Missionary lower primary school pupils were only around 4% as many as those in government primary schools in the 1920s (Albert Feuerwerker, 1983). We check this by regressing our instrument on the total primary school enrollment, which we employ to capture human capital in the 1920s. The result is reported in panel C of table 2. There is no significant correlation between the two variables.

3.4 MEASUREMENTS AND DATA

China's subnational governments can be categorized into four administrative levels: province, city, county and town. There are only 34 observations³ at the provincial level. Particularly, in early 1900s China had only 18 provinces, some of which have been divided and merged into others. Using city-level data we can obtain more observations. Our sample consists of 47 cities listed in table A2. The sample size is restricted by the data of institutions. One complicated issue is that city boundaries have changed a lot during the last 100 years. The

³Totally, China has 34 provincial level sub-national governments, including 23 provinces, 5 autonomous regions, 4 province-level cities and 2 special administrative areas (Hong Kong and Macau).

data of historical enrollment of Protestant missionary primary schools are at county level. Since the boundaries of counties are rather stable during the whole 20th century, we can match the county-level data of Christian mission with the city-level data of institutions.

As mentioned above, we focus on the institution of property right protection in this paper. It is always difficult to measure institutions. There are two basic methods to measure institutions. One is subjective measurement, in which people's opinions about institutions are evaluated through survey and aggregated into a quantitative index. The alternative is objective measurement based on statistical facts about the results of institutions. For example, the waiting time for government approval for starting a business is observed and used as a measurement for institutions. In this paper we use subjective measurement. The data is from a cross-city survey conducted by Pengfei Ni et al in 2002 and 2003 (Ni et al, 2004, 2005). The survey covered 47 cities of prefectural or higher level. For each city, they sent out 2000 questionnaires to scholars, entrepreneurs and randomly sampled citizens, asking them to grade the city's performance in a wide range of aspects. For each listed item, the respondent selected from five options ranging from highest (favorable) to the lowest (unfavorable). The highest option was set by Ni as 1.5 while the lowest -1.5. For each aspect, Ni et al calculated the mean score and then constructed an index ranging from 0 to 1 across 47 cities.

We focus on the index of property rights protection developed by Ni et al. This includes three sub-indices: the extent to which the government resorts to informal tax levies, protection of intellectual property rights, and protection of contract enforcement by the legal system. We take the average of their index of property rights protection for year 2002 and 2003 as our main measurement of institutions. The city with the best institutions is Xiamen, whose average index of property rights protection is 0.896. The lowest in the sample is from Wuhan, which is 0.5035. We find that among the top 10 cities with highest average index, 7 are from Zhejiang, Jiangsu and Guangdong. This is consistent with the index for the most competitive private enterprises of China in 2005 constructed by Liu et al (2007). Ni also constructed the index of comprehensive institutions and the sub-index of informal government collection and fees. We use these two indices as complementary measurements for institutions to check the robustness of our results.

The data of historical enrollment of Protestant missionary lower primary schools is from a survey conducted by the Continuation Committee in 1920. The results of the survey was beautifully edited into a book titled "The Christian Occupation of China". The survey had all the county-level data about the enrollment of Protestant missionary lower and higher primary schools in 1919. We choose only lower primary school as our main measurement of the instrumental variable because the data of higher primary school are rather incomplete. For example, there were only 306 reported higher primary schools out of the 693 Protestant residential centers (Albert Feuerwerker, 1982). Since the survey includes the population for each county as well, we can calculate the enrollment of missionary lower primary schools per 100,000 persons, which is our instrumental variable for institutions.

Finally, to measure the economic performance across regions, we use log GDP per capita of all cities in 2003, following Hall and Jones (1999). The data is obtained from Urban Statistical Yearbook of China 2004, in terms of the Chinese currency, or *yuan*. In table A1 we describe all other variables used in this paper and list the data sources.

Table 1 provides descriptive statistics of our main data. The average of log GDP per capita for all 47 cities in 2003 is 10.048 and the standard deviation in the sample is 0.4842. The maximum observation is 11.004 while the minimum is 8.996, which means that the GDP per capita of the richest city in our sample was almost 7.5 times of the poorest city in 2003. The sample mean of average protection of property rights is 0.6509 and the standard deviation is 0.0979. The average of the enrollment in missionary lower primary schools is 72.258 per 100,000 population and the standard deviation is 84.656. The maximum observation is 420.223 per 100,000 population and the minimum is only 1.3828 per 100,000 population.

3.5 ESTIMATES

3.5.1 The Model

Although institutions are significant in the OLS regression reported in panel A of table 2, it should be read as no more than correlation. We cannot infer a causal relationship between institutions and economic performance from OLS estimates. Moreover, due to the

endogeneity of institutions, the OLS estimate is biased. Hence, we use the two-stage least squares (2SLS) method to estimate the effect of institutions on economic performance. The basic model is

$$y_i = a + \beta \widehat{P}_i + \theta X_i + \epsilon_i \quad (3.1)$$

$$P_i = b + \gamma E_i + \delta X_i + \nu_i \quad (3.2)$$

where y_i , P_i and E_i respectively denote log GDP per capita in 2003, average protection of property rights in 2002-2003 and historical enrollment of missionary lower primary schools for city i . \widehat{P}_i is the predicted value from equation (3.2). We use X_i to denote the covariants such as distance to the coast, rainfall, temperature, approximate historical human capital, government policy and so on. In the first stage we regress the observed measure of current institutional performance P_i on our instrumental variable E_i and the covariants X_i . The ν_i is the error term. In the second stage we regress current GDP per capita y_i on the predicted institutions \widehat{P}_i derived from the first stage, with ϵ_i as the error term. Covariants X_i appear in both regressions. The parameter of interest is the coefficient β in (3.1), the effect of institutions on economic performance. Our identification strategy is that the historical enrollment distribution of missionary lower primary schools is not correlated with the error term ϵ_i in the second stage.

3.5.2 Main Results

Table 3 lists our main findings regarding the effect of institutions on economic outcomes. Panel A lists the estimation results from the second stage regression with log GDP per capita in 2003 as dependent variable. Panel B lists results from the first stage regression with average protection of property rights as the dependent variable. Table 3 is our main specification with the enrollment in Protestant missionary lower primary schools as the instrument for institutions. The 2SLS estimate of institutions is 4.23, which is significant at the 5% level for a two-sided t-statistic.

Compared to the OLS estimate in panel A of table 2, there are two points worthy of notice. First, the coefficient of institutions is significant in both regressions. The coefficient in the 2SLS regression is 4.23, which implies that the city’s GDP per capita will increase by 4.23% if its average index of property rights protection increases by 0.01. For example, if Tianjin could improve its property rights to Beijing’s level, from 0.64 to 0.68, then its GDP per capita could increase by about 17%. Second, the value of the coefficient in the 2SLS is much larger than in the OLS regression. From this perspective our result is similar to Acemoglu et al. (2001), in which their 2SLS result is twice that in OLS. This shows that the OLS estimate of the effect of institutions is downward biased, which is the same as the findings of Hall and Jones (1999) and Acemoglu et al (2001).

We also report the value of the Anderson canonical correlation likelihood ratio test (Alastair Hall, et al., 1996). The null hypothesis of the test is that the first stage regression is underidentified, i.e., that the instrument is not relevant. Under the null hypothesis, the test converges to a Chi-square distribution with one degree of freedom. The Anderson canonical correlation LR test reported in column (1) is 7.491. The small p-value 0.006 means we can significantly reject the null hypothesis.

3.6 ROBUSTNESS

3.6.1 Possible Violations of the Exclusion Condition

We have discussed in section 3 the concerns about validity of the exclusion condition for our instrument with several intuitive OLS regressions. As a robustness test, we insert additional right-hand variables into 2SLS as additional controls to test the validity of our instrumental variable. If our exclusion assumption holds, the coefficient of institutions in the second stage regression should not change remarkably when additional controls are added to the regression. The results are reported in table 4. In column (1) we add distance to the coast as an additional control that enters both stages. In the first stage, both historical enrollment of missionary lower primary schools per 1000 persons and distance to the coast are significant. In the second stage, the coefficient of institutions is 3.779 and is still significant, but the

coefficient of distance to the coast is not significant. This shows that distance to the coast is not significant in explaining the log GDP per capita when institutions are considered.

Column (2) responds to the concern that our instrument might be correlated to the historical geographic distribution of human capital, which affects current economic performance. It is difficult to find the data of the historical human capital. We approximate it with the total primary school enrollment per 1000 population, which includes the historical enrollment of lower and higher primary schools of both missionary and government per 1,000 persons in 1919. In the first stage, we find that only the enrollment of missionary lower primary schools helps to explain the variation of institutions across regions. The total enrollment is not significant. In the second stage, the coefficient of institutions is 4.304 and significant at the 5% level, while the control variable is not significant. So the historical human capital does not affect current economic performance.

In column (3) we examine the possible correlation between the historical geographic distribution of enrollment in Protestant missionary lower primary schools and the initial conditions of different cities before the reform. We use the earliest available cross-city data of national income⁴ we can find to measure the initial condition, and that is for 1985.⁵ The first stage regression shows that both our instrument and initial conditions before the reform are significant. In the second stage regression, the coefficient of institutions is 4.115 and is still significant at 5% level while the initial condition is not significant. In column (4) we consider both distance to the coast and initial conditions together as the control variables. The 2SLS shows that neither of the two controls is significant while institutions are still significant. Overall, our estimates of institutions are rather stable in all specifications, which supports our arguments about exclusion restrictions that our instrument is valid.

3.6.2 Different Measurements of Institutions

We also test whether our result is robust to the measurement of institutions. One difficulty of estimating the impact of institutions lies in how to measure the institutions, more specif-

⁴We approximate the "national income" as the sum of gross agricultural output values and value added in industry for each city. The "national income per capita" is the "national income" divided by each city's population in 1985.

⁵The urban economic reform in China had not been launched in large scale until 1985.

ically for our purpose, how to measure the institution of protecting property rights. The measurement of the institution is always controversial. Whatever measure we adopt, there will always be some unsatisfactory aspects.

As we explained in previous section, our main specification uses the average of the index of property rights protection in the two surveys by Ni et al (2004, 2005) to measure institutions. Ni et al (2004, 2005) also provides some other measures, such as the comprehensive index of institutions and the index for government collection of informal fees, which represents an abrogation of property rights. The comprehensive index of institutions is the general index based on a series sub-indices to measure various aspects of each city's legal, government and enterprise systems. The index showing the prevalence of informal fees measures the extent to which the government imposes extra-legal charges on private business. In table 5 we report the result when those different variables are used to measure institutions. Panel A reports the effects of institutions on log GDP when the measurements listed on the left are used. Institutions are significant with all three different measurements. Panel B reports the result of first stage when institutions are the dependent measured by the variables listed on the left. In all cases, our instrument is significant in explaining institutions.

3.7 INSTITUTIONS, GEOGRAPHY AND POLICY

3.7.1 Institutions versus Geography

As we mentioned in the introduction, geography may play a role in background that influences economic development. Table 6 reports the results of adding geographic controls. One of most popular geographic variables used in the literature is latitude. In column (1), latitude is added into the regression. The inclusion of latitude does not change the result very much. The coefficient of institutions remains significant and takes on a value of 3.559. Latitude is not significant in the second stage regression and is not helpful to interpret the variation of institutions in the first stage regression. Other geographic variables include average temperature and rainfall. Column (2) adds average temperature as the additional control. In the second stage, we find that coefficients of institutions and average temperature are 3.400 and

0.027 respectively and both estimators are significant. However, the average temperature is not significant in the first stage regression, i.e., does not help us to interpret the variation of institutions across regions. In column (3), rainfall is added to the regression. The coefficient of institutions is significant and takes on a value of 3.949. Rainfall is not significant in either stage.

Besides institutions, another channel that may have an effect on today's economy is through the geographically related cultural nature of people. Therefore we should test our argument by controlling the cultural nature across localities. Among the complicated cultural differences across localities in China, the most prominent is the cultural difference between the North and South divided by the Yangzi River, which is mentioned by Jared Diamond (1997). So in column (4) we use north-south dummy as another additional control variable. If the city is located south of the Yangzi River, we set the dummy as 1 and otherwise 0. The coefficient of institutions is 3.950 and is significant at 5% level. The south-north dummy is not significant in either stage and does not help us to interpret the variation of institutions across localities. In column (5), we add all these geographically related variables to the regression. The coefficient of institutions is significant and takes a value of 3.479. All others are not significant.

Overall, adding geographically related variables cannot change the estimate of institutions very much. The estimates of institutions instrumented by historical distribution of missionary lower primary schools are rather stable and always significant, as shown in table 6.

3.7.2 Institutions versus Policies

Some economists argue that government policy is more important than institutions to promote economic growth (Edward Glaeser, et al., 2004). To test this argument in the case of China, we add into the main specification of 2SLS regression some policy variables as control variables. One policy variable we use is the dummy variable of central government policy. For a long time, China was divided into three regions in terms of economic policy:

eastern, central and western, each assigned a specific task.⁶ Although the income per capita varies greatly across the country, it exhibits convergence within each of the three regions. Some believe this is due to the different developing strategies adopted by the government for different regions (Lin, 2004). For example, the eastern region enjoys a more favorable policy to develop the light industries, while the central and western region for a long time focused on agriculture and heavy industries. We use two dummies to capture a city’s policy zone: east and west. If a city falls into the east zone, its east dummy is set as 1 and its west dummy is set as 0. If a city falls into the west zone, its east dummy is 0 and west 1. If a city falls into middle zone, then both dummies are set equal to 0. Results are reported in column (1) of table 7. None of the east and west dummies is significant in the second stage, while average protection of property rights is still significant and the coefficient is 3.866. In the first stage, our instrument is still significant to interpret the variation of institutions across regions and the coefficient is relatively stable. The west dummy is not significant in the first stage. The east dummy is significant and the value is 0.107 in the first stage. It seems to us that the central government development policy is not the main explanation for the difference in GDP across the cities in our sample.

In column (2) of table 7, we add a dummy for coastal open cities as an additional control. These coastal open cities benefited from more favorable policies on economic reform and development. When the dummy for coastal open cities is included, the coefficient of institutions is 4.405 and significant at 5% level in the second stage regression. The coefficient of the dummy for coastal open cities is not significant in either stage.

China’s cities have different administrative ranks. The top rank is provincial-level cities (*zhixiashi*), including Beijing, Tianjin, Shanghai and Chongqing. The second rank is deputy-provincial level (*fushengji*) cities. The third rank is prefectural-level cities (*dijishi*) and includes all outside the top 2 classes. The fourth rank cities are below the prefectural level, i.e. county-level cities (*xian*). The 47 cities in our sample are all of the top three administrative ranks. Higher administrative rank usually means greater political power in competing for

⁶In this paper, the eastern region includes Beijing, Tianjin, Shanghai, Hong Kong, Macau, Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan. The central region includes Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Human, Hubei. And the western region includes Guangxi, Yunnan, Guizhou, Sichuan, Chongqing, Shaanxi, Gansu, Ningxia, Qinghai, Xingjiang, Xizang. Taiwan is not included in our analysis here.

economic resources and favorable policies from the central government. In column (3) of table 7, we construct a dummy for provincial-level and deputy-provincial level cities and add it into the regression as an additional control. The dummy takes value of one when a city belongs to a provincial-level or deputy-provincial level. When the dummy for provincial-level and deputy-provincial level is controlled, the coefficient of institutions is 4.249 and significant at 1% level. The dummy for provincial-level and deputy-provincial level is not significant in both stages. In column (4), we control the above two dummies in the regression at the same time. We find that only the coefficient of institutions is significant. The estimated coefficient of institutions is 4.393.

In the literature of empirical economic growth, the ratio between government consumption and real GDP is a variable used to measure the extent of government involvement (Robert Barro, 2000). In column (5), the ratio between government consumption and real GDP is added as an additional control. The coefficient of institutions is significant and with a value of 4.035. The ratio between government consumption and real GDP is not significant in either stage.

Investment rate is deemed to be an important issue for developing countries. We also consider the investment ratio to GDP as the underlying factor. However, when we regress our instrument on the investment rate in 2004, we find that there is no significant correlation between the two. And when investment rate is added as an explanatory variable for institutions, we find that our instrument is still significant in explaining the institutions at the significance level of 1%. In column (6) we report the result of adding investment rate as additional control. We find that both institutions and investment rate are significant in explaining the economic performance.

The results in table 7 do not support the argument that policy plays a more important role than institutions in economic development. On the contrary, our results show that it is the institutions rather than the government economic policy that accounts for China's economic performance.

3.8 CONCLUSION

Many economists believe that institutional change is a fundamental reason for China's impressive economic performance during the last twenty years. However, since institutions are widely believed to be endogenous, it is difficult to evaluate their effect. Following the method developed by Mauro (1995), Hall and Jones (1999), and Acemoglu et al (2001), we try to isolate the exogenous part of the variation in the institution of property rights protection across cities in China. We choose the enrollment in Protestant missionary lower primary schools in 1919 as the instrument for China's present institutions. We believe that the enrollment in Protestant missionary lower primary schools captures the extent of influence by Western countries in early 20th century. Since the central aspect of China's institutional transition is learning from the West, the historical influence by the West in early 20th century can persist into China's current institutional change.

With the cross-city data in China, we use the two stage least square method (2SLS) to estimate the effect of institutions on China's economic performance. The results show that there exists high correlation between the 1919 enrollment in Protestant missionary lower primary schools and present institutions. The 2SLS estimate shows that institutions are significant in explaining the variation of economic performance among our sample of 47 Chinese cities. Our estimate resembles the result of Acemoglu et al (2001) in that the 2SLS estimate is much greater than the OLS estimate. The significance of institutions survives robustness tests which control variables such as distance to the coast, historical human capital and initial conditions for different cities.

The paper also illuminates the question of which element plays the most important role in economic performance. We compare the effect of institutions and that of geography and government policy. By controlling geographic variables such as latitude, temperature, rainfall and north-south differentiation, we find that institutions are significant, while geography is not significant in explaining the variation of economic performance in our sample. When we control the variables of government policy such as China's zone development policy, coastal city policy and government consumption ratio to local GDP, the institutions are still significant, while government policies are not. Our results support the hypothesis that

institutions occupy a central role in determining economic performance.

Table 1: Descriptive Statistics

	sample mean	minimum	maximum
log GDP per capita in 2003	10.048 (0.4842)	8.996	11.004
institutions (average protection of property rights 2002-2003)	0.6506 (0.0979)	0.5035	0.896
1919 Protestant lower primary school enrollment	0.7225 (0.8465)	0.0138	4.2022

Note: The sample size for all variables is 47. The standard deviations are reported in the parentheses under the means.

Table 2: Instrument the Institutions in China

<i>Panel A: The dependent variable is log GDP per capita</i>			
Institutions	1.921***		1.522**
	(0.678)		(0.726)
Protestant lower primary school enrollment		0.18**	0.12
		(0.08)	(0.084)
R^2	0.15	0.10	0.18
<i>Panel B: The dependent variable is Institutions</i>			
Protestant lower primary school enrollment	0.044***	0.036**	0.051***
	(0.015)	(0.015)	(0.015)
Distance to coast		-0.007**	
		(0.002)	
Investment rate			0.272*
			(0.137)
R^2	0.14	0.25	0.21
<i>Panel C: The dependent variable is Protestant lower primary school enrollment</i>			
Distance to coast	-0.0374		
	(0.027)		
Total primary school enrollment		0.005	
		(0.02)	
			-1.961
			(1.257)
R^2	0.038	0.001	0.05

Note: Standard errors of estimated coefficients are in parentheses.

***: significant at 1%; **: significant at 5%; *: significant at 10%.

Table 3: The Effects of Institutions on Economic Performance

<i>Panel A: 2SLS</i>	
Institutions	4.230** (1.94)
<i>Panel B: The first stage</i>	
Protestant lower primary school enrollment	0.044*** (0.015)
R^2	0.14
F	7.77
Anderson canonical correlation LR test	7.491
p -value	[0.006]

Notes: Panel A reports 2SLS estimates with log GDP per capita in 2003 as dependent variable, and Panel B reports the corresponding first stage. Standard errors of estimated coefficients are in parentheses and the p -values are in brackets. The result from overidentification test reports the Sargan's statistic.

***: significant at 1%; **: significant at 5%; *: significant at 10%.

Table 4: Robustness Test with Additional Controls

	(1)	(2)	(3)	(4)
<i>Panel A: 2SLS</i>				
Institutions	3.599*	4.304**	4.115**	3.621*
	(2.184)	(1.983)	(1.954)	(2.119)
Distance to coast	-0.027			-0.021
	(0.024)			(0.021)
Total primary school enrollment		-0.01		
		(0.013)		
Initial condition (in 1985)			0.566	0.55
			(0.542)	(0.498)
<i>Panel B: The first stage</i>				
Protestant lower primary school enrollment	0.036**	0.043***	0.042***	0.037**
	(0.015)	(0.015)	(0.014)	(0.014)
Distance to coast	-0.007**			-0.005**
	(0.002)			(0.002)
Total primary school enrollment		0.003		
		(0.002)		
Initial condition (in 1985)			0.196***	0.167***
			(0.064)	(0.064)
R^2	0.25	0.19	0.29	0.35

Notes: Panel A reports 2SLS estimates with log GDP per capita in 2003 as dependent variable, and Panel B reports the corresponding first stage. Standard errors of estimated coefficients are in parentheses.

***: significant at 1%; **: significant at 5%; *: significant at 10%.

Table 5: Robustness Test with Different Measurements of Institutions

	(1)	(2)	(3)
<i>Panel A: 2SLS</i>			
Average Protection of Property Rights (main specification)	4.23** (1.94)		
Comprehensive Institutional Index		5.546* (2.89)	
Index for Government informal fees			2.42* (1.24)
<i>Panel B: The first stage</i>			
Protestant Lower Primary School Enrollment	0.044*** (0.015)		
Comprehensive Institutional Index		0.033* (0.018)	
Index for Government informal fees			0.077** (0.029)
R^2	0.14	0.06	0.12

Notes: Panel A reports 2SLS estimates with log GDP per capita in 2003 as dependent variable, and Panel B reports the first stage with the listed measurement of institutions as dependent variable for each specification. In Panel B the explanatory variable is the instrument: the enrollment in Christian missionary lower primary schools in 1919. Standard errors of estimated coefficients are in parentheses. The first column is our main specification in Table 3.

***: significant at 1%; **: significant at 5%; *: significant at 10%.

Table 6: Geography versus Institutions

	(1)	(2)	(3)	(4)	(5)
<i>Panel A: 2SLS</i>					
Institutions	3.559*	3.4*	3.949**	3.95**	3.479*
	(1.874)	(1.923)	(1.867)	(2.057)	(1.932)
Latitude	-0.016				0.034
	(0.011)				(0.06)
Temperature		0.027*			0.712
		(0.016)			(0.079)
Rainfalls			0.026		0.004
			(0.020)		(0.032)
North-south Dummy				0.142	0.016
				(0.178)	(0.3)
<i>Panel B: The first stage</i>					
Protestant Lower Primary	0.043**	0.042**	0.045***	0.04**	0.042**
School Enrollment	(0.016)	(0.016)	(0.016)	(0.015)	(0.016)
Latitude	-0.035				0.016
	(0.225)				(0.01)
Temperature		0.001			0.018
		(0.003)			(0.013)
Rainfalls			-0.002		-0.006
			(0.003)		(0.005)
North-south Dummy				0.039	0.104**
				(0.027)	(0.046)
R^2	0.14	0.14	0.15	0.14	0.28

Notes: Panel A reports 2SLS estimates with log GDP per capita in 2003 as dependent variable, and Panel B reports the corresponding first stage. Standard errors of estimated coefficients are in parentheses. The north-south dummy takes value of one when a city locates in northern China and zero when it locates in southern China.

***: significant at 1%; **: significant at 5%; *: significant at 10%.

Table 7: Policy versus Insitutions (2SLS)

	(1)	(2)	(3)	(4)	(5)	(6)
Institutions	3.866*	4.405**	4.249***	4.393**	4.035*	3.383*
	(2.294)	(2.098)	(2.167)	(2.302)	(2.291)	(1.534)
West Dummy	-0.413					
	(0.32)					
East Dummy	0.056					
	(0.338)					
Dummy for Coastal Open Cities		-0.119		-0.119		
		(0.197)		(0.198)		
Dummy for Provincial or Deputy Provincial			-0.004	0.002		
			(0.166)	(0.165)		
Gov. Consumption/GDP					0.999	
					(3.524)	
Investment Rate in 2004						-1.438**
						(0.717)
Protestant Lower Primary School Enrollment	0.035**	0.041**	0.042**	0.04**	0.038**	0.051***
	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)	(0.015)
West Dummy	0.055					
	(0.053)					
East Dummy	0.107***					
	(0.035)					
Dummy for Coastal Open Cities		0.04		0.039		
		(0.03)		(0.031)		
Dummy for Provincial or Deputy Provincial			0.012	0.009		
			(0.028)	(0.028)		
Gov. Consumption/GDP					0.699	
					(0.51)	
Investment Rate in 2004						0.272*
						(0.137)
R^2	0.3	0.17	0.15	0.18	0.18	0.21

Table 8: A1: Data Sources

Data Descriptions	Sources
Log GDP per capita in 2003	Urban Statistical Yearbook of China (2004)
Institutions (Average protection of property rights 2002-2003)	Ni et. al. (2004 and 2005)
Protestant lower primary school enrollment (per 100,000 population in 1919)	the Continuation Committee (1922)
Distance to coast	Au and Henderson (2002)
Total primary school enrollment (enrollments in missionary and government primary schools per 100,000 population in 1919)	the Continuation Committee
Initial condition (Log national income per capita in 1985) ⁷	Urban Statistical Yearbook of China (1986)
Latitude	Au and Henderson (2002)
Temperature	From various Provincial Statistical Yearbook of China (2004)
Rainfalls (in millimeter)	From various Provincial Statistical Yearbook of China (2004)
Govt. consumption / GDP (2003) ⁸	Urban Statistical Yearbook (2004)

Table 9: A2: Main Data Used in the Paper

Cities	Log GDP per capita in 2003	Institutions (Average Protection of property rights 2002-2003	Instrument (Enrollment in Protestant missionary lower primary schools per 100,000 population in 1919)
Shenzhen	10.90678	0.716	3.354157
Wenzhou	9.714625	0.703	0.363966
Ningbo	10.39326	0.874	0.605413
Shanghai	10.75188	0.8575	0.867647
Jiaxing	10.15782	0.768	0.236241
Huzhou	9.857548	0.672	0.375335
Shaoxing	10.13122	0.8105	0.342742
Zhongshan	10.50819	0.6675	0.744186
Taizhou	9.800402	0.6095	0.202358
Suzhou	10.77254	0.7565	0.566417
Xiamen	10.46336	0.896	4.202231
Hangzhou	10.39876	0.716	0.807204
Qingdao	10.06041	0.824	2.674683
Beijing	10.3754	0.679	1.222187
Dongguan	11.00473	0.6365	0.707389
Zhoushan	9.780133	0.699	0.216511
Nantong	9.466841	0.7255	0.013829
Changzhou	10.17157	0.641	0.303127
Wuxi	10.67255	0.6825	0.32671
Quanzhou	9.820867	0.608	1.233659
Foshan	10.60767	0.646	0.141509
Nanjing	10.2149	0.7195	0.875139
Jinan	10.06858	0.633	0.336659

Table 10: A2: Continue

Cities	Log GDP per capita in 2003	Institutions (Average Protection of property rights 2002-2003	Instrument (Enrollment in Protestant missionary lower primary schools per 100,000 population in 1919)
Huizhou	9.940687	0.558	0.148392
Guangzhou	10.78668	0.5265	0.81036
Yantai	9.914477	0.656	1.352353
Chongqing	8.996776	0.612	0.207788
Chengdu	9.800956	0.662	0.657268
Weihai	10.42709	0.5495	0.389025
Zhuhai	10.984	0.68	0.744186
Nanchang	9.573733	0.625	0.304401
Hefei	9.279866	0.5585	0.123119
Shijiazhuang	9.628261	0.614	0.033106
Dalian	10.28213	0.632	0.204756
Changsha	9.603058	0.5515	0.580194
Haikou	9.724959	0.5675	0.322727
Xi'an	9.411892	0.646	0.520519
Kunming	9.699656	0.5295	0.640646
Tianjin	10.18611	0.641	0.415557
Wuhan	9.973806	0.5035	1.198144
Fuzhou	9.929155	0.5805	2.4713
Shenyang	10.05496	0.5195	0.597351
Changchun	9.836546	0.58	0.133644
Qinhuangdao	9.563529	0.689	0.637698
Haerbin	9.607236	0.5325	0.26263
Zhengzhou	9.744668	0.517	0.19503
Xuzhou	9.20954	0.524	0.292204

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