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Essays on Development and the Function of Financial Markets

by

Jiafu An

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Declaration

This thesis has been composed by myself and contains no material that has been submitted for any other degree or professional qualification at any universities.

The third chapter of this thesis has been published at the *Journal of Corporate Finance*:

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Permission to include text from this paper is warranted by myself.

Signed: Jiafu An

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To my baby girl Emilia and my wife Yiling.

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Lay Summary

This thesis examines three determinants of financial development. In the first study, I construct a new dataset of a key Chinese institution, Xinfang, for protecting private property rights and enforcing contract. I document that Xinfang has encouraged commercial and financial intermediations in China via its key legal functions. While Xinfang is outside the boundary of the formal judicial system, and therefore has not been paid enough scholarly attention by western scholars, it nonetheless provides vital legal functions to the economy and should be considered when assessing the law and finance in China..

In the second study, I examine the impact of the historical TseTse fly and its associated disease, *nagana*, on financial development today. I document that the TseTse fly has a negative effect on firm and household access to external credit, and financial technology, such as mobile money, in Africa. I also find that the deleterious impact of the TseTse fly is operating through a decrease in the level of trust, the quality of information sharing institution, and the tendency to adopt new technology. This study is timely and relevant to policymakers faced with challenging issues in combating large scale infectious disease. By showing that communicable diseases have negative impact on trust, information sharing institutions, the tendency to adopt technologies, and ultimately the operation of financial markets, I emphasize the long-term deleterious impact of diseases. These results thus have high relevance to policymakers when developing the policies to combat epidemic disease.

My last study identifies a gender gap in access to trade credits for manufacturing firms across a large set of developing countries. I document that, in high-gender-biased countries, firms with more female production employees have less access to trade credits. I also find that these empirical patterns cannot be explained solely by firms' endogenous hiring decisions. Lastly, I show that firms with a higher proportion of female employees, on average, have lower unit costs of labor. This suggests that firms in high gender-biased countries are facing trade-offs between access to trade credit and lower labor costs. Combining the results from my last study with existing literature generate important policy implications. Particularly, because females are less likely to use bank loans and are more dependent on informal finance, the finding suggests that directing firms led by female and/or with more female employees to formal financial systems, which do not appear to discriminate against female, can generate social premiums, through correcting an important friction in the financial markets.

Abstract

This thesis includes three empirical studies on financial development and the function of modern financial markets.

The first study investigates the impact of an alternative legal system on financial development in China. Although *Xinfang* is not part of the judicial system, and therefore is largely ignored by scholars studying the law and finance in China, *Xinfang* is a formal institution that addresses an array of commercial, contractual, property, and financial disputes and that often handles more cases than the judicial system. I construct the first cross-province, cross-time measures of *Xinfang* effectiveness and discover that differences in *Xinfang* are associated with differences in industry and firm financing patterns that are consistent with the law and finance view.

The second study examines the impact of the TseTse fly—which is unique to Africa and transmits an epidemic disease harmful to humans and lethal to livestock—on modern financial development in Africa. Exploiting newly georeferenced firm data across the world, I discover that firms in regions that meet the TseTse survival conditions have less access to external finance today and this relationship only exists in Africa. Further tests suggest a causal interpretation of the result. I also find that people are less likely to trust others, to use financial services, and to learn and adopt financial technologies in historically infested regions.

In the third study, I assess the impact of biased gender norms on the function of the trade credit markets. In particular, I examine the effects of female

production workers on firms' access to trade credits across the world. Using two sources of plausibly exogenous variations in gender bias and a cross-sectional analysis framework, I document that firms with more female production workers have less access to trade credits in countries with stronger gender beliefs that favor males. This relationship is largely driven by firms in industries with unexpected credit shortages and industries dominated by males. Since female firms rely more on informal finance, this study is relevant for policies that direct female firms towards formal credit markets in high gender-biased places.

Contents

List of Figures and Tables

Chapter 1: Introduction

Finance plays a key role in economic development. For example, it helps fund innovative profit-generating projects, allocate scarce resources, mobilize savings, monitor firms, and facilitate risk management (see Levine, 1997, for a review). Given its first-order impact on economic growth, it is critical to understand why some places have better financial systems than others. This thesis is devoted to answer part of this question. In particular, I try to understand this question from three related, but distinct, perspectives, including legal environment, natural endowment, and social norms.

The law and finance view suggests that the quality of financial system is shaped by its legal environment (e.g., La Porta, et al., 1998, 1999). Legal system that provides strong investor protections facilitates financial transactions, with positive ramification on financial markets. In contrast, legal system that does not impose constraints on violations of private property rights and does not respect private contracts discourages the efficient flow of capital in an economy, thus hurting the operation of financial markets.

Despite its centrality in the literature on financial development, the law and finance theory seems at odds with Allen, Qian and Qian (2005)'s findings. In an influential study, Allen, Qian and Qian (2005) document that despite its weak legal institutions, China's private sector grows at a substantial rate. This evidence suggests that financing channels based on informal norms can act as a substitute for formal financing. Yet, Ayyagari, Demirgüç-Kunt and Maksimovic (2010) show that firms with bank credits in China are growing faster than firms financed by

other means. If formal financial markets are indeed funding China's growth, then the need for research to reconcile China's weak legal system with the high growth rate is urgent.

In the first study of this thesis, I attempt to fill this gap. I argue that the *Xingang* system, which addresses an array of commercial, contractual, property, and financial disputes and that often handles more cases than the judicial system, should be taken into account when analyzing the law and finance relationship in China. To do so, I construct a time-variant, cross-province measure of the quality of Xinfang system and ask whether provinces with better *Xinfang* are associated with better financial markets. My results suggest that the law and finance theory does apply to the Chinese market after taking into account the *Xinfang* system.

Another influential theory in the literature on financial development suggests that the disease environment is an important determinant of the quality of financial institutions (Beck, Demirgüç-Kunt and Levine, 2003). This theory suggests that the disease environment encountered by the colonizers substantially influenced the formation of long-lasting institutions such as property rights protection and contract enforcement. These institutions continue to shape the operation of financial markets today. However, these conclusions are reached based on cross-country regressions, and are therefore subject to country-level omitted variables bias.

In the second study of my thesis, I aim to address this issue. In particular, I study how the precolonial prevalence of the TseTse fly—which transmits an epidemic disease harmful to humans and lethal to livestock—influences financial development in Africa today. To mitigate the omitted variable issue, I focus on a particular vector

of epidemic disease with precise information on its geographical distribution and transmission requirements. This, combined with granular data on measures of financial development, allows a better identification strategy where I can include both country, and in some specifications, ethnic location fixed effects. My results are consistent with the view that disease environment harms modern financial markets.

Social norms are also believed to materially influence the operation of modern financial markets. In my third study, I investigate whether gender norms favoring males are associated with frictions in the informal financial markets. While existing research has overwhelmingly focused on gender bias associated with managers, I assess whether there is a gender-based credit friction associated with employees. I argue this is an important question to ask since gender norms apply to all labor participants, rather than just a selected few on the management level. I find that, in high gender-biased countries, firms with a larger fraction of female production employees have less access to trade credits. This result thus offers an important complement to existing research that focuses on the gender gap in formal credit markets.

The rest of this thesis is organized as follows. Chapter 2 is devoted to the study on law and finance in China; Chapter 3 focuses on the causal relationship between disease environment and financial development; Chapter 4 examines the impact of gender norms on the function of financial markets today; and Chapter 5 concludes.

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Chapter 2: Law and Finance in China: The Role of Xinfang

2.1 Introduction

An extensive literature explores how legal systems shape the operation of financial markets. As discussed by La Porta et al (1998, 1999, 2008), Gennaioli and Shleifer (2007), and Levine (2005), legal systems differ in how effectively they safeguard private property from encroachments by the state or others, enforce contracts, resolve disputes, and adapt to support the evolving demands of firms and individuals in a dynamic economy. In turn, a large body of empirical work confirms that these legal system differences impact the functioning of financial systems and the financing of firms, e.g., La Porta et al (1997, 1998, 1999, 2000, 2008), Demirguc-Kunt and Maksimovic (1998), Beck et al (2003), Djankov et al (2003, 2008), Qian and Strahan (2007), Brown et al (2013, 2017), and many others.

Evidence from China, however, challenges this law and finance view. Allen et al. (2005) find that the fastest growing firms in China do not rely on formal legal or financial systems, raising questions about the applicability of the law and finance view to China. Using a much larger database, however, Ayyagari et al. (2010) show that Chinese firms receiving bank loans experience faster growth than firms receiving informal financing.[1] None of these authors, however,

[1] In a recent study, Allen, Qian and Xie (2019) further differentiate the impact of different types of informal financing. They find that firms rely on constructive informal financing (e.g., trade

provides direct evidence on how the Chinese legal system shapes the operation of financial markets and the financing of firms.

In this paper, I (1) construct a new dataset on a central institution for protecting private property, enforcing contracts, and resolving disputes in China—the Xinfang system—and (2) use these data to reevaluate the relationship between the law and finance in China. Although the Xinfang system is not part of the judicial system, and therefore has often been ignored by western scholars studying the Chinese legal system, the Xinfang system is a formal institution that plays key roles in addressing a wide array of legal system disputes. Indeed, the Xinfang system often handles more cases than the judicial system. Therefore, ignoring Xinfang will yield only a partial view of the formal systems in China that address commercial and financial disputes and might, therefore, lead researchers to draw misleading inferences about the law and finance nexus in China. I develop cross-province, cross-time measures of the effectiveness of Xinfang institutions in protecting private property, enforcing contracts, and resolving disagreements. I believe that I am the first to construct such measures. I then evaluate whether the relationship between cross-province differences in Xinfang and corporate

credits, family borrowing) do grow faster, lending support to Allen et al. (2005). However, firms that depend on underground financing such as money lenders who use violence for enforcement perform badly, which is consistent with the findings in Ayyagari et al. (2010). This research thus provides a way of consolidating the seemingly conflicting findings in previous studies.

financing patterns are consistent with key predictions from the law and finance literature.

Xinfang has operated in China for over three thousand years (Liu, 2005). During imperial times, Xinfang served a crucial governance role: It allowed citizens to report grievances against local officials to authorities at the provincial or even central government level, helping to mitigate agency problems between the emperor and his hierarchy of officials through provinces, prefectures, counties, townships, etc. This governance role continued after the Communist Party came to power in 1949. More recently, Xinfang has expanded its role to address disputes concerning the legal rights of individuals and the enforcement of contracts among individuals and firms. In particular, the explosive growth of the Chinese economy since the 1970s created demands for an assortment of new commercial and financial arrangements. The Chinese courts have been slow to supply these services, partially because the courts require the enactment of new bodies of law and the development of procedures for enforcing those new statutes. Xinfang, however, has evolved to address modern commercial and financial disputes in a manner that parallels, and sometimes replaces, the courts. Today, individuals and firms in China can initiate a case in the courts or Xinfang and if a plaintiff or defendant is unsatisfied with a court's decision, they can file a grievance with Xinfang to have the decision overruled[2].

[2] See http://www.gjxfj.gov.cn/2015-09/23/c_134650967.htm for an example (in Chinese).

To get a further sense of how omitting the Xinfang system could impede research into the law and finance in China, it is helpful to compare Xinfang and the Chinese judiciary with respect to two key legal system traits: independence and adaptability. First, La Porta, Lopez-de-Silanes, Shleifer, Pop-Eleches, and Shleifer (2004) note that independence tends to enhance the ability of legal systems to protect individuals and their property from the potentially coercive power of the state. Across much of China, Xinfang enjoys greater independence from local politics than the judiciary, potentially giving it an advantage in addressing disputes. In particular, local governments (prefectures, counties, and townships) have considerable influence over local courts by setting budgets and appointing, promoting, and dismissing court officials. This influence can adversely affect the objective application of the law through the courts at the local level.[3] In contrast, local officials typically have less influence over local Xinfang bureaus, because participants in Xinfang disputes can readily appeal cases to the provincial (and national) Xinfang offices. While it would be wrong to argue that Xinfang is independent of the government, as Xinfang officials are government bureaucrats, it would also be wrong to characterize the Xinfang systems as reflecting the political preferences of local officials to the same degree as the courts. Thus, omitting Xinfang could materially affect studies of the degree to

[3] A survey of 632 disputants in Xinfang bureaus in Beijing shows that 78% of them regard local officials as "less trustworthy" than higher level government officials (Cai, 2002).

which the Chinese legal system objectively and effectively protects private property, enforces contracts, and facilitates the operation of the financial system in China.

Second, there are notable differences between the Xinfang and court systems with respect to adaptability. As emphasized by Levine (2005) and Gennaioli and Shleifer (2007), adaptability shapes how effectively legal institutions evolve to support the commercial and financial needs of dynamic economies. In China, the government enacts laws and courts implement them, with little avenue for the law to evolve through the court's interpretation and resolution of particular cases. Under the Xinfang system however, disputes are resolved by consulting the law, social norms, and principles of fairness articulated in the constitution. As such, the Xinfang system can adapt to changing economic conditions as it seeks efficient resolutions to particular cases. The ability of Xinfang to adapt effectively to changing economic conditions is further enhanced by the provincial-level organization of Xinfang: each province adapts to the demands of its firms and individuals. Thus, ignoring Xinfang could materially distort studies of the Chinese legal system, especially during its recent period of extraordinary growth.

To construct a cross-year, cross-provincial index of Xinfang institutions, I hand collect data on Xinfang procedures from China's 31 provinces over the period from 1991 through 2014. More specifically, I gather information on 52 Xinfang features for each province in each year. These features measure the speed of dispute resolution, the degree to which a province's Xinfang regulations

ease the ability of individuals and firms to access the Xinfang system, and the degree to which Xinfang motivates its workers to treat participants well and resolve cases expeditiously and fairly. I create and analyze several provincial Xinfang indexes that apply different weights to the individual features.

I first document that provinces with stronger Xinfang institutions tend to have firms that obtain more external finance than other provinces, where external finance is measured by short-term loans, long-term debts, and trade credit. This pattern holds when including province and year fixed effects, as well as individual province time trends. These results are also robust to controlling for cross-province differences in output, output per capita, the size of the government, government corruption, government intervention in the provincial economy, the quality of accounting and judicial services, literacy, and province exports and imports to other countries. Thus, by controlling for all time-invariant province effects, province time trends, and an array of time-varying province characteristics, I attempt to reduce omitted variable concerns by "saturating" the regression.

Second, I move from these cross-provinces analyses and further differentiate by industries and firms to assess whether the relationship between Xinfang and firm finance varies across provinces, industries, and firms in ways that are consistent with the law and finance view. In particular, the law and finance view suggests that more effective legal systems facilitate external finance, so that provinces with more effective legal systems should foster a greater flow of external finance to firms, especially firms in industries that depend heavily on

external finance for technological reasons. Therefore, I test whether the level of Xinfang development has a more pronounced, positive relationship with external finance in industries that depend more on external finance for technological reasons. I follow Rajan and Zingales (1998) and use the external financing of U.S. industries as a proxy for the degree to which an industry depends on external finance for technological reasons. I assign a value of one to an industry if it is above the median of external finance across U.S. industries and zero if it is below. Under the assumption that the U.S. has well-developed legal and financial systems with few frictions, this external financial dependence dummy variable provides information of the degree to which the industry heavily depends on external finance for technological reasons. I then test whether provinces with better Xinfang institutions facilitate the flow of external finance to firms in industries that are heavily dependent on external finance.

The results are consistent with predictions from the law and finance literature: In provinces with stronger Xinfang institutions, more external finance flows to industries that depend heavily on external finance. This result holds when controlling for both province-year and industry-year fixed effects, reducing concerns that the results are driven by an omitted variable. The estimated coefficients suggest that the economic magnitudes are large. If a province were to move its Xinfang index from the 25th percentile to the 75th percentile of the cross-province distribution, the coefficient estimates imply that the external finance measures for industries that depend heavily on external credit would rise higher than the measures of industries with less dependence on external credit by 12%-18% of the sample means.

Finally, I show that the predictions of the law and finance view hold when examining cross-firm differences. In particular, I evaluate the hypothesis that privately-owned firms rely more on the judicial and Xinfang enforcement of contracts than state-owned firms, as stressed by Acemoglu and Johnson (2005). I therefore test whether Xinfang has a more pronounced, positive relationship with firm financing in privately-owned firms. My findings are consistent with the hypothesis. I find that positive relationship between external finance and cross-province Xinfang effectiveness is much more pronounced among privately-owned firms than it is among state-owned firms.

The remainder of this paper proceeds as follows. Section II introduces the institutional background, section III describes the data, section IV presents empirical methodology and the results, section V conducts robustness tests and section VI concludes.

2.2 Institutional Background of the Xinfang System

2.2.1 The Xinfang System

Xinfang emerged about 3,000 years ago as a formal system for resolving disputes (Liu, 2005). During imperial times, the Xinfang system allowed citizens to report complaints directly to the central government. Over time, Xinfang developed into a system that parallels, and sometimes even replaces, the legal system (Minzner, 2006). For example, some provincial Xinfang regulations now require that (1) Xinfang bureaus have the ability to address the full range of legal system disputes and accept "appeals of illegal decisions" made by governments and courts (Minzner, 2006) and (2) Xinfang workers have detailed knowledge of regulations

and laws, provide legal advice to citizens, and invite legal professionals to provide such counseling when Xinfang workers do not have sufficient expertise.

The procedure of resolving a Xinfang case varies by provinces, but it generally takes the following steps summarized in Appendix Figure 1. After filing a complaint in a Xinfang bureau, the citizen will receive an official notice within 5-7days. This carries the information of how the case will be dealt with, either filed, transferred or rejected. If the case is transferred to another Xinfang bureau, the citizen will receive a similar notice indicating whether the case is accepted or rejected within 5 days upon the transfer. When a Xinfang case is successfully filed, it will be resolved with a written judgement by the involved government officials over the next 30-60 days. Based on the province in which the case is filed, this period can be extended up to three months. After receiving the written judgement, citizen who filed the case has two options: either accept it, or appeal. If they choose to appeal, the appellate result can take 30-90 days based on where it is filed. Although some provinces only allow two appeals, citizens can always rephrase their case and start over. In fact, there is no limit on how many times a case can be appealed as long as the citizen rephrases the compliant (Ying, 2004).

Although the Xinfang system is run by government, it enjoys greater independence from local politics than the formal legal system. Particularly, local governments (prefectures, counties, and townships) have a large amount of influence over local judiciary (i.e., courts) by setting budgets and appointing, promoting, and dismissing court officials. This influence can have negative ramification on the objective application of the law through the courts at the local

level. On the other hand, local officials typically have less influence over local Xinfang system, because participants in Xinfang can appeal cases to the provincial (and national) Xinfang offices. As we discussed in the Introduction, while it would be wrong to argue that Xinfang is independent of the government, as Xinfang officials are government bureaucrats, it would also be wrong to characterize the Xinfang systems as reflecting the political preferences of local officials to the same degree as the courts.

In terms of operations, the Xinfang system addresses a wide array of disputes including those involving private property, commercial and financial contracts, whistle-blowing of illegal behaviors by government officials, and appeals of rulings by regional governments and courts in the following manner (Liu 2005; Minzer, 2006).

Recent statements by President Xi emphasize the continuing importance of the Xinfang system under his administration. For example, on the 21st of April 2016, President Xi urged that "all governments and government agencies should attach great importance to Xinfang operations, strengthen their responsibility to the Xinfang system, and combine law, state policy, economic conditions, and administrative policies to resolve Xinfang cases and meet citizens' reasonable and legitimate demands."[4] As another example, on the 20th of July 2017, President Xi stressed that "party committees, governments and officials at all levels should

[4] See http://politics.people.com.cn/n1/2016/0421/c1024-28295004.html.

consider Xinfang as one of the most important tasks on their job lists. They should do everything possible to solve the cases for the people."[5] China's recent anti-corruption campaign also heavily relies on Xinfang cases to identify corrupt government officials to start inspections.[6]

2.2.2 Differences between Xinfang and the Legal System

In addition to the notable differences between the Xinfang system and the Chinese judiciary on independence and adaptability, they also differ in terms of efficiency, costs and enforcement quality. While a Xinfang case takes up to three months to reach a judgement, a litigation case typically takes six months to receive the court decision. Xinfang system does not charge any fee in dispute resolution, but judicial system incurs court and attorney fees. Finally, local courts often find difficult to enforce court judgements due to the lack of resources. The Xinfang judgements, however, are from the governments, which has the power to ensure they are performed. Xinfang system is widely used in China presumably because of these features. Figure 1 shows that the number of cases filed in the

[5] See http://dangjian.people.com.cn/n1/2017/0720/c117092-29416533.html (in Chinese)

[6] See http://www.ccdi.gov.cn/lswh/lilun/201311/t20131112_119297.html (in Chinese)

Xinfang system was substantially larger than those filed in the legal system during 1986-2001 period.[7]

2.3 Data

In this section, I describe the key data that I use in my examination of the link between the Xinfang system and corporate finance. I start by detailing the data sources on provincial Xinfang regulation, my codification of these regulations, and the construction of the Xinfang index.[8] I then describe the data on corporate finance at the provincial, industry, and firm levels as well as other data used in

[7] To the best of my knowledge, there isn't any systematic information on the monetary value for Xinfang cases. Therefore, it is difficult to make sensible comparisons of the monetary values of cases filed in the two systems (Xinfang *versus* the judiciary). However, a collection of anecdotes may provide a partial view on the relative monetary importance for cases in the two systems. In Appendixes 3 and 4, I translated nine cases filed in either the Xinfang or legal systems. From these cases, I make three observations: (1) the monetary values of similar cases (e.g., breach of contract involving the purchasing of a flat) filed in the two systems are comparable (e.g., Appendix 3.4, 3.5 and 4.1); (2) there are high-stake cases filed in the Xinfang system (Appendix 3.3 regarding the dispute about a large area of land); and (3) there are cases that are filed in both systems (Appendix 3.6). Thus, I cannot reject the conjecture that the monetary values of cases in both systems are similar.

[8] The National Xinfang Bureau provides an English-translated example of the document describing the operation of the Xinfang system in a province (see http://www.gjxfj.gov.cn/2006-03/07/content_6399309.htm).

my analyses. Table A1 gives detailed variable definitions and information on data sources. Table 3 provides summary statistics.

2.3.1 The Xinfang Index

I first obtain the annual directories of provincial regulations published by the State Council in the Law Yearbook of China, which covers the period from 1991 to 2014.[9] The directories contain important information on the titles of provincial regulations, as well as information on amendments and start dates. [10]

Since the directories only provide the titles of the provincial regulations, I obtain the content of provincial Xinfang regulations from official government websites, and three databases 1) CNKI database, 2) PKULAW database, and 3)

[9] The Law Yearbooks of China are available through CNKI Yearbook Database (http://nianjian.cnki.net).

[10] There are two types of titles: titles of specific regulations and titles named "Notice of Amendments of Some Local Regulations." For the latter, the directories do not indicate which regulations the government intends to amend, so we trace these amendments to official government websites and identify if the amendments contain Xinfang regulations. In total, about 90% of the titles in the directories are specific regulations and the rest are amendments. In total, we obtain 48 such directories that correspond to the 24 Directories of Local Regulations and 24 Directories of Local Government Regulations.

Wanfang database.[11] I first search "province name + Xinfang regulations + year" and choose the websites with the suffix of "gov.cn" and find 34 out of 60 Xinfang regulations in the official government websites. For the remaining 26 provincial Xinfang regulations, I search "province name + Xinfang regulations + year" in the three databases listed above and find that 20 out of the remaining 26 provincial Xinfang regulations appear in two of the three databases (identify copies) and five appear in one of the databases. I cannot find information on Shandong Interim Xinfang Regulation (1992) in any of the listed databases, but I was able to piece these together from several other sources. Although I include data on Shandong Interim Xinfang Regulations in my analyses below, all of the results hold when excluding these data. Table A2 list the sources of the Xinfang regulations. Table 1 shows the summary of the provincial Xinfang regulations.

To codify Xinfang regulations, I gather information on 52 features of Xinfang for each province in each year. These features reflect the Xinfang quality on three aspects: namely the efficiency of dispute resolution, the degree to which a province's Xinfang system supports individuals and firms to access Xinfang, and

[11] More specifically, CNKI was founded by Tsinghua University in 1999, supported by the Ministry of Education and the Ministry of Technology and Science. It can be accessed through http://cnki.net/. PKULAW was founded and operated by Peking University, School of Law. Subscription is needed to access. Website address is http://pkulaw.cn/. Wanfang database was founded by China Science and Technology Information Institute. Subscription is needed to access. Website address is http://www.wanfangdata.com/.

the degree to which Xinfang systems punish and reward Xinfang officers for treating participants well and resolving cases expeditiously and fairly. Each category is immediately described below. Table 2 shows a summary of these features.

There are eight features that measure the speed of dispute resolution. As stressed by Djankov et al. (2003), the duration of dispute resolution is crucially associated with consistency and fairness in judicial decisions. I label this category as the speed index. The way a provincial Xinfang system supports citizens and firms to file complaints can take many forms. For example, a provincial Xinfang system can provide various mechanisms of dispute resolution including holding public hearings, paying visit to disputants, and holding Xinfang officers accountable for unsolved cases, etc. A province's Xinfang system can also facilitate people access Xinfang through providing standardized documentation files, accepting cases written in minority languages, allowing collective actions, etc. In total, there are 37 features that fall into this category and I label it as support index. Finally, there are seven features that aim to provide incentives to Xinfang workers. These features punish behaviors that harm the operation of the Xinfang system and reward actions that benefit the functioning of the system. I thus label this category as incentive index.

For 40 out of these 52 features, I assign the value of one to provinces in years where the provincial Xinfang regulations specify the feature and zero otherwise. For example, when the Xinfang systems mention the speed of dispute resolution, this is coded as a one; and when the Xinfang system discusses the

rewards and punishments regarding the treatment of citizens by Xinfang workers, then this category of Xinfang regulations is coded a one. For 12 Xinfang traits, which are harmful to functioning of the provincial Xinfang system, I assign a value of zero when a provincial Xinfang regulation in a year has such trait and one otherwise. For example, I assign the value of zero if a provincial Xinfang regulation in a year requires that individuals and firms must accept the Xinfang judgment, with less ability to appeal.

To construct the Xinfang index, I combine the 52 binary measures to form an overall measure of the quality of provincial Xinfang systems. Following the approach used in most law and finance literature, each of the features is weighted equally in the Xinfang index (La Porta et al., 1997; 1998; 1999; 2000). The dataset covers the period of 1992-2014 and 27 provinces. Some provinces promulgated their first Xinfang regulation after 1992. The total number of province-year observations is 519. After merge with financial development measures over 1998-2009, the number of observations reduces to 336. Figure 2 shows the equal-weighted Xinfang index, averaged during 1998-2009, across Chinese provinces and Table 3 provides summary statistics. The results presented in Table 4-9 are based on this measure. For robustness checks, I show that the results are materially consistent for four different weighting schemes in section V.

2.3.2 Financial Development Indicators

The provincial-, industry-, and firm-level measures of corporate financing are based on the National Statistics Bureau's Annual Surveys of Industrial Production.

It provides firm-level data from 31 provinces over the period from 1998-2009. There are about 1.6 million observations, covering about 95% of China's total industrial output each year. The surveys provide information on the number of employees, the year that the firm was established, industry, sales, ownership type, and debt structure. The advantage of such data is its extensive firm coverage and therefore its representativeness of the functioning of the debt markets. Song et al. (2011) and Hsieh and Klenow (2009) also use this database.

It is important to note that Annual Surveys of Industrial Production covers industrial firms with revenue equal to or larger than 500 million RMB each year. It is likely that firms around the threshold may be included in one year, and excluded in another year. This may raise concerns that my empirical evidence may be driven by the cross-time, cross-province differences in coverage of firms. However, to bias my results, the survey coverage must change in a way that it includes more firms with higher level of debts in a province-year when the Xinfang index increases and/or includes less highly-leveraged firms in a province-year when the Xinfang index decreases. In section V, I show that firms with higher revenues are actually associated with higher level of total debts in my sample.[12] The results remain consistent after excluding observations near the

[12] The elasticity between the amounts of debt and revenue is 0.67, meaning a one percent increase in revenue is associated with 0.67 percent increase in total debts.

near the threshold (i.e. firms with revenues between 500-550, 500-600, 500-650 or 500-800 million RMB).

At the province-level, I use four indicators. Total liability to GDP equals the total liabilities of firms in a province divided by the provincial gross product. It measures the extent to which a province's savings are channeled to its firms through financial institutions and inter-firm financial transactions. As shown in Table 3, Total liability to GDP ranges from 0.003% to 0.111%, with sample mean of 0.043% and the standard deviation of 0.02%. Similarly, Current liability to GDP, Long-term liability to GDP, and Trade Credit to GDP equal to the total current liability, long-term liability and account payable aggregated from firms within the same province, divided by the provincial gross product, respectively. Table 3 implies that an average firm covered in the sample has a debt structure mostly covered by current liability, as the mean of Current liability to GDP accounts for 74% of the mean value of Total liability to GDP. At the industry-level, I use four similar access-to-finance measures. Instead of aggregating at province level, I combine firm debt at province-industry level, and then divide them by their respective aggregated revenues. Specifically, Total liability to revenue equals the total liability aggregated from firms in the same industry, same province, then divided by the corresponding total revenues. As reported in Table 3, Total liability to revenue ranges from 0.07 to 16.37, with a mean of 1.26 and a standard deviation of 1.39. I also scale the industrial-aggregated debt measures by their corresponding industrial output and sale value, since revenue may not best represent industrial gross product. Parallel to the provincial measures, the mean

of current liability measures accounts for about 70% of the mean value of total liability measures as shown in Table 3.

At the firm -level, I use four measures to gauge the extent to which firms get access to finance from the financial system and receive trade credit from other firms. Specifically, Total liability to total assets equals firm's total liability divide by total assets. It ranges from 0.01 to 0.98 as shown in Table 3, with a mean of 0.53 indicating that a typical firm would have a capital structure equally divide between debt and equity. Similarly, Current liability to total assets, Long-term liability to total assets, and Trade credit to total assets equal to firm's current liability, long-term liability and account payable divided by total asset, respectively.

To estimate the relation between the provincial Xingfang index and the financial development measures, there is a concern on cross-province financing. I emphasize that if firms located in one province can borrow from lenders located in other provinces to the same extent as firms borrow from local lenders, the Xinfang-finance relationship I present in this paper would not change. In fact, under this strong assumption, firms across the entire China would face the same debt market and therefore potentially unobserved differences across provincial debt markets that could bias my results would no longer exist. In this scenario, however, the Xinfang-finance link may also be a result of the crowding out effects. That is, when lenders in provinces with poor Xinfang institutions give loans to firms located in provinces with better Xinfang quality, there would be less external finance available for firms in poor Xinfang provinces. However, lack of

cross-province finance data, I am not able to differentiate between these effects. In section V, I conduct several sensitivity tests to assess to what extent cross-province finance might influence the interpretation of my main results. My conclusion is not materially changed.

2.3.3 Other Province, Industry and Firm Characteristics

In the province-level analyses, I control for a large array of variables that might potentially confound my results. As stressed by La Porta et al. (1998, 1999, 2008), Gennaioli and Shleifer (2007), and Levine (2005), legal systems differ in their emphasis of property rights protection and contract enforcement, and these differences can cause financial development to diverge. I therefore include two factors that measure cross-province variations in formal legal environment from China's National Economic Research Institute (NERI). Specifically, Entrepreneur protection is constructed from the answers of a survey[13] question—"how do you feel about the quality and efficiency of local legal and administrative enforcement?"—with higher values indicating better quality. It ranges from -1.91

[13] Surveys of Chinese Business Managers 1996-2010 were conducted jointly by the State Council, the State Economics and Trade Commission, and the National Bureau of Statistics. Specifically, the Surveys were conducted through mailed questionnaires to a randomly selected group of enterprises' legal persons. The random group were selected through industry-based stratified sampling. Each survey (there were 15 during 1996-2010) covers about 6,000 enterprises and spans over all 31 provinces.

for Tibet in 2009 to 10 for Shanghai in 2003. Quality of legal and accounting service is another measure of provincial legal environment. It is constructed from survey question asking how the entrepreneurs feel about the quality of the service provide by local lawyers and accountants. It ranges from -12.27 for Tibet in 2009 and 11.28 for Beijing and Shanghai in 2002.

Rajan and Zingales (2003) stress the role of political incumbents in influencing the path of financial development. I thus include two variables to account for the effects exerted by local governments. Government scale is measured by the number of people employed in public administration and social organization scaled by total population for each province in each year. It is constructed by NERI in a similar manner to Entrepreneur protection and Quality of legal and accounting service. The worst performer in terms of this measure is again Tibet, with an average value of about -10, and the best are Chongqing, Guangxi and Jiangsu provinces. Following Rajan and Zingales (2003), I also include provincial exports and imports scaled by provincial gross product to other countries (Import and export to GDP), because local governments may better develop their financial markets if borders are open to trade. Import and export to GDP ranges from 0% to 24%, with a mean of 4% and a standard deviation of 6%.

Shleifer and Vishny (1993) and Mauro (1995) emphasize the deleterious effects of corruption in government efficiency and growth. Since the two most important factors in promoting finance, namely property rights protection and contract enforcement, are both provided by government, I include two measures

of government efficiency in isolating the link between Xinfang and finance. Corruption is constructed based on the Surveys of Chinese Business Managers (1996-2010). Particularly, the survey asks around 6000 randomly-selected business managers across 31 provinces of how much extra tax they pay as a share of firm's yearly revenue. Then the answers are coded, weighted and aggregated by NERI to form a corruption index. It ranges from 0 for Hubei in 2001 and above 16 for Hainan, Tibet, and Qinghai in 2006, with higher value indicating less corruption. Government intervention is constructed similarly by NERI and is based on answers to question that ask how easy and convenient the business managers feel about local administrative approval procedure. It ranges from -12.95 to 10.13, with higher value indicating less intervention.

In a within-country study, D'Acunto, Prokopczuk and Weber (2017) find that human capital exerts a strong, persistent effects on modern financial development. I therefore include a measure of human capital in my estimations. Specifically, Literacy is calculated as the number of college graduates each year in each province scaled by the size of local population. The National Bureau of Statistics collected the data on college graduates with substantial variation in sample size across years, but not across provinces. Although I observe a substantially large range of Literacy in my sample (0.04-2378.20), it is driven by the variation of sample size across years. In my estimation models, I include a year fixed effects to address this concern.

In the province-level analyses, I further control for macroeconomic conditions across provinces. Specifically, I include provincial gross product (GDP)

to account for the size and provincial gross product per capita (GDP per capita) for the development of the provincial economy. Both variables are from CSMAR China Macroeconomic Research Database (column Gdp0101 and column Gdp0116, respectively).

In the industrial-level analyses, I follow Rajan and Zingales (1998) and differentiate industries based on the extent to which an industry depends, for technical reasons, on external credit. Specifically, Dependence on external finance is first calculated as the fraction of capital expenditures not financed with internally generated cash flows for firms listed in NYSE, AMEX or NASDAQ in the United States during the 1980s. I then assign the value of 1 to an industry if it is above the median and zero if it is below. Under the assumption that the U.S. has well-developed legal and financial systems with few frictions, this external financial dependence dummy variable provides information of the degree to which the industry heavily depends on external finance for technological reasons.

In the firm-level analyses, I control for the following firm specific characteristics. Ln Number of employees is the natural logarithm of the number of employees; Founding year equals the first year that a firm starts operation; Private equals to 1 if a firm is registered as private or foreign firm, and 0 if registered as state-owned; Operating profit is a firm's operating profit divided by revenue; Ln Total assets is the natural logarithm of the value of a firm's total assets.

2.4 Xinfang and Financial Development

In this section, I assess the relationship between the Xinfang system and firm access to finance across China. I conduct my analyses based on three different levels of firm financing indicators. The province-level analyses focus on provincial aggregated external credit channeled to firms, while the firm-level and industry-level emphasize the heterogeneous patterns of firm's access to finance.

2.4.1 Overall Financial Development

I begin with cross-province, cross-time, ordinary least squares (OLS) regressions to assess the relationship between the Xinfang system and provincial aggregated size of external finance. Specifically, I use the following regression specification:

$$FDI_{p,t} = \alpha + \beta Xinfang_{p,t} + \boldsymbol{\Gamma} X'_{p,t} + \Phi_p + \Psi_t + Л_p + \varepsilon_{p,t} \quad (1)$$

where the dependent variable, $FDI_{p,t}$, is one of the province-level (p) indicators of external finance: Total liability to GDP, Current liability to GDP, Long-term liability to GDP or Trade credit to GDP. The key explanatory variable is $Xinfang_{p,t}$ from province p. Other explanatory variables, $X'_{p,t}$, control for an assortment of province characteristics and $\boldsymbol{\Gamma}$ represents the vector of coefficients on these variables. In most specifications, I control for Entrepreneur legal protection, Quality of legal service, Government scale, Import and export to GDP, Corruption, Government intervention, and Literacy. In several specifications, I add control variables for GDP, and GDP per capita. I also include province and time fixed effects, as represented by Φ_p and Ψ_t, and a liner trend for each province $Л_p$ in all analyses. My coefficient of interest is β, which measures the relationship between the Xinfang system and firm access finance. Wald t-

statistics that allow homoscedasticity within province clusters are reported in parentheses.[14] I summaries my results in Figure 3.

As reported in Table 4, the Xinfang system measured by $Xinfang_{p,t}$ is strongly, positively associated with financial development when either using Total liability to GDP, Current liability to GDP, Long-term liability to GDP or Trade credit to GDP. For example, consider the Total liability to GDP regressions. $Xinfang_{p,t}$ enters all regressions positively and significantly at least at five percent level and the estimated coefficients are economically large. If a province with a median value of Xinfang index were to move to the 75th percentile of the cross-province distribution of the Xinfang index, the coefficient estimates from column (9) imply that the Total liability to GDP ratio would increase by 9 (=4*2.25). This effect is large given the sample mean[15] of Total liability to GDP is only 43.04. Furthermore, the results are robust with only fixed effects in column (1) (4) (7) and (10), when controlling for plausibly exogenous province traits in

[14] Our results remain robust in eleven out of twelve regressions when we cluster our standard errors at both province and year levels. The results are not tabulated but available upon request. We specifically address the concern with serially correlated dependent and independent variables in the next sub-section.

[15] In the provincial regressions, we inflate the dependent variables by 10000 for interpretation purpose.

column (2) (5) (8) and (11), and when further conditioning on GDP and GDP per capita in column (3) (6) (9) and (12).

It is important to note that my estimates in column (3) (6) (9) and (12) may be biased since both my right- and left-hand side variables contain GDP. I report these estimates in order to show that my results are not driven by the potential impact of Xinfang on the macro economy (same as in Table 5 and 6), since finance is also influenced by economic growth (e.g., Levine, 1997). The coefficients reported in in column (3) (6) (9) and (12), as shown in Table 4, are not very different from other specifications without controlling for GDP in the right-hand side of the equation."

There are several potential concerns with the panel regressions: (1) the dependent variables are positively serially correlated; (2) in most provinces, the Xinfang indicator only changed once during the sample period; and (3) there might be some time-variant omitted variables that drive my results. I address the first two concerns here and the third in the industrial level cross-sectional analyses in the next section.

The bias resulted from serial correlation can be severe. It can lead to serious overestimation of t-statistics and significance levels. Bertrand, Duflo, and Mullainathan (2004) estimate a false rejection rate of 0.44 (0.675 when standard errors are not clustered at state-year level) when the null hypothesis is no effects. I follow Bertrand, Duflo, and Mullainathan (2004) and use a residual aggregation method to alleviate this concern. The authors show that the false rejection rate is

reduced to 0.06 with 20 clusters, corresponding to a 5% confidence level, when using residual aggregation.[16]

Specifically, I first regress the dependent variable, either Total liability to GDP, Current liability to GDP, Long-term liability to GDP or Trade credit to GDP, on all the covariates including Entrepreneur legal protection, Quality of legal service, Government scale, Import and export to GDP, Corruption, Government intervention, Literacy, GDP, and GDP per capita, and province, time fixed effects as well as provincial linear trend. I then divide the residuals into two groups: residuals from years before the Xinfang index change, and residuals after the change. I then regress the change of the Xinfang index on this two-period panel with various cluster strategies. This method ignores the time series information and can significantly reduce the false rejection rates. The results are summarized in Figure 4.

As shown in Table 5, the Xinfang index enters positively and significantly in all of the regressions. This holds when the dependent variable is either Total liability to GDP, Current liability to GDP, Long-term liability to GDP or Trade credit to GDP. In terms of the economic size of the coefficients, consider Total liability to GDP regressions. If an average province were to improve its Xinfang index by one standard deviation (2.32), the coefficient estimates from column (7)

[16] A substantial reduction in the estimating power is the drawback of such model (from 0.663 of OLS to 0.183 of residual aggregation).

imply that the Total liability to GDP ratio would increase by 3.18 (=2.32*1.34), which accounts for about 7% of the sample mean.

I continue to test whether Xinfang affects industrial growth through facilitating firm access to finance. Specifically, I first regress the dependent variable, either Industrial Output to GDP, Sale value to GDP, or Revenue to GDP, on the Xinfang index and all the covariates with province, time fixed effects and province linear trend. As reported in Table 6, column (1), (5) and (9), the Xinfang index enters positively and significantly at 1% significance level in all three regressions. The economic magnitude this reduced form estimate is non-trivial. Consider the estimates from column (1), if a province were to move its Xinfang index from the 25th percentile to the 75th percentile of the cross-province distribution, the coefficient estimate implies that the Industrial Output to GDP ratio would increase by 10.88 (=4*2.72), which amounts to 25% of the sample mean.

In column (2), (6) and (10) of Table 6, I insert Total liability to GDP into the regression. If the Xinfang system affects industrial production only through facilitating firm access to credits, I would expect the Xinfang index loses its explanatory power and Total liability to GDP to be strongly and positively correlated with measures of province industrial production. The results from Table 6 confirm my predictions. The coefficient of Total liability to GDP enters positively and significantly in all three regressions, while the Xinfang index becomes insignificant. The estimated economic magnitude is large. For example, if a province were to move its Xinfang index from the 25th percentile to the 75th

percentile of the cross-province distribution, the coefficient estimates from column (9) in Table 4 and column (2) in Table 6 imply that the Industrial Output to GDP ratio would increase by 9 (=4*2.25*1), which amounts to 16.44% of the mean.

In column (3), (7) and (11) of Table 6, I replace Total liability to GDP with Current liability to GDP and Long-term liability to GDP, and in column (4), (8) and (12), I replace Current liability to GDP with Trade credit to GDP and (Current liability - Trade credit) to GDP. In these analyses, I show that the Xinfang system is associated with industrial production mainly via current liability. Although both informal (Trade credit to GDP) and formal debt ((Current liability - Trade credit) to GDP) are important in linking Xinfang to growth, informal debt appears to exert more influence.

2.4.2 Firm Access to Finance: Differentiating by Industry Traits

I next conduct industrial level cross-sectional analyses to examine whether the relationship between Xinfang and firm finance varies across provinces and industries in ways that are consistent with the law and finance view. In particular, the law and finance view suggests that more effective legal systems facilitate external finance, so that provinces with more effective legal systems should foster a greater flow of external finance to firms, especially firms in industries that heavily depend on external credit for technological reasons. I relate this to Xinfang by testing whether Xinfang has a more pronounced, positive relationship with finance in industries that heavily depend on external finance for technological reasons. If these cross-province, cross-industry predictions hold, it

would reduce concerns that the previous results are spurious or reflect an omitted variable.

I follow Rajan and Zingales (1998) and calculate the degree to which U.S. industries use external finance. Specifically, Dependence on external finance is first calculated as the fraction of capital expenditures not financed with internally generated cash flows for firms listed in NYSE, AMEX or NASDAQ in the United States during the 1980s. I then assign the value of 1 to an industry if it is above the median and zero if it is below. Under the assumption that the U.S. has well-developed legal and financial systems with few frictions, this external financial dependence dummy variable provides information of the degree to which the industry heavily depends on external finance for technological reasons. I then test whether provinces with better Xinfang institutions facilitate the flow of external finance to firms in industries that are heavily dependent on external finance.

I use the following regression specification to assess the relationship between Xinfang and firm finance while differentiating by industry:

$$IFD_{p,i,t} = \alpha + \beta Xinfang_{p,t} * \Omega_{\boldsymbol{i}} + \Gamma_i + \Phi_p + \Psi_t + \Gamma_i * \Psi_t + \Phi_p * \Psi_t + \varepsilon_{p,i,t} \quad (2)$$

where the dependent variable, $IFD_{p,i,t}$, is either Total liability to revenue, Current liability to revenue, Long-term liability to revenue, or Trade credit to revenue for industry i, in province p, in year t. The key explanatory variable is the interaction term, $Xinfang_{p,t} * \Omega_{\boldsymbol{i}}$, where $\Omega_{\boldsymbol{i}}$ is Dependence on external finance. Province (Φ_p), industry (Γ_i), and year (Ψ_t) fixed effects, as well as province by year and industry by year fixed effects are included. As a result, $Xinfang_{p,t}$ and $\Omega_{\boldsymbol{i}}$ drop as regressors. I report heteroskedasticity robust t-statistics in the parentheses, with

standard errors either clustered at province and industry levels, or multi-way clustered at province, industry and year levels. Results are reported in Table 7.

As reported in Table 7, the relationships between Xinfang and the firm financing indicators vary across industries in a manner that is fully consistent with the theoretical prediction articulated above. In particular, the $Xinfang_{p,t} * \Omega_i$ enters 7 out of 8 regressions positively and significantly, indicating that the relationship between Xinfang and firm access finance is especially strong in industries that naturally depend heavily on external credit. In terms of the economic magnitudes, consider the estimates from column (6) of Table 7, in which the dependent variable is Total liability to revenue. If a province were to move its Xinfang index from the 25th percentile to the 75th percentile of the cross-province distribution, the coefficient estimates imply that the Total liability to revenue ratio for industries that heavily depend on external credit would rise by 0.23 (=4*1*0.0572) higher than that of industries with less dependence on external credit. This magnitude is considerable, given that the sample average of Total liability to revenue equals 1.26. Thus the relationship between Xinfang and the financing of firms holds more strongly among firms in industries that rely heavily, for technological reasons, on external credit, which is consistent with the view that the Xinfang system promotes finance.[17]

[17] The results are similar when we use sales value and industrial output to scale these debt measures. In both sets of regressions, the coefficient of the interaction term between Xinfang and

Similarly to the province-level analyses, I conduct a residual aggregation analyses to address the concerns of serial correlation using cross-sectional analyses (Bertrand, Duflo, and Mullainathan, 2004). Particularly, I first regress the dependent variables on all the fixed effects, and then I divide the residuals into two groups: residuals from years before the Xinfang index change, and residuals after the change. I then regress the two-period residuals on the change of Xinfang index, Dependence on external finance, and their interaction. Results are reported in Table 8. Heteroskedasticity robust t-statistics are in the parentheses, with standard errors either clustered at industry level, or multi-way clustered at province and industry.

As shown in Table 8, the interaction terms enters 7 out of 8 regressions positively and significantly, confirming the results reported in Table 7. The estimated economic magnitude is even larger. Using the same example above, if a province were to move its Xinfang index from the 25th percentile to the 75th percentile of the cross-province distribution, the coefficient estimates from column (6) Table 8 imply that the Total liability to revenue ratio for industries that heavily depend on external credit would jump by 0.41 (=4*1*0.1037) higher than that of industries with less dependence on external credit. These results

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dependence on external finance enters 6 out of 8 regressions positively and significantly. Results are tabulated in Table A4 and Table A5 in the online appendix.

confirm the view that the Xinfang system exerts positive influence on the financial institutions.

2.4.3 Firm Access to Finance: Differentiating by Firm Ownership Type

I next conduct firm-level cross-sectional analyses to examine whether the relationship between Xinfang and firm finance varies across ownership type. Theoretically, if a firm is owned by the government, it would encounter less difficulties in protecting its property rights and enforcing a contract since the government is the ultimate arbiter of property and contracts (Acemoglu and Johnson, 2005; Acemoglu, 2003). I therefore predict that Xinfang has a more (less) pronounced, positive relationship with finance in private-owned (state-owned) firms because they do not have the state protection as government-owned firms. If this cross-firm prediction holds, it would add further evidence to the Xinfang-finance nexus.

Specifically, I use the following OLS model to examine the relationship between Xinfang and firm access to finance, while differentiating by firm ownership type:

$$FFD_{p,i,f,t} = \alpha + \beta Xinfang_{p,t} * Private_{\boldsymbol{f}} + \boldsymbol{\Gamma} X'_{p,i,f,t} + \boldsymbol{\Sigma} + \varepsilon_{p,i,f,t} \quad (3)$$

where the dependent variable, $FFD_{p,i,f,t}$, is either Total liability to total assets, Current liability to total assets, Long-term liability to total assets, or Trade credit to total assets for firm f, industry i, in province p, in year t. The key explanatory variable is the interaction term, $Xinfang_{p,t} * Private_{\boldsymbol{f}}$, where $Private_{\boldsymbol{f}}$ is a

binary variable that equals 1 if a firm is registered as private or foreign owned, and 0 if is state-owned. $X'_{p,i,f,t}$ controls for an assortment of time-variant and –invariant firm characteristics and $\boldsymbol{\Gamma}$ represents the vector of coefficients on these variables. Specifically, I control for Private, Operating profit, Founding year, Ln Total assets, and Ln Number of employees. $\boldsymbol{\Sigma}$ includes province, industry, year, province by year and industry by year fixed effects. As a result, $Xinfang_{p,t}$ drops as a regressor. I report heteroskedasticity robust t-statistics in the parentheses, with standard errors clustered at firm level.

As reported in Table 9, the relationships between Xinfang and the firm financing indicators vary across ownership type in a manner that is fully consistent with the theoretical prediction elucidated above. The interaction term enters 6 out of 8 regressions positively and significantly. The economic magnitude is non-trivial. For example, if a province were to move its Xinfang index from the 25th percentile to the 75th percentile of the cross-province distribution, the coefficient estimates from column (8) in Table 9 imply that the Trade credit to total assets ratio for firms that are privately owned would rise by 0.36 (=4*1*0.089) higher than that of state-owned firms. This magnitude accounts for 2.4% of the sample mean.

2.5 Robustness Checks

In this section, I conduct several robustness tests in attempt to address concerns regarding the weighting methods used in construction the Xinfang index, the sample coverage of my data on firm financing, and cross-province finance.

2.5.1 Different Weighting Schemes in Xinfang Index Construction

Each of the 52 features are weighted equally in the Xinfang index following the standard approach in the law and finance literature (La Porta et al., 1997; 1998; 1999; 2000). However, it is possible that certain features are relatively more important than others. Besley (1995), Milgrom and North (1990) and Messick (1999) suggest that providing multiple dispute resolution mechanisms and facilitating access to Xinfang can lower the costs of disputants, and therefore are first-order important to the operation of the Xinfang system. Djankov et al. (2003) emphasize the importance of the speed of dispute resolution to the functioning of the system. Although the literature does not take the relative importance into consideration when constructing indices, I explore whether the results are robust to unequal weights allocated to the support, speed and incentive sub-indices as defined in section III. To do so, I firstly run the following regression specification:

$$FDI_{p,t} = \alpha + \beta_1 Support_{p,t} + \beta_2 Speed_{p,t} + \beta_3 Incentive_{p,t} + \Phi_p + \Psi_t + Л_p + \varepsilon_{p,t} \quad (4)$$

where the dependent variable, $FDI_{p,t}$, is one of the province-level (p) indicators of external finance: Total liability to GDP, Current liability to GDP, Long-term liability to GDP or Trade credit to GDP. The key explanatory variables are $Support_{p,t}$, $Speed_{p,t}$, and $Incentive_{p,t}$ from province p. I include province and time fixed effects, as represented by Φ_p and Ψ_t, and a linear trend for each province $Л_p$ in all analyses. My coefficients of interest are β_1, β_2, and β_3, which measures the relative importance of features in support, speed and incentive

categories. Wald t-statistics that allow homoscedasticity within province clusters are reported in parentheses. Results are presented in Table 10. It is worth noting that the incentive index is not significant in Table 10. This does not necessarily mean that incentive features in Xinfang system are not important. It is plausible that some of the incentive effects are already captured by the support and speed indices, since the incentives can motivate Xinfang workers process and resolve cases more efficiently. Similarly, it is also difficult to unbundle the effects of support and speed indices, since the efficiency effect is likely to be reflected in the entire operation of the Xinfang system. The exercise here merely aims to provide alternative weighting schemes.

Secondly, I assign weights for each category based on the regression estimates. In particular, I calculate the magnitude of each coefficient by multiplying the coefficients with one standard deviation of the indices, and then divide each by the total magnitude of the three to get the weights. Take column 1 in Table 10, the magnitudes for the support, speed and incentive indices are 4.88 (=2.15*2.27), 4.13 (=3.25*1.27) and 0.97 (=0.81*1.20). Their weights are, therefore, 0.489 (=4.88/(4.88+4.13+0.97)), 0.414, and 0.097.

Finally, I multiply the support, speed and incentive indices by the empirically derived weights, and sum them up to construct an alternative Xinfang index. My preferred empirical weighting scheme is based on the estimates from column 1 in Table 10, because it has the second highest R-squared. Compared to column 4 in Table 10, the coefficients are more precisely estimated since both the support and incentive indices are statistically significant. I re-do my empirical

analyses using this alternative Xinfang index and the results (not tabulated) remain robust. Adjusting weights using estimates from column 2, 3, 4 of Table 10 does not materially alter my results either.

2.5.2 Sample Coverage

As noted in section III, my main dataset, Annual Surveys of Industrial Production, includes firms with revenues equal to or larger than 500 million RMB each year. This could potentially introduce sample selection bias, if firms with revenues near the cut-off point tend to have better access to external financing. In this sub-section, I make several attempts to address this concern.

Firstly, I estimate the relation of between revenue and total debts and find that firms with revenues that are close to the 500 million RMB cut-off are unlikely to have larger debts compared to firms with revenues well beyond the threshold. The coefficient from regressing the natural logarithms of total debt and revenue is 0.67, suggesting a one percent increase in firm revenue is associated with 0.67 percent increase in debt. This implies that firms that cause the sample coverage difference in the survey are unlikely to be the main driver of my results.

Secondly, I limit my sample to firms with revenues that are further away from the 500 million RMB threshold. Specifically, I re-conduct my main analyses in samples excluding firms with revenues fall into 500-550 million RMB, 500-600

million RMB, 500-650 million RMB, or up to 500-800 million RMB. My results rarely change.[18]

2.5.3 Cross-province Finance

In this sub-section, I discuss the issue of cross-province financing. To manage risks, provincial regulations are issued by Bureaus of Banking Supervisions to restrict cross-province lending.[19] Firms are therefore unlikely to borrow from outside provinces to the same extent as they borrow locally. Only the largest firms tend to have cross-province financing opportunities because of lower monitoring costs (checking assets and verifying collaterals in different provinces) for the lenders. I therefore conduct analyses to examine how the presence of cross-province finance in large firms may change my interpretation of the results. Specifically, I exclude firms with revenues that fall into the top 2%, 4%, 6%, 8% and 10% of the revenue distribution in each province-year, and re-do my main analyses.

These untabulated results suggest that excluding the top 2% firms in terms of revenue reduces the estimated Xinfang-finance magnitude by a half when using current liability to provincial GDP as dependent variable. When using long-term debt to provincial GDP as dependent variable, the coefficients lose

[18] Due to space constraint, these results are not tabulated, but are available upon request.

[19] For more details, see: http://www.cbrc.gov.cn/hubei/docPcjgView.

their statistical power. This provides suggestive evidence that the largest firms tend to borrow long-term loans from other provinces. From lender's perspective, they tend to value institutional quality more when making long-term investments.

The presence of cross-province financing does not change the Xinfang-finance relationship. Local Xinfang quality still matters in the lending decision of banks from other provinces. In fact, if firms were able to borrow from other provinces to the same extent as they borrow from local lenders, firms in China would face the same debt market. This would alleviate the concern that potentially unobserved differences across provincial debt markets may confound my results and reinforce the Xinfang-finance link.

2.6 Conclusion

In this paper, I provide new data about a central institution for protecting private property and enforcing contracts in China and then use these data to reassess the law-finance nexus. Specifically, I first note the central role of Xinfang in protecting private property rights, addressing contract disputes, and adapting to support a burgeoning array of commercial and financial interactions in China. Although Xinfang is not defined as part of the judicial system, and therefore has been largely ignored by western scholars, it nevertheless provides these vital legal functions to the economy and should be incorporated into assessments of the law and finance in China. Second, I develop measures of the cross-province effectiveness of Xinfang institutions and show that Xinfang are associated with cross-province, cross-industry, and cross-firm differences in corporate financing patterns that are consistent with key predictions from the law and finance view.

My work emphasizes the importance of institutional adaptability. Although the transformation of the Chinese economy over the last three decades created demands for—and perhaps required—the development of legal institutions to support new commercial, corporate, and financial arrangements, the legislature and courts were unable to adapt effectively by writing, enacting, and implementing new statues. Xinfang, however, evolved to satisfy these demands. The evidence suggests that Xinfang helped reduce the gap between the contracting needs of the economy and the capabilities of the legal system.

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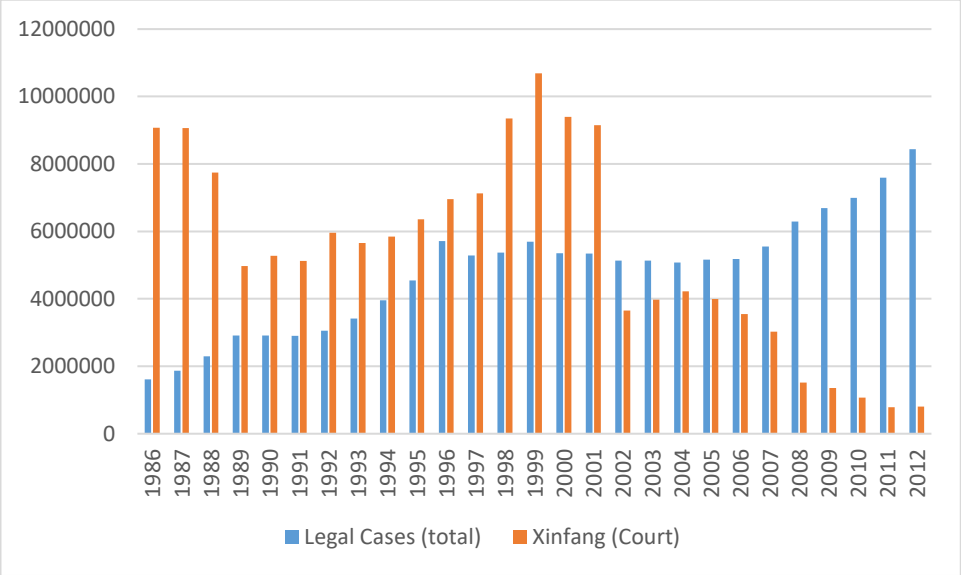
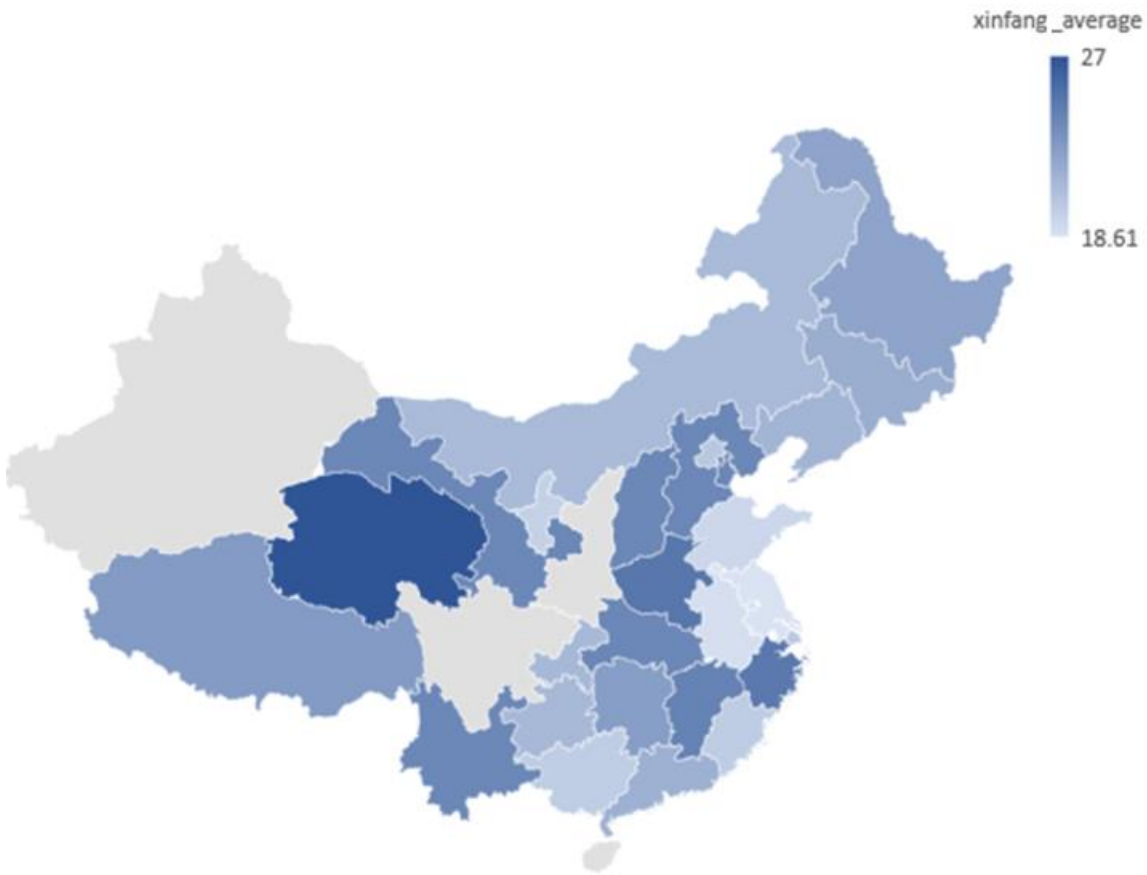
Figure 2.1: Number of Cases in Legal and Xinfang System



Note: Data is from Work Reports of Supreme People's Court, Supreme People's Procuratorate, Ministry of Public Security, and People's Congress (1987-2013)

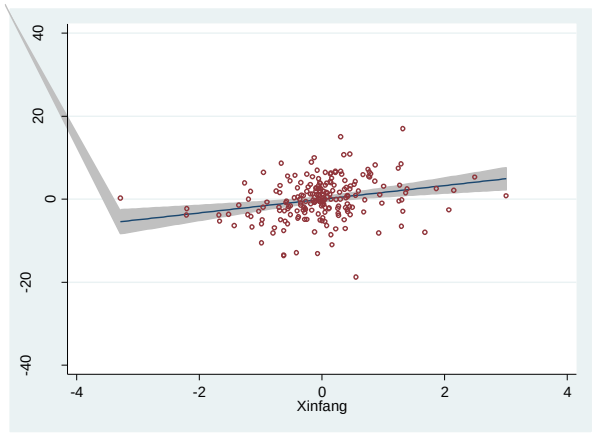
Figure 2.2: Spatial Distribution of Average Xinfang Index 1999-2009



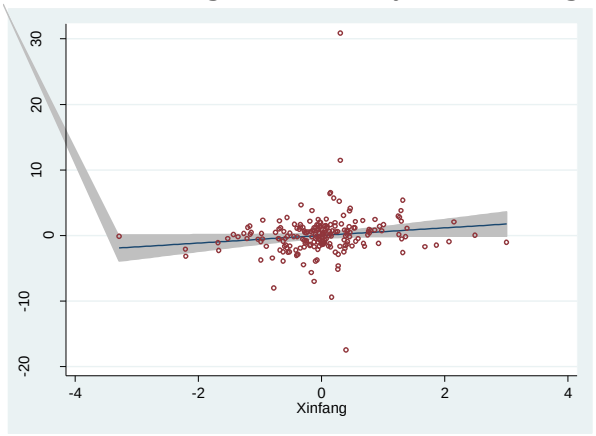
Note: This figure plots the distribution of the Xinfang score for each province, averaged over 1998-2009. The Xinfang score is calculated by aggregating 52 Xinfang features for each province-year, using an equal-weight method. Higher score corresponds to better Xinfang institutions.

Figure 2.3: Xinfang and Financial Development: Panel Regressions

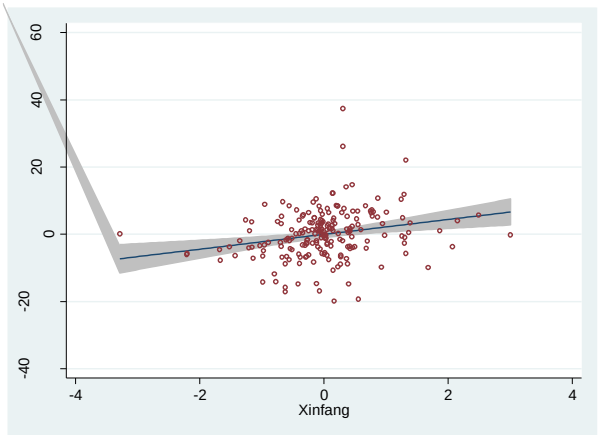
Panel A: Current liability and Xinfang



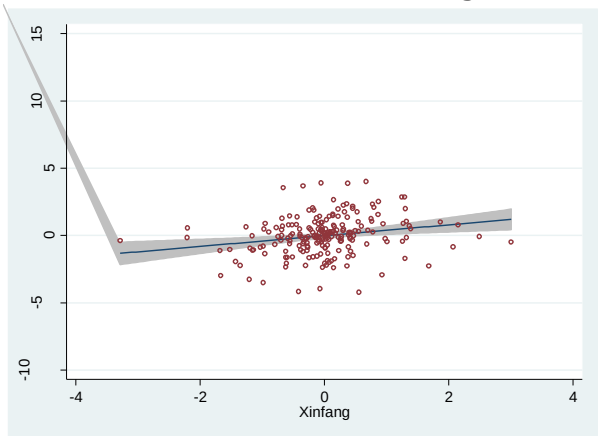
Panel B: Long-term liability and Xinfang



Panel C: Total liability and Xinfang



Panel D: Trade credit and Xinfang



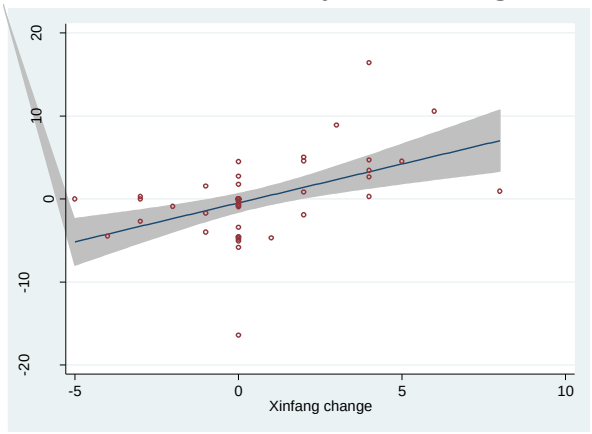
Note: This figure shows the relationship between Xinfang and financial market development at province-level. Specifically, it plots the following panel regressions:

$$FDI_{p,t} = \alpha + \beta Xinfang_{p,t} + \boldsymbol{\Gamma} X'_{p,t} + \Phi_p + \Psi_t + \Pi_p + \varepsilon_{p,t}$$

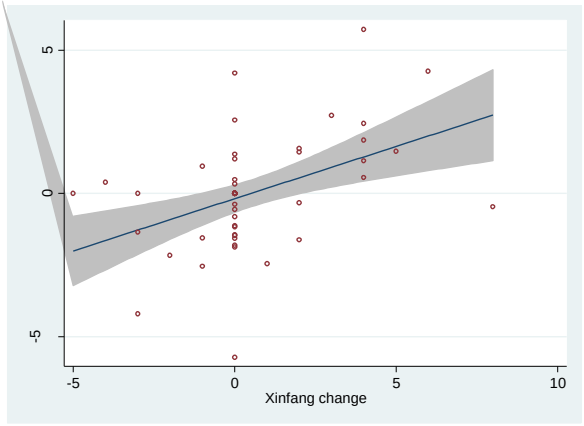
where the dependent variable is *Current liability to GDP* in Panel A, *Long-term liability to GDP* in Panel B, *Total liability to GDP* in Panel C and *Trade credit to GDP* in Panel D. Control variables include *Entrepreneur legal protection, Quality of legal service, Government scale, Import and export to GDP, Corruption, Government intervention, Literacy*, *GDP* and *GDP per capita.* Province, year fixed effects and province linear trend are also included. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. The x-axis is the residual of regressing *Xinfang* on all control variables, fixed effects and linear trends. The y-axis is the residual regressing dependent variables on all control variables, fixed effects and linear trends.

Figure 2.4: Xinfang and Financial Development: Residual Aggregation

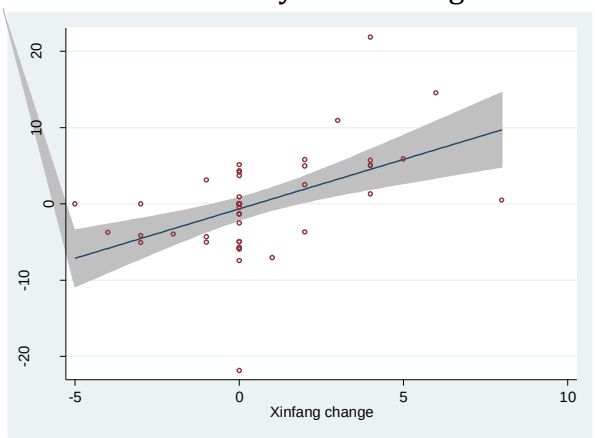
Panel A: Current liability and Xinfang



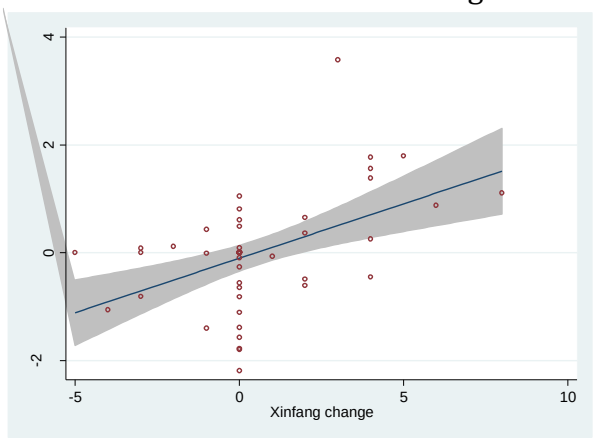
Panel B: Long-term liability and Xinfang



Panel C: Total liability and Xinfang



Panel D: Trade credit and Xinfang



Note: This figure shows the relationship between the change of Xinfang and the change of financial market development at province-level. Specifically, I first regress the dependent variable, either *Total liability to GDP*, *Current liability to GDP*, *Long-term liability to GDP* or *Trade credit to GDP*, on all the covariates including *Entrepreneur legal protection*, *Quality of legal service*, *Government scale*, *Import and export to GDP*, *Corruption*, *Government intervention*, *Literacy*, *GDP*, and *GDP per capita*, and province, time fixed effects as well as provincial linear trend. I then divide the residuals into two groups: residuals from years before the Xinfang index change, and residuals after the change. I then regress the change of the Xinfang index on this two-period panel with various cluster strategies. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. The x-axis is the residual of regressing *Change of Xinfang* on all control variables, fixed effects and linear trends. The y-axis is the residual regressing dependent variables on all control variables, fixed effects and linear trends.

Table 2.1: Summary of the Provincial Xinfang Regulations

Province	No.	Name	Year of Promulgation	Version
Beijing	1	Beijing Xinfang Regulations	01/01/1995	First
Beijing	2	Beijing Xinfang Regulations	01/01/2007	Second
Tianjin	3	Tianjin Xinfang Regulations	01/11/1994	First
Tianjin	4	Tianjin Xinfang Regulations	01/12/2005	Second
Hebei	5	Hebei Xinfang Regulations	01/09/1995	First
Hebei	6	Hebei Xinfang Regulations	30/07/2010	Second
Shanxi	7	Shanxi Xinfang Regulations	01/08/1996	Second
Shanxi	8	Shanxi Xinfang Regulations	01/07/2010	Third
Inner Mongolia	9	Inner Mongolia Xinfang Regulations	31/05/1994	First
Inner Mongolia	10	Inner Mongolia Xinfang Regulations	17/09/2010	Second
Liaoning	11	Liaoning Xinfang Regulations	25/09/1994	First
Liaoning	12	Liaoning Xinfang Regulations	01/08/2003	Second
Liaoning	13	Liaoning Xinfang Regulations	25/05/2007	Third
Liaoning	14	Liaoning Xinfang Regulations	30/07/2010	Fourth
Jilin	15	Jilin Xinfang Regulations	14/09/1992	First
Jilin	16	Jilin Xinfang Regulations	01/01/2002	Second
Heilongjiang	17	Xinfang Provisions on Sheltering	23/10/1991	Second
Heilongjiang	18	Xinfang Provisions on Sheltering	01/07/1998	Third
Shanghai	19	Shanghai Xinfang Regulations	15/12/1993	First
Shanghai	20	Shanghai Xinfang Regulations	01/10/2003	Second
Shanghai	21	Shanghai Xinfang Regulations	01/04/2013	Third
Jiangsu	22	Jiangsu Xinfang Regulations	17/10/1997	First
Jiangsu	23	Jiangsu Xinfang Regulations	01/10/2006	Second
Zhejiang	24	Zhejiang Xinfang Regulations	01/12.1994	First
Zhejiang	25	Zhejiang Xinfang Regulations	01/02/1997	Second
Zhejiang	26	Zhejiang Xinfang Regulations	01/03/2004	Third
Zhejiang	27	Zhejiang Xinfang Regulations	30/12/2009	Fourth
Zhejiang	28	Xinfang Provisions on Retrials	01/03/2012	Fifth
Anhui	29	Anhui Xinfang Regulations	01/01/1996	First
Anhui	30	Anhui Xinfang Regulations	01/05/2006	Second

Fujian	31	Fujian Xinfang Regulations	25/04/1996	First
Jiangxi	32	Jiangxi Xinfang Regulations	01/05/2004	First
Jiangxi	33	Jiangxi Xinfang Regulations	01/01/2010	Second
Shandong	34	Shandong Interim Xinfang Regulations	16/11/1992	First
Shandong	35	Shandong Xinfang Regulations	01/03/2001	Second
Shandong	36	Xinfang Provisions on Retrials	01/07/2008	Second
Henan	37	Henan Xinfang Regulations	01/03/1997	First
Henan	38	Henan Xinfang Regulations	29/11/2012	Second
Hubei	39	Hubei Xinfang Regulations	01/02/2006	First
Hunan	40	Hunan Xinfang Regulations	04/08/1998	First
Hunan	41	Hunan Xinfang Regulations	01/10/2006	Second
Guangdong	42	Guangdong Xinfang Regulations	11/10/1996	First
Guangdong	43	Guangdong Xinfang Regulations	01/01/2007	Second
Guangdong	44	Guangdong Xinfang Regulations	01/07/2014	Third
Guangxi	45	Guangxi Xinfang Regulations	25/09/1996	First
Guangxi	46	Guangxi Xinfang Provisions on Hearing	01/09/2007	Second
Chongqing	47	Chongqing Xinfang Regulations	01/07/1995	First
Chongqing	48	Chongqing Xinfang Regulations	01/01/2002	Second
Chongqing	49	Chongqing Xinfang Regulations	01/05/2009	Third
Guizhou	50	Guizhou Xinfang Regulations	01/11/2006	Second
Yunnan	51	Yunnan Xinfang Regulations	28/09/2003	Second
Tibet	52	Tibet Xinfang Regulations	01/05/1995	First
Tibet	53	Tibet Xinfang Regulations	01/08/2008	Second
Gansu	54	Gansu Xinfang Regulations	30/06/1992	First
Gansu	55	Gansu Xinfang Regulations	26/07/2002	Second
Gansu	56	Gansu Xinfang Regulations	28/09/2006	Third
Ningxia	57	Provisions on Step-by-step Filing	11/02/1995	First
Ningxia	58	Xinfang Provisions on Monitoring	02/09/1999	Second
Qinghai	59	Qinghai Xinfang Regulations	01/01/1997	First
Qinghai	60	Qinghai Xinfang Regulations	01/07/2011	Second
Shanxi	61	Shanxi Interim Xinfang Regulations	10/01/1985	First

Heilongjiang	62	Heilongjiang Xinfang Regulations	10/01/1984	First
Guizhou	63	Guizhou Xinfang Regulations	27/11/1990	First
Yunnan	64	Yunnan Xinfang Regulations	26/04/1993	First

Table 2.2: Features of the Xinfang Index

	No.	Name
Speed features		
	1	Within 15 days limit on notifying Xinfangers whether the case is accepted
	2	Within 60 days limit on resolving a Xinfang case
	3	Within 60 days limit on extension in resolving a Xinfang case
	4	Within 10 days limit on transferring a case
	5	Within 60 days limit on resolving a transferred case
	6	Within 60 days limit on time extension in resolving a transferred Xinfang case
	7	Within 60 days limit on resolving a re-checked Xinfang case
	8	Within 60 days limit on time extension in resolving a re-checked or third-time-checked Xinfang case
Support features		
	1	Leadership responsibility system
	2	Hearing system
	3	Disclosure of hearing participants information
	4	Visiting Xinfangers system
	5	Case-review system
	6	Hearing costs
	7	Public hearing
	8	Avoid conflict of interest in public hearing
	9	Follow-up responsibility
	10	Case accountability
	11	Confidentiality
	12	Verified hearing notes
	13	First-responsibility
	14	Hearing committee ID
	15	Formatted proposal
	16	Reply letter
	17	Reply language
	18	(-) Force to accept
	19	(-) Limit on stay
	20	(-) Limit on place
	21	(-) Limit on number of Xinfangers
	22	(-) Xinfanger ID
	23	(-) Ban on bypassing

	24	(-) Limit on multiple filing
	25	(-) Discourage Xinfangers
	26	(-) Detention of elderly, disabled, and injured
	27	(-) Put detention into work assessment
	28	Flexible Xinfang time and location
	29	Xinfang language
	30	Case support
	31	Disabled facilities
	32	Security of Xinfang funding
	33	Allow cases filed against legal violations of Xinfangers
	34	Prohibition of Xinfanger with infectious disease
	35	Prohibition of Xinfanger with psychiatric disorder
	36	(-) Criticize Xinfangers
	37	(-) Limit on time to apply for appeal
Incentive features		
	1	Punish-cover-up unqualified behavior
	2	Punish-fail to act
	3	Punish-fail to refrain
	4	Punish-fail to file
	5	Punish-threats, retaliation
	6	Reward-improve national organs
	7	Reward-report of violations

Table 2.3: Summary Statistics

Variable	N	Mean	SD	Min	P25	P50	P75	Max
Province-level variables								
Xinfang	336	22.04	2.67	17.00	20.00	22.00	24.00	27.00
Speed	336	1.92	1.27	0	1.00	2.00	3.00	5.00
Support	336	16.28	2.27	11.00	15.00	16.00	17.00	24.00
Incentive	336	3.85	1.20	0	3.00	4.00	5.00	6.00
Current liability to GDP	233	0.032%	0.016%	0.002%	0.020%	0.030%	0.039%	0.083%
Long-term liability to GDP	233	0.011%	0.007%	0.001%	0.006%	0.009%	0.014%	0.060%
Total liability to GDP	233	0.043%	0.020%	0.003%	0.028%	0.041%	0.054%	0.111%
Trade credit to GDP	233	0.005%	0.006%	0.000%	0.000%	0.003%	0.008%	0.024%
Industrial Output to GDP	233	0.055%	0.046%	0.000%	0.020%	0.041%	0.078%	0.188%
Sale value to GDP	233	0.053%	0.045%	0.000%	0.020%	0.039%	0.077%	0.184%
Revenue to GDP	233	0.057%	0.043%	0.002%	0.023%	0.040%	0.076%	0.184%
Entrepreneur protection	307	3.88	2.03	-1.91	2.69	3.84	5.08	10.00
Quality of legal and accounting service	307	3.35	2.77	-12.27	1.10	2.86	5.34	11.28
Government scale	284	4.90	3.64	-13.47	3.54	5.60	7.11	10.56
Import and export to GDP	336	0.04	0.06	0.00	0.01	0.02	0.05	0.24
Corruption	284	10.86	4.22	0.00	7.09	12.68	14.52	16.46
Government intervention	307	4.25	3.31	-12.95	2.61	4.17	6.12	10.13
GDP (in 100,000,000 RMB)	336	7124	7542	91	2129	4766	9236	46013
GDP per capita	336	17700	14800	2364	7259	12920	22453	78989
Literacy	341	101.70	336.86	0.04	1.35	1.75	3.20	2378.20
Industrial-level variables								
Current liability to revenue	8648	0.91	0.96	0.04	0.39	0.65	1.09	11.79

Long-term liability to revenue	8648	0.31	0.51	0.00	0.04	0.12	0.37	5.10
Total liability to revenue	8648	1.26	1.39	0.07	0.47	0.84	1.58	16.31
Trade credit to revenue	8648	0.07	0.11	0.00	0.00	0.04	0.12	1.42
Current liability to sale value	7723	0.89	0.93	0.03	0.38	0.64	1.07	9.56
Long-term liability to sale value	7723	0.31	0.50	0.00	0.04	0.12	0.36	4.77
Total liability to sale value	7723	1.24	1.34	0.06	0.46	0.82	1.56	14.15
Trade credit to sale value	7723	0.06	0.09	0.00	0.00	0.02	0.10	0.66
Current liability to industrial output	7722	0.85	0.84	0.03	0.37	0.62	1.03	7.83
Long-term liability to industrial output	7722	0.30	0.48	0.00	0.03	0.11	0.35	4.35
Total liability to industrial output	7722	1.18	1.24	0.07	0.44	0.79	1.50	13.16
Trade credit to industrial output	7722	0.06	0.09	0.00	0.00	0.02	0.10	0.65
Firm-level variables								
Current liability to total assets	1428689	0.47	0.27	0.00	0.25	0.48	0.70	0.97
Long-term liability to total assets	1470434	0.05	0.12	0.00	0.00	0.00	0.02	0.64
Total liability to total assets	1410736	0.53	0.26	0.01	0.33	0.56	0.75	0.98
Trade credit to total assets	1275877	0.15	0.18	0.00	0.01	0.08	0.22	0.79
Private	1466515	0.87	0.34	0.00	1.00	1.00	1.00	1.00
Operating profit	1599290	0.02	0.23	-4.68	0.00	0.03	0.07	0.44
Founding year	1474054	1997	12	1600	1995	2001	2004	2009
Ln Total assets	1474585	9.79	1.41	5.46	8.80	9.63	10.63	15.11
Ln Number of employees	991652	4.61	1.09	1.61	3.85	4.50	5.29	8.66
Industrial-level variables								
Dependence on external finance	5155	0.53	0.50	0.00	0.00	1.00	1.00	1.00

Table 2.4: Xinfang and Provincial Financial Development: Panel Regressions

This table reports OLS regression results of provincial financial development on the Xinfang index. The dependent variable is *Current liability to GDP* in columns 1-3, *Long-term liability to GDP* in columns 4-6, *Total liability to GDP* in columns 7-9 and *Trade credit to GDP* in 10-12. The key explanatory variable, *Xinfang*, is a province-year index that measures the quality of the functioning of Xinfang system. *Entrepreneur legal protection* measures the quality of provincial legal environment. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how well their formal legal rights are protected. *Quality of legal service* measures the quality of local accounting and legal services. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs the quality of services provided by local law and accounting firms. *Government scale* measures the size of local government. It is constructed by National Economic Research Institute and calculated by dividing the number of government employees by the number of local population. *Import and export to GDP* is calculated by dividing the value of both import and export by provincial gross product. *Corruption* measures the degree to which a government is corrupted. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how much extra tax they pay as a share of firm's yearly revenue. *Government intervention* measures the degree to which a government intervenes business procedures. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how easy and convenient the business managers feel about local administrative approval procedure. Literacy is calculated by dividing the number of people who graduated from college or above by the provincial population. The data of number of people who graduated from college or above is from annual census conducted by the National Statistics Bureau. The sampling size differs greatly each year but varies little across province. *GDP* and *GDP per capita* are the gross provincial product and gross provincial product per capita, and are from CSMAR/GTA database. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variable											
	Current liability to GDP Mean: 31.25			Long-term liability to GDP Mean: 10.85			Total liability to GDP Mean: 43.04			Trade credit to GDP Mean: 5.21		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Xinfang	2.17***	1.85***	1.69**	0.55*	0.64*	0.56*	2.72***	2.49***	2.25**	0.49***	0.47***	0.47***
	[3.27]	[3.35]	[2.70]	[2.03]	[2.00]	[1.82]	[3.17]	[3.09]	[2.49]	[3.76]	[4.21]	[3.41]
Entrepreneur legal protection		-0.26	-0.12		0.99	0.99		0.67	0.81		-0.03	0.01
		[-0.26]	[-0.12]		[1.37]	[1.29]		[0.47]	[0.54]		[-0.18]	[0.05]
Quality of legal and accounting service		-0.18	-0.37		-0.93	-0.95		-0.94	-1.16		-0.10	-0.15
		[-0.20]	[-0.39]		[-1.34]	[-1.20]		[-0.64]	[-0.73]		[-0.49]	[-0.71]
Government scale		-0.57	-0.84		-0.94	-0.99		-1.49	-1.82		0.54	0.48
		[-0.25]	[-0.38]		[-1.26]	[-1.15]		[-0.52]	[-0.62]		[0.97]	[0.88]
Import and export to GDP		0.00	0.00		-0.00	-0.00		-0.00	-0.00		-0.00	-0.00
		[0.01]	[0.12]		[-0.62]	[-0.58]		[-0.14]	[-0.00]		[-0.69]	[-0.72]
Corruption		-1.27*	-1.14*		-0.30	-0.28		-1.55*	-1.39		-0.18	-0.15
		[-1.94]	[-1.75]		[-0.96]	[-0.99]		[-1.74]	[-1.59]		[-0.90]	[-0.72]
Government intervention		-0.29	-0.33		-0.17	-0.18		-0.42	-0.48		0.13	0.12
		[-0.41]	[-0.47]		[-0.53]	[-0.55]		[-0.43]	[-0.48]		[0.63]	[0.62]
Literacy		11.48	12.68		-21.58	-23.25		-9.88	-10.68		5.12	6.88
		[0.47]	[0.49]		[-0.87]	[-0.93]		[-0.25]	[-0.26]		[1.04]	[1.43]
GDP			0.00			0.00			0.00			0.00
			[0.94]			[0.04]			[0.71]			[0.83]
GDP per capita			-0.00			0.00			0.00			-0.00

			[-0.11]			[0.94]			[0.27]			[-0.89]
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	233	208	208	233	208	208	233	208	208	233	208	208
R-squared	0.837	0.876	0.875	0.672	0.690	0.686	0.809	0.838	0.837	0.929	0.928	0.929
Level of cluster	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.
Clusters	27	27	27	27	27	27	27	27	27	27	27	27
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.5: Xinfang and Provincial Financial Development: Residual Aggregation

This table reports OLS regression results of provincial financial development on the Xinfang index, using a residual aggregation method. The dependent variable is *Current liability to GDP* in columns 1-3, *Long-term liability to GDP* in columns 4-6, *Total liability to GDP* in columns 7-9 and *Trade credit to GDP* in 10-12. The key explanatory variable is the change of *Xinfang*, a province-year index that measures the quality of the functioning of Xinfang system. I first regress the dependent variables on all the covariates, fixed effects and time trends. Then I divide residuals into two groups: residuals from years before the Xinfang index change, and residuals after the change. I then regress the change of the Xinfang index on this two-period panel with various cluster strategies. The controls variables include: including *Entrepreneur legal protection*, *Quality of legal service*, *Government scale*, *Import and export to GDP*, *Corruption*, *Government intervention*, *Literacy*, *GDP*, and *GDP per capita*. *Entrepreneur legal protection* measures the quality of provincial legal environment. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how well their formal legal rights are protected. *Quality of legal service* measures the quality of local accounting and legal services. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs the quality of services provided by local law and accounting firms. *Government scale* measures the size of local government. It is constructed by National Economic Research Institute and calculated by dividing the number of government employees by the number of local population. *Import and export to GDP* is calculated by dividing the value of both import and export by provincial gross product. *Corruption* measures the degree to which a government is corrupted. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how much extra tax they pay as a share of firm's yearly revenue. *Government intervention* measures the degree to which a government intervenes business procedures. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how easy and convenient the business managers feel about local administrative approval procedure. Literacy is calculated by dividing the number of people who graduated from college or above by the provincial population. The data of number of people who graduated from college or above is from annual census conducted by the National Statistics Bureau. The sampling size differs greatly each year but varies little across province. *GDP* and *GDP per capita* are the gross provincial product and gross provincial product per capita, and are from CSMAR/GTA database. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variable											
	Current liability to GDP Mean: 31.25			Long-term liability to GDP Mean: 10.85			Total liability to GDP Mean: 43.04			Trade credit to GDP Mean: 5.21		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Change of Xinfang	0.98***	0.98***	0.98***	0.36***	0.36**	0.36***	1.34***	1.34***	1.34***	0.24***	0.24***	0.24***
	[3.12]	[3.47]	[3.17]	[2.77]	[2.76]	[2.73]	[3.16]	[3.43]	[3.20]	[3.71]	[4.30]	[3.68]
Observations	54	55	54	54	55	54	54	55	54	54	55	54
R-squared	0.225	0.225	0.254	0.183	0.183	0.213	0.237	0.237	0.265	0.236	0.236	0.265
Level of cluster	Province	Time	Both	Province	Time	Both	Province	Time	Both	Province	Time	Both
Clusters	27	2	27, 2	27	2	27, 2	27	2	27, 2	27	2	27, 2
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.6: Xinfang and Provincial Industrial Output

This table reports OLS regression results of provincial industrial output on the Xinfang index and provincial financial development measures. The dependent variable is *Industrial Output to GDP* in columns 1-3, *Sale value to GDP* in columns 4-6, and *Revenue to GDP* in columns 7-9. *Xinfang* is a province-year index that measures the quality of the functioning of Xinfang system. *Total liability to GDP, Current liability to GDP, Long-term liability to GDP* and *Trade credit to GDP* are provincial aggregated total liability, current liability, long-term liability and account payable divide by provincial gross product. *Entrepreneur legal protection* measures the quality of provincial legal environment. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how well their formal legal rights are protected. *Quality of legal service* measures the quality of local accounting and legal services. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs the quality of services provided by local law and accounting firms. *Government scale* measures the size of local government. It is constructed by National Economic Research Institute and calculated by dividing the number of government employees by the number of local population. *Import and export to GDP* is calculated by dividing the value of both import and export by provincial gross product. *Corruption* measures the degree to which a government is corrupted. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how much extra tax they pay as a share of firm's yearly revenue. *Government intervention* measures the degree to which a government intervenes business procedures. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how easy and convenient the business managers feel about local administrative approval procedure. Literacy is calculated by dividing the number of people who graduated from college or above by the provincial population. The data of number of people who graduated from college or above is from annual census conducted by the National Statistics Bureau. The sampling size differs greatly each year but varies little across province. *GDP* and *GDP per capita* are the gross provincial product and gross provincial product per capita, and are from CSMAR/GTA database. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variable											
	Industrial Output to GDP Mean: 54.73				Sale value to GDP Mean: 53.30				Revenue to GDP Mean: 56.73			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Xinfang	2.72***	0.47	-0.11	-0.24	2.68***	0.47	-0.10	-0.23	2.48***	0.27	-0.32	-0.52
	[2.99]	[0.49]	[-0.13]	[-0.29]	[2.98]	[0.49]	[-0.11]	[-0.28]	[2.88]	[0.34]	[-0.49]	[-0.86]
Total liability to GDP		1.00***				0.98***				0.98***		
		[4.20]				[4.19]				[4.25]		
Current liability to GDP			1.73***				1.69***				1.72***	
			[14.61]				[14.26]				[13.16]	
Long-term liability to GDP			-0.17	-0.12			-0.17	-0.12			-0.20	-0.12
			[-1.22]	[-0.86]			[-1.19]	[-0.84]			[-1.28]	[-0.82]
Trade credit to GDP				2.73***				2.67***				3.20***
				[6.51]				[6.23]				[7.68]
(Current liability - Trade credit) to GDP				1.43***				1.40***				1.27***
				[8.86]				[8.46]				[8.52]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	208	208	208	208	208	208	208	208	208	208	208	208
R-squared	0.942	0.972	0.981	0.982	0.941	0.971	0.981	0.981	0.937	0.971	0.982	0.984

Level of cluster	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.	Prov.
Clusters	27	27	27	27	27	27	27	27	27	27	27	27
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.7: Xinfang and Firm Access Finance: Differentiating by Industrial Traits, Panel Regression

This table shows the heterogeneous effects of Xinfang on firm access finance by differentiating industries by their dependence on external finance. The dependent variable is *Current liability to revenue* in columns 1-2, *Long-term liability to revenue* in columns 3-4, *Total liability to revenue* in columns 5-6 and *Trade credit to revenue* in 7-8. The key explanatory variable is the interaction term of *Xinfang* and *Dependence on external finance*. *Xinfang* is a province-year index that measures the quality of the functioning of Xinfang system. *Dependence on external finance* is first calculated as the fraction of capital expenditures not financed with internally generated cash flows for firms listed in NYSE, AMEX or NASDAQ in the United States during the 1980s. I then assign the value of 1 to an industry if it is above the median and zero if it is below. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variables							
	Current liability to revenue		Long-term liability to revenue		Total liability to revenue		Trade credit to revenue	
	Mean: 0.91		Mean: 0.31		Mean: 1.26		Mean: 0.07	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Xinfang * Dependence on external finance	0.0375**	0.0375*	0.0133***	0.0133**	0.0572**	0.0572**	0.0021**	0.0021
	[2.08]	[1.91]	[2.64]	[2.42]	[2.18]	[2.03]	[2.19]	[1.60]
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5154	5154	5154	5154	5154	5154	5154	5154
R-squared	0.449	0.449	0.346	0.346	0.452	0.452	0.571	0.571
Level of cluster	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year
Clusters	27, 46	27, 46, 11	27, 46	27, 46, 11	27, 46	27, 46, 11	27, 46	27, 46, 11
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.8: Xinfang and Firm Access Finance: Differentiating by Industrial Traits, Residual Aggregation

This table shows the heterogeneous effects of Xinfang on firm access finance by differentiating industries by their dependence on external finance, using a residual aggregation method. The dependent variable is *Current liability to revenue* in columns 1-2, *Long-term liability to revenue* in columns 3-4, *Total liability to revenue* in columns 5-6 and *Trade credit to revenue* in 7-8. The key explanatory variable is the interaction term of change of *Xinfang* and *Dependence on external finance*. *Xinfang* is a province-year index that measures the quality of the functioning of Xinfang system. *Dependence on external finance* is first calculated as the fraction of capital expenditures not financed with internally generated cash flows for firms listed in NYSE, AMEX or NASDAQ in the United States during the 1980s. I then assign the value of 1 to an industry if it is above the median and zero if it is below. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variables							
	Current liability to revenue Mean: 0.91		Long-term liability to revenue Mean: 0.31		Total liability to revenue Mean: 1.26		Trade credit to revenue Mean: 0.07	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Change of Xinfang * Dependence on external finance	0.0663*	0.0663*	0.0339**	0.0340	0.1036*	0.1037*	0.0174***	0.0174***
	[1.67]	[1.78]	[1.98]	[1.37]	[1.91]	[1.74]	[3.63]	[3.39]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1213	1209	1213	1209	1213	1209	1213	1209
R-squared	-0.001	0.002	-0.001	0.002	-0.001	0.002	0.009	0.012
Level of cluster	Industry	Pro., Ind.	Industry	Pro., Ind.	Industry	Pro., Ind.	Industry	Pro., Ind.
Clusters	46	27, 46	46	27, 46	46	27, 46	46	27, 46
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.9: Xinfang and Firm Access Finance: Differentiating by Firm Ownership Type

This table shows the heterogeneous effects of Xinfang on firm access finance by differentiating firms by their registered ownership type. The dependent variable is *Current liability to total assets* in columns 1-2, *Long-term liability to total assets* in columns 3-4, *Total liability to total assets* in columns 5-6 and *Trade credit to total assets* in 7-8. The key explanatory variable is the interaction term of *Xinfang* and *Private*. *Xinfang* is a province-year index that measures the quality of the functioning of Xinfang system. *Private* is a binary variable that equals to 1 if a firm's controlling shareholder is private or foreign enterprise, and 0 if it is state entity. Firm controls include *Private, Operating profit, Founding year, Ln Total assets*, *and Ln Number of employees.* All dependent variables are inflated by a factor of 100 for interpretation purposes. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

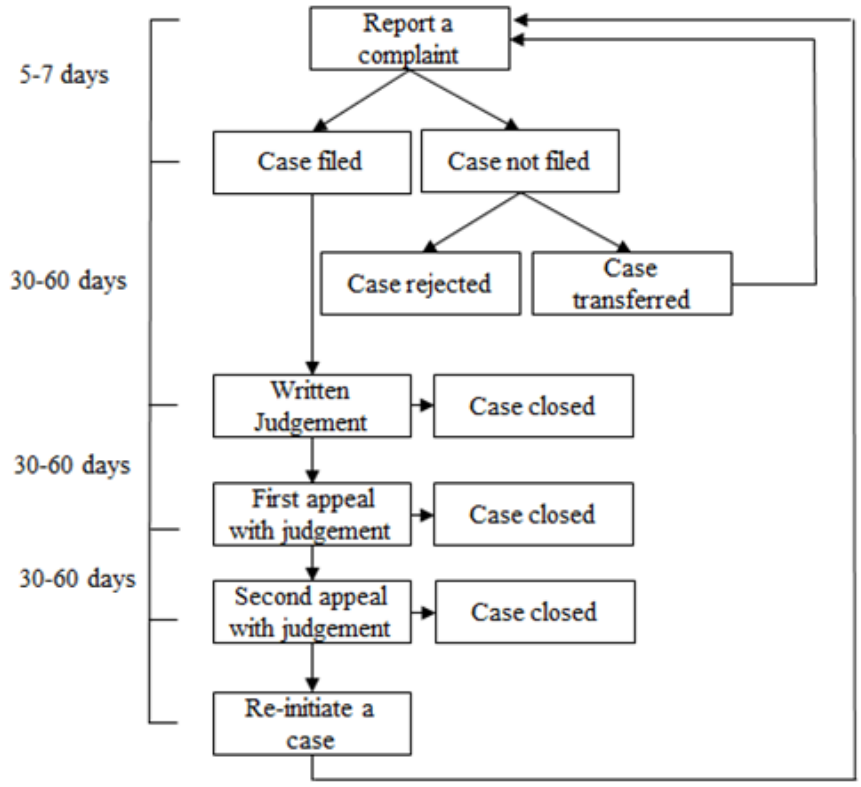
	Dependent variable							
	Current liability to total assets		Long-term liability to total assets		Total liability to total assets		Trade credit to total assets	
	Mean: 47.40		Mean: 4.85		Mean: 53.29		Mean: 14.96	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Xinfang * Private	-0.026	-0.095	0.205***	0.302***	0.228***	0.284***	0.146***	0.089**
	[-0.56]	[-1.49]	[6.66]	[7.42]	[4.75]	[4.41]	[4.38]	[2.27]
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1419291	799795	1460763	808803	1401560	796090	1291053	776401
R-squared	0.111	0.155	0.117	0.096	0.084	0.127	0.067	0.083
Level of cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Clusters	573395	442175	584714	446828	567612	440141	503237	425668
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Table 2.10: Xinfang and Provincial Financial Development: Sub Index Analyses

This table reports OLS regression results of provincial financial development on three Xinfang sub-indices. The dependent variable is either *Current liability to GDP* in column 1, *Long-term liability to GDP* in column 2, *Total liability to GDP* in column 3 or *Trade credit to GDP* in column 4. The key explanatory variables, *Speed*, *Support* and *Incentive* are province-year indices that measure the speed of dispute resolution, the degree to which a province's Xinfang regulations support individuals and firms to access the Xinfang system, and the degree to which Xinfang motivates its workers to treat participants well and resolve cases expeditiously and fairly. All models include province and year fixed effect. Linear trend for each province is also included. All dependent variables are inflated by a factor of 10,000 for interpretation purpose. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variable			
	Current liability to GDP	Long-term liability to GDP	Total liability to GDP	Trade credit to GDP
	Mean: 31.25	Mean: 10.85	Mean: 43.04	Mean: 5.21
	(1)	(2)	(3)	(4)
Support Index	2.15***	0.55*	2.73***	0.68***
	[3.84]	[2.03]	[3.54]	[5.02]
Speed Index	3.25**	0.73	3.91*	0.40
	[2.13]	[1.08]	[2.03]	[1.46]
Incentive Index	0.81	0.30	1.17	0.22
	[0.78]	[0.63]	[0.89]	[0.65]
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Linear trend	Yes	Yes	Yes	Yes
Observations	233	233	233	233
R-squared	0.836	0.668	0.808	0.930
Level of cluster	Province	Province	Province	Province
Clusters	27	27	27	27
Specifications	OLS	OLS	OLS	OLS

Appendix Figure 1: Procedure of Xinfang



Source: Xinfang regulations of 31 provinces over 1992-2015

Appendix Table 2.1: Variable Definition and Sources

Variable	Definition	Source
Province-level variables		
Xinfang	Xinfang is a measure of the efficiency of the operation of provincial Xinfang system. The index is derived from the provincial Xinfang regulations during 1998-2009. It contains three components, including speed, support, and incentive indices described immediately below.	Authors' coding and calculation.
Speed	Speed is a measure of the speed of dispute resolution in Xinfang system. It is calculated as adding up the eight Xinfang features that measure the duration of dispute resolution during 1998-2009.	
Support	Support is a measure of the extent to which the Xinfang system supports citizens and firms to file complaints. It is calculated as adding up the 37 Xinfang features that measure the extent to which the provincial Xinfang system facilitates and supports disputants during 1998-2009.	
Incentive	Incentive is a measure of the extent to which the Xinfang system motivates Xinfang workers. It is calculated as adding up the seven Xinfang features that measure the incentives a provincial Xinfang system provides during 1998-2009.	

Current liability to GDP	Current liability to GDP is the ratio of current liability to provincial gross product. Current liability is calculated by aggregating the current liability of industrial firms located in the same province. Provincial gross product is a provincial equivalent measure of gross domestic product and is from CSMAR/GTA.	National Bureau of Statistics' Annual Surveys of Industrial Production (1998-2008); CSMAR/GTA
Long-term liability to GDP	Long-term liability to GDP is the ratio of long-term liability to provincial gross product. Long-term liability is calculated by aggregating the long-term liability of industrial firms located in the same province.	
Total liability to GDP	Total liability to GDP is the ratio of total liability to provincial gross product. Total liability is calculated by aggregating the total liability of industrial firms located in the same province.	
Trade credit to GDP	Trade credit to GDP is the ratio of trade credit to provincial gross product. Trade credit is calculated by aggregating the account payables of industrial firms located in the same province.	
Industrial output to GDP	Industrial output to GDP is the ratio of industrial output to provincial gross product. Industrial output is calculated by aggregating the industrial out of firms located in the same province. Firm's industrial output is the total output of all the facilities producing goods within a firm.	
Sale value to GDP	Sale value to GDP is the ratio of sales value to provincial gross product. Sales value is calculated by aggregating the sale value of industrial firms located in the same province. Sale value includes revenue and the value of products provided within the firm.	

Revenue to GDP	Revenue to GDP is the ratio of revenue to provincial gross product. Revenue is calculated by aggregating the revenue of industrial firms located in the same province.	
Entrepreneur protection	Entrepreneur protection measures the quality of provincial legal environment. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how well their formal legal rights are protected.	National Economic Research Institute (2011)
Quality of legal and accounting service	Quality of legal and accounting service measures the quality of local accounting and legal services. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs the quality of services provided by local law and accounting firms.	
Government scale	Government scale measures the size of local government. It is constructed by National Economic Research Institute and calculated by dividing the number of government employees by the number of local population.	
Corruption	Corruption measures the degree to which a government is corrupted. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how much extra tax they pay as a share of firm's yearly revenue.	
Government intervention	Government intervention measures the degree to which a government intervenes business procedures. It is constructed by National Economic Research Institute from survey data that specifically asks entrepreneurs how easy and convenient the business managers feel about local administrative approval procedure.	

Import and export to GDP	Import and exports to GDP is calculated by dividing the value of both import and export by provincial gross product.	CSMAR/GTA
GDP (in 100,000,000 RMB)	GDP is the gross provincial product and is from CSMAR/GTA database.	
GDP per capita	GDP per capita is the per capita level of gross provincial product and is calculated by dividing the gross provincial product by the provincial population.	
Literacy	Literacy is calculated by dividing the number of people who graduated from college or above by the provincial population. The data of number of people who graduated from college or above is from annual census conducted by the National Statistics Bureau. The sampling size differs greatly each year but varies little across province.	
Industrial-level variables		
Current liability to revenue	Current liability to revenue is calculated by dividing the value of aggregated current liability at province-industry level by the value of aggregated province-industry revenue. The value of aggregated current liability (revenue) is calculated by adding the current liability (revenue) of firms in the same industry within a province.	National Bureau of Statistics' Annual Surveys of Industrial Production (1998-2008)
Long-term liability to revenue	Long-term liability to revenue is calculated by dividing the value of aggregated long-term liability at province-industry level by the value of aggregated province-industry revenue.	
Total liability to revenue	Total liability to revenue is calculated by dividing the value of aggregated total liability at province-industry level by the value of aggregated province-industry revenue.	

Trade credit to revenue	Trade credit to revenue is calculated by dividing the value of aggregated account payable at province-industry level by the value of aggregated province-industry revenue.
Current liability to sale value	Current liability to sale value is calculated by dividing the value of aggregated current liability at province-industry level by the value of aggregated province-industry sale value. The value of aggregated current liability (sale value) is calculated by adding the current liability (sale value) of firms in the same industry within a province. Firm's sale value differs from revenue because it also includes the value of products provided within a firm.
Long-term liability to sale value	Long-term liability to sale value is calculated by dividing the value of aggregated long-term liability at province-industry level by the value of aggregated province-industry sale value.
Total liability to sale value	Total liability to sale value is calculated by dividing the value of aggregated total liability at province-industry level by the value of aggregated province-industry sale value.
Trade credit to sale value	Trade credit to sale value is calculated by dividing the value of aggregated account payable at province-industry level by the value of aggregated province-industry sale value.

Current liability to industrial output	Current liability to industrial output is calculated by dividing the value of aggregated current liability at province-industry level by the value of aggregated province-industry industrial output. The value of aggregated current liability (industrial output) is calculated by adding the current liability (industrial output) of firms in the same industry within a province. Firm's industrial output is the total output of all the facilities producing goods within a firm.	
Long-term liability to industrial output	Long-term liability to industrial output is calculated by dividing the value of aggregated long-term liability at province-industry level by the value of aggregated province-industry industrial output.	
Total liability to industrial output	Total liability to industrial output is calculated by dividing the value of aggregated total liability at province-industry level by the value of aggregated province-industry industrial output.	
Trade credit to industrial output	Trade credit to industrial output is calculated by dividing the value of aggregated account payable at province-industry level by the value of aggregated province-industry industrial output.	
Firm-level variables		
Current liability to total assets	Current liability to total assets is calculated as firm's current liability divided by total assets.	National Bureau of Statistics' Annual Surveys of Industrial Production (1998-2008)
Long-term liability to total assets	Long-term liability to total assets is calculated as firm's long-term liability divided by total assets.	
Total liability to total assets	Total liability to total assets is calculated as firm's total liability divided by total assets.	
Trade credit to total assets	Trade credit to total assets is calculated as firm's account payable divided by total assets.	

Private	Private is a binary variable that equals to 1 if a firm's controlling shareholder is private or foreign enterprise, and 0 if it is state entity.	
Operating profit	Operating profit is defined as operating profit divided by firm's revenue.	
Founding year	Founding year is the year when a firm is founded.	
Ln Total assets	Ln Total assets is the natural logarithm of a firm's total assets.	
Ln Number of employees	Ln Number of employees is the natural logarithm of a firm's number of employees.	
Industrial-level variables		
Dependence on external finance	Dependence on external finance is the fraction of capital expenditures not financed with internally generated cash flows for firms listed in NYSE, AMEX or NASDAQ in the United States during the 1980s. The median level of dependence on external finance for ISIC industries is used.	Rajan and Zingales (1998)

Appendix Table 2.2: Sources of Xinfang Regulations

For Xinfang regulations that are recorded by the State Council, 34 of 60 can be obtained from official government websites. For the rest, 35 can be obtained through the law databases. Here I only provide the database website because the databases require subscription to get access to the content. With subscriptions to those databases, the Xinfang regulations can be easily obtained. For the one left, I list three distinctive web sources that provide the content. Numbers "2" and "3" indicate the second and third source respectively.

Province	No.	Time Accessed	Sources
Beijing	1	21/09/2016	http://www.gjxfj.gov.cn/xffg/2009-11/24/c_1395084.htm
Beijing	2	21/09/2016	http://www.gjxfj.gov.cn/xffg/2009-11/24/c_1395089.htm
Tianjin	3	21/09/2016	http://www.tjrd.gov.cn/rdzlk/system/1994/12/01/000004292.shtml
Tianjin	4	21/09/2016	http://www.tjxfb.gov.cn/Showit/52b8e75b-9f78-419b-9f0d-a8bb3b1f3a0b
Hebei	5	21/09/2016	http://www.gjxfj.gov.cn/2014-05/12/c_133327640.htm
Hebei	6	21/09/2016	http://fgk.chinalaw.gov.cn/article/dffg/201007/20100700337163.shtml
Shanxi	7	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D140009715
Shanxi	8	21/09/2016	http://fgk.chinalaw.gov.cn/article/dffg/201005/20100500336945.shtml
Inner Mongolia	9	21/09/2016	http://www.hhxc.gov.cn/xcjg/zf/xfj/zcfg/ZFXW1027.html?InfoORG=AGA039
Inner Mongolia	10	21/09/2016	http://govinfo.nlc.gov.cn/nmgfz/xxgk/nmgzzqwht/201308/t20130801_3806234.shtml?classid=346
Liaoning	11	21/09/2016	http://fgk.chinalaw.gov.cn/article/dffg/199409/19940900316394.shtml
Liaoning	12	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D210000187
Liaoning	13	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D210002470
Liaoning	14	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D220014453
Jilin	15	21/09/2016	http://www.pkulaw.cn
Jilin	16	21/09/2016	http://www.jlrd.gov.cn/zwgk/gzzd/201005/t20100514_717831.html

Heilongjiang	17	21/09/2016	http://www.gsfzb.gov.cn/FLFG/Print.asp?ArticleID=7682
Heilongjiang	18	21/09/2016	http://www.cnki.com.cn/Journal/G-G1-HLZB-1998-12.htm
Shanghai	19	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D310017591
Shanghai	20	21/09/2016	http://www.12333sh.gov.cn/201412333/xxgk/flfg/dfxfg/xgsrdfg/201405/t20140506_1181039.shtml
Shanghai	21	21/09/2016	http://www.shanghai.gov.cn/nw2/nw2314/nw3124/nw3134/nw3140/u6aw195.html
Jiangsu	22	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D320018955
Jiangsu	23	21/09/2016	http://www.gjxfj.gov.cn/2014-05/12/c_133327651.htm
Zhejiang	24	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D330021397
Zhejiang	25	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D330021064
Zhejiang	26	21/09/2016	http://www.cnki.com.cn/Article/CJFDTotal-ZJRG200401003.htm
Zhejiang	27	21/09/2016	http://www.tzsjs.gov.cn/Resource/ContentShow/ItemHtml/2012-02/1667094703/1258798766.html
Zhejiang	28	21/09/2016	http://www.mlr.gov.cn/zwgk/flfg/dfflfg/201206/t20120607_1107745.htm
Anhui	29	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D340022432
Anhui	30	21/09/2016	http://www.ah-n-tax.gov.cn/publicfiles/business/htmlfiles/ahtax2009/xfzc/201003/970590.html
Fujian	31	21/09/2016	http://www.pkulaw.cn
Jiangxi	32	21/09/2016	http://www.gjxfj.gov.cn/2014-05/12/c_133327638.htm
Jiangxi	33	21/09/2016	http://www.jiangxi.gov.cn/awz/ldxx/xgwj/201410/t20141013_1082468.html
Shandong	34	21/09/2016	2. http://law.lawtime.cn/d585367590461.html; 3. http://www.110.com/fagui/law_266354.html; http://www.law-lib.com/lawhtm/1992/55447.htm
Shandong	35	21/09/2016	http://www.zqxf.gov.cn/nzcms_show_news.asp?id=2910
Shandong	36	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D370012261
Henan	37	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D410029765
Henan	38	21/09/2016	http://www.pkulaw.cn
Hubei	39	21/09/2016	http://www.gjxfj.gov.cn/xffg/2009-11/24/c_1395086.htm

Hunan	40	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D430032011
Hunan	41	21/09/2016	http://www.yzxf.gov.cn/art/2008/5/14/art_836_215363.html
Guangdong	42	21/09/2016	http://www.upo.gov.cn/pages/wsbs/xfjd/1828.shtml
Guangdong	43	21/09/2016	http://www.gdep.gov.cn/zcfg/dffagui/201010/t20101014_114924.html
Guangdong	44	21/09/2016	http://www.gdwsxf.gov.cn/web/article/articleff8080814ac0a798014ac10b7ea60194.html
Guangxi	45	21/09/2016	http://www.gxfda.gov.cn/gxfdanet/difangxingfagui/11071.jhtml
Guangxi	46	21/09/2016	http://www.gxzf.gov.cn/wsjl/xfzc/xffg/201104/t20110409_286945.htm
Chongqing	47	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D500040633
Chongqing	48	21/09/2016	http://www.gsfzb.gov.cn/FLFG/Print.asp?ArticleID=3011
Chongqing	49	21/09/2016	http://www.chinalaw.gov.cn/article/fgkd/xfg/dfxfg/200906/20090600135096.shtml
Guizhou	50	21/09/2016	http://www.gzsxfj.gov.cn/zcfg/249869.shtml
Yunnan	51	21/09/2016	http://fgk.chinalaw.gov.cn/article/dffg/200309/20030900310485.shtml
Tibet	52	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D540045785
Tibet	53	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D540000545
Gansu	54	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D620048006
Gansu	55	21/09/2016	http://www.gaotai.gov.cn/zwgk/xxgk/bsflfg/2014/10/28/11573715926.html
Gansu	56	21/09/2016	http://www.gov.cn/gzdt/2006-10/09/content_407586.htm
Ningxia	57	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D640049651
Ningxia	58	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D640049392
Qinghai	59	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D630048794
Qinghai	60	21/09/2016	http://www.pkulaw.cn; 2. http://d.wanfangdata.com.cn/Claw/D630003974
Shanxi	61	21/09/2016	http://www.pkulaw.cn
Heilongjiang	62	21/09/2016	http://fgk.chinalaw.gov.cn/article/dffg/198408/19840800317842.shtml
Guizhou	63	21/09/2016	http://www.pkulaw.cn

Appendix Table 2.3: Xinfang and Firm Access Finance: Differentiating by Industrial Traits Based on Taiwan and Hong Kong Samples

This table shows the heterogeneous effects of Xinfang on firm access finance by differentiating industries by their dependence on external finance. The dependent variable is *Current liability to revenue* in columns 1-2, *Long-term liability to revenue* in columns 3-4, *Total liability to revenue* in columns 5-6 and *Trade credit to revenue* in 7-8. The key explanatory variable is the interaction term of *Xinfang* and *Dependence on external finance*. *Xinfang* is a province-year index that measures the quality of the functioning of Xinfang system. *Dependence on external finance* is calculated in the sample way as before, but with data from Taiwan and Hong Kong in 1990s. I then assign the value of 1 to an industry if it is above the median and zero if it is below. See the Table A1 in the Online Appendix for more detailed variable definitions and data sources. T-statistics calculated using clustered standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Dependent variables							
	Current liability to revenue		Long-term liability to revenue		Total liability to revenue		Trade credit to revenue	
	Mean: 0.91		Mean: 0.31		Mean: 1.26		Mean: 0.07	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Xinfang * Dependence on external finance	0.0412**	0.0292**	0.0153***	0.0103**	0.0452**	0.0630**	0.0019**	0.0023*
	[2.10]	[1.98]	[2.68]	[2.43]	[2.25]	[1.98]	[2.15]	[1.69]
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry * Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5154	5154	5154	5154	5154	5154	5154	5154
R-squared	0.459	0.459	0.366	0.366	0.472	0.472	0.569	0.569
Level of cluster	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year	Province, Industry	Pro., Ind., Year
Clusters	27, 46	27, 46, 11	27, 46	27, 46, 11	27, 46	27, 46, 11	27, 46	27, 46, 11
Specifications	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Appendix 3: Xinfang Anecdotes

Appendix 3.1: From Zhaodong City

In 2014, Ma, a resident of Zhaodong prefecture city, Heilongjiang province, filed a Xinfang case at the national Xinfang bureau, accusing a local property developer of breaching contract. The local developer started a re-development project aimed at transforming the shantytown areas of Zhaodong city in October, 2010. The developed signed a contract with local residents stating the amount of compensation for relocation during the re-development project and promised that the residents including Ma could move back in two years. However, by April, 2014, the project was still not completed and the developer owed Ma of RMB 18, 600.

The National Xinfang Bureau conducted thorough investigation and confirmed the allegation was true. The bureau urged the developer to make the compensation owed to Ma. In 2015, Ma received the correct amount of relocation allowances and the project will start as soon as possible. (Source: The National Xinfang Bureau. Retrieved from http://www.gjxfj.gov.cn/2016 04/25/c 135309 560.htm).

Appendix 3.2: From Xi'an District

In December 2015, Zhong, a resident of Xi'an district, Mudanjiang city, Heilongjiang province, filed a Xinfang case at the national Xinfang bureau, accusing a local property developer of breaching contract. The local developer started a re-development project aimed transforming the shantytown areas of Xi'an in 2012. Due to lack operating finances, the developed project was delayed.

By December 2015, the project should have been completed according to the contract. In addition, the developed also owed Zhong RMB 17, 478 relocation allowances.

The National Xinfang Bureau conducted thorough investigation and confirmed the allegation was true. The bureau urged the developer to make the compensation owed to Zhong. On 23rd, February 2016, Zhong received the correct amount of relocation allowances and the project will complete soon (Source: The National Xinfang Bureau. Retrieved from http://www.gjxfj.gov.cn/2016 04/25/c_135309 558.htm).

Appendix 3.3: From Meixian District

In November 2015, Guo, a resident of Meixian District, has filed a Xinfang case at the National Xinfang Bureau against Minglei Golf Company, accusing it of breaching contract. In 2003, Minglei Golf Company has signed a contract with Guo and other residents of Meixian District to use their land to develop a new golf court. The deal included 1,987,660 m^2 land but the developer only paid the amount worth 533,600 m^2 land of relocation allowances. Even the allowances for the 533,600 m^2 part was less than the regulations required.

The National Xinfang Bureau conducted thorough investigation and confirmed the allegation was true. The bureau urged the company firstly to pay for the difference between the amount actually paid and the amount required by the local regulations; secondly, for those unpaid land, the company has to compensate the residents according to the latest local regulation. Guo was

satisfied with the ruling results (Source: The National Xinfang Bureau. Retrieved from http://www.gjxfj.gov.cn/2016 04/25/c_135309 489.htm).

Appendix 3.4: From Bazhong City

On 28th October, 2015, Zhang, a resident of Bazhong city, Sichuan province, has filed a Xinfang case at the National Xinfang Bureau against a local property developer, accusing it of breaching contract. Specifically, in 2010, Zhang and other residents have prepaid RMB 50, 000 each for new flats developed by Seven Stars Property Development Company. However, because its legal person, Feng, had involved in illegal conduct and therefore arrested, this flat project had been stopped and Feng's company, Seven Stars Property Development Company, had also been de-registered. However, upon Feng's release, he registered a new company and re-opened the construction of the flat project. In 2013, the local government found out that this flat project did not meet certain criteria to start and Feng did not acquire necessary documents for the construction of the flats. Therefore, the project was once again put to halt.

The National Xinfang Bureau conducted thorough investigation and confirmed the allegation was true. The bureau urged the company to repay the prepaid money back to Zhang and other residents. Feng and local officials related with this project were under investigation (Source: The National Xinfang Bureau. Retrieved from http://www.gjxfj.gov.cn/2016 04/25/c_135309 483.htm).

Appendix 3.5: From Xingtang County

On 27th May, 2015, Li, a resident from Xingtang county, Hebei province, has filed a Xinfang case at the National Xinfang Bureau against a local developer, Gold Land Property Development Company, accusing it of breaching contract. Specifically, in February 2011, the Gold Land Property Development Company had approached Li and 9 other residents of Xingtang county in a bid to buy their residential land. The property company offered RMB 40,000 relocation allowances for each resident and a new flat in 18 months from then in exchange for their current residential land. Li and the other 9 residents accepted the offer and signed the contract with the developer. However, till 2015 Ma when Li started to file Xinfang cases, the residents still had not received their new flats.

The National Xinfang Bureau conducted thorough investigation and confirmed the allegation was true. The bureau urged the county government for form a special committee chaired by the county Party secretary to quickly resolve the case. The committee held several meetings where the residents, government officials and the developer had all participated. Under the supervision of the local government, the developer was requested and compensated each resident RMB 6, 000 each year for relocation fees while actively working on their new flats (The National Xinfang Bureau. Retrieved from http://www.gjxfj.gov.cn/2016 04/25/c_134900 452.htm).

Appendix 3.6: From Taizhou County

In 2003, Xu Yu, a resident of Taizhou city, Jiangsu province, filed a case at Taizhou Xinfang Bureau requesting compensation for his mother's accident. In 2001, Xu Yu's mother was paralyzed in an accident caused by a local firm. He filed a legal

case first and the court ruled in favor of him: local firm is required to pay a total amount of RMB 90,000 as compensation to his mother. However, local legal enforcement was weak, and the local firm did not pay the required amount.

Upon filing the case, the Taizhou Xinfang Bureau responded immediately by facilitating the legal enforcement. With the support and supervision of Taizhou government, Xu received the compensation within half year upon filing the Xinfang case (Source: Wu, W.D. (2009). Xinfang, relief, and legal institutions: Evidence from two Xinfang cases. Manager's Journal, 2009 (17), 166-166).

Appendix 4: Legal cases

Appendix 4.1: From Rizhao City

On 29th April, 2003, Zou and Zhang signed a contract which specified that Zou sold his land (which Zou received as relocation compensation from the local government) to Zhang for RMB 56,900. After the purchase, Zhang did not build anything on the land. In 2013, the local government gave Zou (the original owner of the land) a new flat to replace the land as relocation compensation. Zhang, upon receiving this news, thought that the new flat should be given to him instead of Zou since Zhang already purchased the land from Zou in 2003. Zou and Zhang disputed the ownership of the new flat. In the same year, Zou sued Zhang for breaching of contract (Source: http://www.court.gov.cn/zixun-xiangqing-16210.html).

Appendix 4.2: Breaching Borrowing Contract

On 31st December, 2011, Ran asked Zheng to lend him RMB 20,000 for flat purchasing. Zheng agreed. Since they know each other well, Zheng did not ask for a written contract. After six months, Ran did not return the money, and when Zheng asked for it, Ran came up with different excuses. On 6th August 2014, Zheng filed a legal case against Ran.

Appendix 4.3: Breaching Borrowing Contract

On 16th January, 2000, Li borrowed RMB 2,000 from Huang with a written borrowing contract specifying the exact terms. However, Li died unexpectedly in the same year. Li's son inherited Li's houses (five rooms). Huang thought that Li's

son should repay the debt of his father's, but he did not reach an agreement with Li's son on this debt. Huang therefore filed a legal case against Li's son.

Chapter 3: Epidemic Disease and Financial Development

3.1 Introduction

Finance plays a key role in economic development (Levine, 1997). It is thus crucial to understand why some regions have developed better financial systems than others. Existing studies have used different approaches to explain the variations in financial development across countries, such as legal systems and institutions in La Porta et al. (1997, 1998) and culture in Stulz and Williamson (2003). In their influential study, Beck, Demirgüç-Kunt and Levine (2003) propose that disease environment can also play an important role in shaping financial development. They document that the disease environment faced by colonizers affects the formation of private property rights and contract institutions, which in turn shapes financial development today.

This paper studies how the precolonial prevalence of the TseTse fly—which transmits an epidemic disease harmful to humans and lethal to livestock—influences modern financial development in Africa. In her seminal work, Alsan (2015) constructs detailed information on the distribution of the precolonial TseTse fly and discovers that the fly has impeded African economic growth through precluding large-scale agriculture and political centralization. Following this line of inquiry (Beck, et al., 2003; Alsan, 2015), I assess whether and how the TseTse fly influences modern country, firm, and household financial development and decision-making. In doing so, we add to the literature by developing a clear case of how disease can shape financial development.

There are several important reasons of using the TseTse fly setting to study the disease and finance nexus. First, as shown in Alsan (2015), detailed information on the distribution of the TseTse fly creates large enough within-country variation in epidemic exposure, which enables me to zoom in and explore how epidemic disease affects granular level financial development while controlling for the country-level institutional environment. In addition, the TseTse's non-monotonic temperature requirement for survival permits a research design that further distinguishes the impact of the fly from the pure temperature effect, thus adding strength to our identification strategy. Second, the fact that the TseTse only exists in Africa allows powerful placebo tests in places outside of Africa but physiologically suitable for the fly's survival.[20] This unique feature can help separate the impact of the TseTse from confounders

[20] As documented by Krafsur (2009), the TseTse fly is a prehistoric species and originated about 100 million years ago. Researchers also find that the TseTse fly is restricted to Africa because of climate change, continental separation, and glaciations during the late Miocene or Pliocene epoch (Lambrecht ,1964). Following Alsan (2015), my study focuses on the impact of the TseTse-transmitted *Trypanosomiasis*, a disease that is harmful to humans and lethal to livestock, on modern financial development. There are three forms of *trypanosomes* (*T. equiperdum, T. evansi* and *T. vivax*) that have spread beyond Africa during the process of European colonization (FAO 1998). However, they were not as virulent as in Africa because of the lack of a specialized vector for transmission, the TseTse fly, and a large population of wild, immune animals (Alsan, 2015).

associated with the tropical climate which have long plagued studies on the economic impact of disease (e.g., Gallup and Sachs, 2004; Kiszewski et al., 2004). Lastly, the TseTse has been described as the "greatest curse" on Africa, and the value of the continent would be substantially larger in the absence of the fly (Johnston, 1984; Alsan, 2015). It therefore warrants more scholarly attention and provides a unique setting to study the financial implication of epidemic disease.

My paper is distinct from Beck et al. (2003) in three important ways. First, I study a particular vector of epidemic disease with precise information on its geographical distribution and transmission requirements. This, combined with granular data on measures of financial development, enables a better identification strategy where I can hold both country, and in some specifications, ethnic location effects constant. Second, I examine indicators of financial development at the country level, as well as measures of access to finance at the firm and household level. This facilitates a more complete understanding on the disease-finance nexus. In addition, I explore three potential channels, namely trust, information sharing, and willingness to adopt new technology, through which the epidemic disease influences financial development today. These social norms predate the widely studied institutions established by the colonial powers in Africa and provide an alternative way of understanding African growth trajectory. Relatedly, I also examine the disease effect on internet and mobile finance penetration.

Several lines of research frame my study of how the TseTse fly shapes the modern financial markets in Africa.[21] First, ethnic groups sustain lower level of trust in the TseTse-infested areas than others, and lower level of trust, in turn, impedes the willingness of household to interact with the financial markets, and reduces the propensity of potential lenders to supply credit (e.g., Guiso, et al., 2004; 2008, Karlan, et al., 2009). As emphasized in Alsan (2015) and Diamond (1997), ethnic groups were more likely to rely on hunting and gathering versus intensive agriculture in the TseTse-infested areas since the fly transmits a lethal parasite to domesticated livestock. This subsistence strategy helped solidify and perpetuate narrow ethnic identities through limiting inter-ethnicity mixing and development of similar culture. A well-established literature suggests that people living in more ethnically fragmented society have a lower inclination to trust others (see, Alesina and La Ferrara, 2002, 2005, Costa and Kahn, 2003, Glaeser, et al., 2000).[22] I therefore hypothesize that the TseTse-infested regions suffer from a lower level of trust, with negative ramifications on financial development today. Second, the fly-induced ethnic fragmentation may have led to the

[21] We use the TseTse fly, the TseTse, and the fly interchangeably throughout the text.

[22] Communicable diseases can directly reduce the level of trust. For example, as vividly described in Boccaccio's The Decameron (1903, Rigg translation), as the death rate went higher during the Black Death, people stopped working for their patrons in Italy. The servants who had served a family for generations just left. The whole social system broke down including the multi-generational trust relationships between families, and between people and the governments.

breakdown of social cohesion, which in turn had deleterious effects on the development of information sharing institutions among diffuse ethnic groups (Easterly and Levine, 1997). As suggested by Pagano and Jappelli (1993) and Djankov et al. (2007), the lack of well-functioning information sharing systems helps perpetuate information asymmetries between lenders and borrowers, which impedes the function of financial markets. Lastly, the TseTse fly may have changed Africans' tendency to adopt new technology in infested areas. Several pieces of evidence suggest that the presence of TseTse precluded Africans from adopting domesticated animals and the associated technologies (Nash, 1969, Goody, 1971, Diamond, 1997, Gifford-Gonzalez, 2000).[23] I conjecture that the reduction in the willingness to adopt technology may persist today in the fly-infested regions, and hinders people from adopting financial technologies, such

[23] The medical camps sent by the colonial powers during the colonial period to cure and prevent the sleeping sickness, the disease transmitted by the TseTse fly, may have also contributed to the low tendency to adopt new technologies in Africa. As documented in Headrick (2014), Africans who were treated by the medical camp were often forced to get injections at gun points. The injections, which contained atoxyl, an arsenic based drug, were not effective in curing the sleeping sickness and often led to severe side effects such as blindness and death. The coverage of such medical campaigns was large in central Africa. According to Lowes and Montero (2020), in Cameroon alone, 663,971 people were examined in 1928. This experience may have led Africans to reject new medical technologies, and this, in turn, may have spilled over to other types of technologies today.

as mobile and internet finance, which represent a non-trivial proportion of modern financial services.[24]

I measure the precolonial prevalence of the TseTse fly and the associated epidemic diseases (sleeping sickness for human and nagana for livestock) using the TseTse suitability index (TSI) constructed by Alsan (2015). Alsan (2015) provides data on TSI for all ethnicity locations in Africa, and those outside of Africa but within the Tropics of Capricorn and Cancer. In particular, the TSI is the standardized value (Z-score) of the fly's steady-state population derived from insect growth modelling, gridded climate data, and geospatial data for each ethnic location. The exact functional forms linking the TseTse fly birth and death rates to climate (e.g., temperature and humidity) are derived from controlled laboratory experimentation on the fly (Bursell, 1960; Rajagopal and Bursell, 1965; Mellanby, 1937). In my country-level regressions, I use the area-weighted country average of TSI to conduct my analyses.

To preview my results, I discover that the TseTse fly has a deleterious effect on modern financial development. Countries with higher precolonial TseTse prevalence have lower private credit to gross domestic product (GDP) and deposit to GDP ratios today; in highly infested sub-national regions, firms have lower amount of bank and external financings; households are less likely to

[24] Among wage recipients, 19% receives wage through a mobile phone in Sub-Saharan Africa, while the world average is 11% (Global Findex Database, 2017).

borrow from and use financial services (i.e., credit card, mortgage). I also uncover that the TseTse fly has reduced the level of trust, the quality of information sharing institution, and the tendency to adopt new financial technology. In places with high TseTse fly prevalence, people are less trusting in general and also in financial institutions; banks are less trusting in firms; private credit bureaus have a lower coverage (as % of adult population); people have a lower tendency to learn new technologies to manage their finances. Most of these results are obtained conditional on country and year fixed effects, as well as a large vector of household/firm covariates. At the firm-level analyses, I further control for industry, and even ethnic location fixed effects in several specifications. This allows us to isolate the effect of the TseTse fly from other country/ethnicity location confounding factors, such as those associated with the colonial legacy, geography, climate, and culture.

My results are subject to concerns of omitted variable and measurement error bias.[25] The omitted variable concern is that some other variables may have jointly determined the precolonial prevalence of the TseTse fly and measures of financial development today. The sign of the bias depends on the specific omitted variable(s). The second concern is measurement error: the TSI index may capture the effect of other factors on modern development, such as the tropical climate.

[25] Reverse causality is unlikely given our explanatory variable aims to capture the precolonial prevalence of the TseTse.

I address the endogeneity concerns by exploiting two unique features of the fly: (a) the TseTse only exists in the African continent, and (b) its viability critically depends on specific, non-monotonic temperature requirement. In particular, I replicate my firm-level results at all regions in the Tropics of Capricorn and Cancer outside of Africa (i.e., the Americas and Asia Pacific).[26] If the measure of the TseTse fly is only capturing the spurious effects of tropical climate and agriculture suitability, then it should have the same predictive power in firm access to finance in other tropical areas outside of Africa. On the other hand, if the TseTse suitability index is indeed capturing the effect the fly and the associated disease, the measure should not have any predictive power outside of Africa since the TseTse is restricted to the African continent. This is what I find. The TSI does not have a statistically meaningful relationship with firm access to finance outside of Africa. Next, I re-run my firm-level analyses replacing TSI with two manipulated alternatives. Because the viability of the TseTse fly depends on non-monotonic temperature requirement, manipulating the temperature inputs in the formulas of TSI in quantitatively slight but physiologically important ways can generate useful placebo indicators. If the TSI is only capturing a temperature effect, then manipulating the temperature input up/downward slightly in the construction of the TSI should not change its predictive power in firm access to external finance. If, on the contrary, the TSI is appropriately capturing the fly and

[26] We cannot conduct the same exercise for household access to finance due to data limitations.

disease effect, these manipulated measures should not have any predictive power in firm financing patterns. This is what I discover.

To further mitigate the omitted variable concern, I test whether the negative relationship between firm access to finance today and the precolonial prevalence of the TseTse fly differs across industry in a theoretically consistent manner. This strategy allows the inclusion of ethnicity location fixed effects which eliminate any time-invariant confounding factors at the ethnic location level. Specifically, if the TseTse and the associated disease influenced trust, institution to share information, and tendency of technology adoption in ways that continue to impede the efficient financing of firms, then the relationship between the TseTse and obtaining external finance should be especially pronounced for firms that depend, for technological reasons, on external finance. I test this conjecture using the approach in Rajan and Zingales (1998) and Fisman and Love (2003) and find results consistent with my prediction.[27]

My empirical analyses are divided into five parts. I begin by documenting, for the first time, a strong and negative correlation between the precolonial

[27] In addition, we follow Oster (2019) to perform a bounding exercise. Using conservative parameters (i.e., setting maximum R-squared equal to two times of the estimated R-squared), the result suggests that selection on unobservables needs to be implausibly large (ranging from two to four times of selection on observables) to "explain away" our main results. This is robust given Oster (2019)'s threshold of one.

prevalence of the TseTse and modern financial development. To measure financial development, I use the ratios of private credit to GDP, deposit to GDP and private credit bureau coverage (% of adult population) obtained from the Global Financial Development Database. The negative relationship between the TseTse and overall financial development holds when I control for many country characteristics that are found to be important for financial development in the literature, including slave exports, legal origins, geography, natural resources and culture (e.g., Pierce and Snyder, 2018, Levine, et al., 2020, La Porta, et al., 1997, 1998, Pascali, 2016, D'Acunto, et al., 2019; Natividad, 2019). Since Alsan (2015) finds that the TseTse has a negative impact on modern economic development, I further control for GDP per capita and its growth rate. The fact that my result remains robust suggests that the TseTse fly has an independent relationship with financial development today.

The second part of my analyses focuses on the impact of the TseTse fly on the level of trust. To capture the level of trust, I consider eight different measures that gauge the degree of trust that people have in financial institutions, people in general, relatives, neighbors, courts, parliament, and the extent of trust that banks have in firms as proxied by unfavourable interest rates on loans and whether banks offer lines of credit to firms. I discover that the TseTse is strongly, negatively associated with all measures of trust. This relationship is obtained conditional on a wide range of country traits or ethnic characteristics when I include country fixed effects and is not observed in regions outside of Africa.

I examine the causal impact of the TseTse fly on firm access to external finance in the third part of analyses. I obtain firm information from the World Bank Enterprise Survey (2019). My measures of firm access to external finance are the proportions of working capital financed by banks and external creditors, respectively. After manually matching firm locations to the ethnicity map of Africa, I discover that firms in historically high TseTse prevalence regions today have smaller proportions of working capital financed by banks and external creditors. This result is obtained when conditioning on a wide range of firm characteristics and country fixed effects. To push for a causal interpretation of the results, I perform three additional sets of tests. First, I show that the result remains robust when I replace the TSI with three alternative measures of the TseTse fly prevalence, and when I consider three alternative assumptions in calculating the standard errors. Second, I perform two sets of placebo tests as discussed above: (a) I replicate my analysis in all regions covered by the Tropics of Capricorn and Cancer, and only obtain this result in Africa; and (b) I replace the TSI with slightly manipulated alternatives and do not obtain similar results. Lastly, I conduct a industrial level cross sectional exercise where I further include ethnic location fixed effects, and find that the negative impact of the TseTse is more pronounced on firms that are more reliant on external finance. Although it is difficult to eliminate the endogeneity concerns with any single set of tests, the results combined suggest that the relationship between the TseTse fly and firm financing patterns is causal.

Next, I study the impact of the TseTse fly on household finance. An influential literature demonstrates that household finance is important to

economic stability and growth (e.g., Campbell, 2006, Mian and Sufi, 2009, Mian, Rao and Sufi, 2013, Levine, et al., 2020). My measures of household financing capture: (a) the likelihood of having a debt, a credit card and a mortgage issued by financial institutions, and (b) the willingness to use services of financial institutions. These data are retrieved from World Bank's Global Financial Inclusion database. My results suggest that households in historically TseTse-infested areas are less likely to own a credit card and a mortgage, and less likely to have borrowed from financial institutions. In addition, they are less likely to use financial institutions to receive/send remittance, pay utility bills and school fees, and receive wages and government transfers. I obtain these results when conditioning a large set of household and country characteristics.

Lastly, I assess the relationship between the TseTse fly and financial technology penetration in Africa. Since the TseTse fly precluded Africans to adopt domesticated animals and its associated technologies (e.g., the plough, water power, etc.), I conjecture that the TseTse may have changed the general tendency of Africans to adopt new technologies. I test this conjecture using a newly digitized database, FinScope, which asks respondents whether they are prepared to learn new technologies to manage their money matters. I discover that in historically high TseTse-infested regions, people are less likely to be prepared to learn new technologies. This result is obtained when conditioning on country fixed effects and a large set of household and ethnic location characteristics. Further, when examining the impact on modern financial technology adoption, I find that in historically high TseTse-infested areas, household are less likely to adopt internet and mobile finance in general, and less likely to use mobile money

to receive/send remittance, pay utility bills and school fees, and receive wages and government transfers.

This paper contributes to the scant literature on disease and financial development. To the best of my knowledge, Beck et al. (2003) is the only research so far that examines the impact of disease environment on the function of modern financial systems. I advance this literature in three important fronts. First, while Beck et al. (2003) look at the general disease environment, I focus on a specific epidemic disease transmitted by the TseTse fly. I thus can trace the precise transmission environment and therefore exploit a better identification strategy. In addition, I go beyond the cross-country relationship by investigating within country, cross ethnic location variations in firm and household access to finance, as well as financial technology penetration. This facilitates a more complete understanding of the disease-finance nexus. Lastly, I look at the disease environment prior to colonization. This offers two benefits: (a) it allows us to examine channels that are independent to the institutions established by the colonial powers; and (b) it is more relevant to policymakers because epidemic diseases, without colonization, can be controlled and mitigated through effective domestic policies.

This paper is also related to an emerging, but quickly expanding literature on history and finance (see D'Acunto, 2017 for a review). A common theme in this literature is to understand various dimensions of modern financial development by exploiting historical events, such as the passage of the Public Law 280 in the United States (Brown et al., 2016), a change in the Catholic doctrine during the

Italian Renaissance (Pascali, 2016), antisemitism violence in Germany (D'Acunto et al., 2018), the slave trades in Africa (Pierce and Snyder, 2017, Levine et al., 2020), the establishment of the mining mita in Peru (Natividad, 2019), the arrival of telegraph in China (Lin et al., 2020), and the historical adoption of the plough across the developing world (An, 2020). My examination of a historical epidemic disease suggests that the long-term impact of diseases on finance, as well as on the operating mechanisms (i.e., trust, etc.), should be taken into account when designing the policies to combat infectious diseases.

3.2 Data

In this section, I describe the data used in assessing the link between the TseTse fly and modern financial development in Africa and the potential mechanisms through which the fly influences the functioning of financial systems today. My main data sources include the Global Financial Development Database (2017), the World Bank's Doing Business survey (Djankov, et al., 2007), World Development Indicators, the Global Financial Inclusion Database (2014), Afrobarometer (2008), FinScope (2016), and the World Bank's Enterprise Survey (2019). Table A1 in the Online Appendix provides detailed definition and sources of all variables, and Table 1 provides summary statistics.

3.2.1 Measures of the TseTse Fly

I obtain the measures of the precolonial prevalence of the TseTse fly from Alsan (2015). Specifically, the TseTse suitability index (TSI) is the standardized value (Z-score) of the fly's steady-state population derived from insect growth

modelling, gridded climate data, and geospatial data for each ethnicity. The exact functional forms linking the TseTse fly birth and death rates to climate (e.g., temperature and humidity) are derived from controlled laboratory experimentation on the fly. The climate data that are used to construct this measure is from the National Oceanic and Atmospheric Administration's twentieth century reanalysis version 2 (20CRv2). Alsan (2015) uses the temperature and humidity data from the earliest available year, 1871, in this database.[28] In this study, I use TSI at my ethnic location level analyses, and the area weighted country average in my country level analyses (Country_TSI).

As shown in Table 1, TSI ranges from -2.14 to 1.50 at the ethnic location level, and -2.22 to 1.37 at the country level, with larger number indicating higher precolonial prevalence of the TseTse fly. Although there are 44 countries in Alsan (2015)'s sample, I have 30 country level observations after merging with other country level control variables, which I will discuss later. There is considerable cross-country and cross-ethnic location variations in the TSI. Standard deviations are 0.83 and 0.99, respectively. Figure 1 shows the geographic distribution of the TSI in my sample, with darker colour representing higher values.

[28] Alsan (2015) shows African long-run temperature over 1500-1900 changes little using paleoclimate data from Mann et al. (2008), which eases the concern that the index might not reflect the TseTse population in precolonial Africa.

I consider five alternative measures of the TSI. Intrinsic rate of growth is calculated as the difference between the birth and death rates of the fly in the experiment-derived stead-state population. Box-plot is the box plot transformation of the steady-state population of the TseTse fly. This variable is constructed to address the negative skewness in the TSI. Optimal conditions is an indicator that equals to one if a location has above average conditions for the fly's survival and zero otherwise. It is constructed using data from Rogers and Randolph (1986). I expect Intrinsic rate of growth, Box-plot and Optimal conditions to have the same relationship with the outcome variables as TSI. The last two alternatives are Perturb TSI shift left and Perturb TSI shift right. These two are constructed by manipulating the temperature input in the TSI formulas in quantitatively slight but physiologically important ways. Specifically, the temperature input is manipulated downward by one standard deviation in Perturb TSI shift left, and one standard deviation upward in Perturb TSI shift right. I expect these two variables to have no relationship with my outcome variables, because they no longer capture the survival conditions of the TseTse fly after the manipulations. As shown in Table 1, the five alternatives exhibit substantial variations in my sample.

3.2.2 Financial Development Indicators

I use various country-, firm-, and household-based measures for financial development. At the country level, I use two bank-based cross-country indicators of financial development because banking system accounts for a large bulk of African financial institutions. Private credit to GDP equals the total amount of

credit issued by domestic money banks (commercial banks and other deposit-taking financial institutions) to the private sector as a share of GDP averaged over the 2006-2014 period. It measures the extent to which a country's savings are channeled to private sector through financial institutions. As shown in Table 1, Private credit to GDP ranges from 4.31 to 144.62%, with a sample mean of 22.61% and a standard deviation of 27.23%. Deposit to GDP equals the demand, time and saving deposits in deposit money banks and other financial institutions as a share of GDP averaged over the 2006-2014 period. If the institutions that are conducive to financial development are well developed (e.g., trust), people will have more confidence and thus deposit more in the financial system.

At the firm level, I use two measures to gauge the extent to which firms can get access to finance from the financial system. I obtain data from the World Bank's Enterprise Survey, which provides information on firm locations at the survey cluster (mostly municipality) level. This allows us to match the firm locations, using the centroid of the survey cluster, to Murdock (1967)'s ethnicity map in Africa, at which Alsan (2015) constructs the measures of the TseTse fly. The matching enables us to add country fixed effects in my regressions and thus can eliminate the country level, time-invariant confounding factors that might influence my results. In sum, 7,220 firms are matched to 68 ethnic locations in Africa. Figure 1 offers a visualization of the matching. I also geo-reference firms

outside of Africa, but within the Tropics of Capricorn and Cancer.[29] This opens the opportunity for a powerful placebo test, which will be discussed in detail later. Figure 2 and 3 shows the corresponding matchings in Americas and Asia Pacific.

I consider two firm level financial development indicators. Bank finance equals the proportion of working capital in a firm that is financed by borrowing from banks. External finance equals to the share of working capital financed by external creditors, including banks and non-bank financial institutions. As reported in Table 1, both measures exhibit substantial variations in the sample, with Working capital financed from banks ranging from 0 to 50%, and Working capital financed externally ranging from 0 to 80%.

At the household level, I use 17 indicators of household access to finance and financial technology from the World Bank's Financial Inclusion Database (2014). In particular, Borrow from financial institutions equals one if the respondent borrowed from a formal financial institution 12 months prior to the 2014 survey and zero otherwise. Credit card equals one if the respondent reports having a credit card and zero otherwise. Mortgage equals one if the respondent

[29] Unlike in Africa, only the centroids of ethnic groups are mapped outside the African continent. Following Alsan (2015)'s approach, we use these centroids to construct Thiessen polygons that approximate ethnic boundaries. This approach offers non-overlapping, and close-to real ethnic boundaries, as evidenced in a similar exercised in Africa. We then geo-match the firms in Enterprise Survey to this newly constructed ethnicity map outside of Africa.

has a loan from a bank or other types of formal financial institution to purchase a home, an apartment, or land, and zero otherwise. Internet transactions is an indicator that equals to one if the respondent has made transactions online using the internet and zero otherwise. Similarly, Mobile transactions is an indicator that equal to one if the respondent has made transactions via mobile phones and zero otherwise. I consider 12 measures that gauge the extent to which households interact with financial institutions and use mobile finance services. Remittance, Utility bills, School fees, Receive wage, Government transfers, and Agriculture payments measure whether the respondent uses financial institutions (or mobile money as indicated in specific analysis) to send/receive remittance, pay utility bills, receive wage, government transfers and agriculture related payments. They equal to one if a respondent uses these services and zero otherwise. As shown in Table 1, all variables vary substantially in my sample.

3.2.3 Mechanism Indicators

I examine trust, information sharing institution, and the tendency to adopt new technologies as three potential mechanisms through which the historical TseTse fly influences modern financial development in Africa.

I consider eight measures of trust. First, Mistrust in financial institutions is obtained from the World Bank's Financial Inclusion Database (2014). It equals to one if the respondent does not have a bank account due to lack of trust in banks and zero otherwise. I obtain the next five trust indicators from Afrobarometer (2008), which provides information on household ethnicity. My analysis can thus exploit within-country, cross-ethnic location variations in the prevalence of the

TseTse fly. In particular, Trust in most people equals to one if the respondent agrees that most people can be trusted and zero otherwise. Trust in relatives, Trust in neighbors, Trust in court and Trust in parliament measure the level of trust that respondents have in their relatives, neighbors, courts and the parliament. These four measures range from zero to three, with larger value representing a higher amount of trust. Lastly, I consider two firm-based proxies that measure the degree of trust that banks have in firms. These data are obtained from the World Bank's Enterprise Surveys (2018). Specifically, High interest equals to one if the firm reports that it did not apply loans in the past year because of unfavourable interest rates and zero otherwise. Similarly, Without line of credit equals to one if the firm reports that it does not have a line of credit and zero otherwise. Summary statistics of these indicators are presented in Table 1, and they suggest large variations across observations.

I obtain two measures of information sharing institution from the World Bank's Doing Business database (Djankov, et al., 2007). Private credit bureau equals the percentage of adult population (age above 15) covered by private credit bureaus in a country, averaged over 2006-2014. A private credit bureau is defined as a private firm or non-profit organization that maintains a database on the creditworthiness of borrowers (individuals or firms) in the financial system and facilitates the exchange of credit information among creditors. Public credit registry, similarly, equals the percentage of adult population (age above 15) covered by public credit registries in a country, averaged over 2006-2014. Public credit registries are usually managed by the central bank or the superintendent of banks and perform similar functions as the private credit bureaus (Djankov, et

al., 2007). As shown in Table 1, they range from 0 to 55.6% for Private credit bureau and 0 to 51.1% for Public credit registry, and have standard deviations of 11.16% and 10.41%, respectively.

To construct the measure of the tendency to adopt new technologies, I digitize a new database, FinScope (2016). [30] Finscope (2016) provides information on households' tendency to adopt new technologies to manage financial matters, their survey locations (at the district level) and various other features including the respondent's age, gender, education, income source and living area (urban versus rural). I match household survey locations to Murdock's (1967) ethnic maps and as a result, I have 37,182 households matched to 20 ethnic groups.[31] The matching, again, allows us to exploit within-country, cross-ethnic groups variations in the prevalence of the TseTse fly, thus eliminating any country level time-invariant confounding factors. Specifically, Prepared to learn new technology equals to one if the respondent reports that he/she is prepared to learn new technologies to manage financial matters and zero otherwise.

3.2.4 Other Country, Ethnic location, Firm, and Household Indicators

[30] FinScope surveys are initiated and conducted by FinMark Trust, an independent non-profit trust. Its purpose is to make financial markets work for the poor, by promoting financial inclusion and regional financial integration. For more details, see http://finmark.org.za/about/.

[31] The 20 ethnic groups are located in three countries, including Kenya, Ghana and Rwanda.

A large strand of literature documents that several historically determined country traits shape the function of modern financial markets. In examining the independent link between the precolonial TseTse fly and the operation of modern financial systems across Africa, I control for these key national traits.

First, Slave exports, constructed by Nunn (2008), equals to the natural logarithm of the total number of slaves exported from each country between 1400 and 1900 in the four slave trades normalized by land area. As emphasized by Lovejoy (2000), Nunn and Wantchekon (2011), Levine et al. (2020) and Pierce and Snyder (2018), enslavement in Africa created a culture of distrust that persists till today, and distrust consequently harms the functioning of financial systems by impeding both transactions among unfamiliar counterparties and intertemporal exchange. In the ethnic location level analyses, I control for a similar measure, but calculated at the ethnic location level (Nunn and Wantchekon, 2011).

Second, French legal origin equals one if a country implants laws from the French civil law traditions and zero if a country has English common law origin. All countries in my sample belong to either French or English legal families. La Porta et al. (1997, 1998) show that the quality of investor protection varies greatly across countries with different legal origins and these variations continue to shape the functioning of modern financial systems.

Third, Settler mortality equals annualized death rates faced by former European settlers in European colonies in the early 19th century. It is developed by Acemoglu, Johnson, and Robinson (2001) who argue that Europeans tend to

adopt institutions that protect property rights, enforce contracts and provide checks against government in places where environment is favourable for settlement and tend to adopt extractive institutions in places where disease and climate are not suitable for Europeans to settle. To quantify cross-country differences in the degree to which Europeans found the environment more or less familiar and hospitable, I also supplement Settler mortality with Latitude, which equals the logarithm of the absolute distance between each country and the equator.

Fourth, La Porta et al. (1999), Beck et al. (2003), Stulz and Williamson (2003), and Levine, et al. (2020) emphasize the effects of religious differences in shaping modern financial institutions. I therefore control for each country's religious composition. In particular, Catholic, Muslim, and Protestant equal the percentage of population that are Catholic, Muslim and Protestant in 1980, respectively.

Several researchers also stress that longer periods of independence from colonial rules allowed countries to develop institutions that are conducive to financial development (Easterly and Levine, 2003; Beck, et al. 2003). I therefore control for Independence, which equals the first year that a country obtained its independence. I also control for historical climate conditions to isolate the effect of TseTse fly on modern financial system. Particularly, Humid is the average of daily mean relative humidity in 1871. Temperature is the average of daily mean temperature in 1871. Relatedly, Tropical is the proportion of land area covered in the tropics. I obtain these measures from Alsan (2015).

I further control for geographical factors that might potentially confound my results. As stressed by a number of researchers, natural endowment such as geography has considerable impact on modern economic and financial institutions (Easterly and Levine, 2003; Engerman and Sokoloff, 1997). Particularly, Longitude is a country's longitude; Coastline by land area is the ratio of the length of a country's coastline to its land area; Gold, Oil and Diamonds are quantiles of gold, oil and diamonds production per capita, respectively; SI is the agriculture suitability index that measures the average land quality for cultivation within each country; Malaria index measures the contribution of regionally dominant vector mosquitoes to the force of transmission of malaria in each country.

To isolate the effects of the TseTse fly on financial development from its impact on economic development as shown in Alsan (2015), I also control for GDP per capita, which equals the natural logarithm of gross domestic product divided by total population in 2005 U.S. dollars, and GDP per capita growth, which equals the average annual growth rate of GDP per capita during 2006-2014. As reported later, my results are robust to the inclusion of these macro economy controls.

In the ethnic location level analysis, I control for Slave exports, Longitude, Latitude, SI, Malaria index, Humidity, Temperature and Tropical. These variables share the same definitions as my country level control variables, but calculated at the ethnic location level. In addition, I also include Coast, an indicator that equals to one if an ethnic location is near the coast and zero otherwise; River, an indicator that equals to one if an ethnic location has a river and zero otherwise;

Missions, which equals to one if an ethnicity had European missionary contact during the colonial period and zero otherwise, and Population density, which is the natural logarithm of population density in each ethnic location at early twentieth century. These variables are obtained from Nunn and Wantchekon (2011) and Alsan (2015).

In the household level analyses, I control for an assortment of respondent characteristics, including Gender, an indicator that equals one if the respondent is female and zero otherwise; Age, which equals respondent's age; Income, an indicator of income quintiles;[32] Education, an indicator of respondent education levels. These variables are available in all three household databases used in my analyses, including the World Bank's Financial Inclusion Database (2014), Afrobarometer (2008) and Finscope (2016). I further control for Urban, an indicator that equals to one if a respondent is living in an urban area and zero otherwise, when using Finscope (2016) and Urban, ten education fixed effects, five living conditions fixed effects, 18 religion fixed effects and 25 occupation fixed effects when using Afrobarometer (2008).

In my firm level analyses, I control for the following firm specific characteristics. Firm size is an indicator of firm's number of employees; Firm age equals the first year that a firm starts operation; Government (Foreign) is the

[32] Finscope only provides income sources. Therefore, the analyses associated with FinScope data (presented in Table 12) control for household income sources.

share of company owned by government (foreign parties), Export is the share of sales exported outside of the country; Sales growth is the median value of firms' sales growth within an industry in each year; Profit is the profit margin; Business group is a dummy variable that equals one if the firm is part of a larger company and zero otherwise; CEO experience equals the number of years of experience that a firm's CEO has.

3.3 TseTse Fly and Modern Financial Development

In this section, I assess the relationship between the precolonial prevalence of the TseTse fly and modern financial institutions across Africa. I conduct my analyses based on three different levels of financial development indicators. The country level analyses focus on overall financial development; the firm level examination emphasizes firm's access to external finance; and the household level investigation focuses on household access to finance and the use of financial technologies. Before examining the reduced-form impact of the TseTse on financial development, I also present evidence on the potential mechanisms that link the TseTse fly to the function of modern financial markets.

3.3.1 TseTse Fly and Overall Financial Development

I begin by presenting graphical evidence on the relationship between the TseTse fly and overall financial development in Africa today. Figure 4 and 5 show the scatter plots between the country level TSI, and Private credit to GDP and Deposit

to GDP, respectively. These figures suggest that the TseTse fly has a strong, negative correlation with modern financial development in Africa.

Next, I use cross-country, ordinary least squares (OLS) regressions to further investigate the relationship between the TseTse fly and the overall financial development. Specifically, I use the following regression specification:

$$Outcome_c = \alpha + \beta Country\_TSI + \Gamma X_c' + \varepsilon_c \quad (1)$$

where the dependent variable, $Outcome_c$, is either Private credit to GDP, Deposit to GDP, Private Credit Bureau, or Public Credit Registry. The key explanatory variable is $Country\_TSI$ from country c. X_c' is a vector of country level control variables. In most specifications, I control for Slave exports, French legal origin, Settler mortality, Malaria index, SI, Humidity, Temperature, Latitude, Longitude, Tropical, Independence, Coastline by land area, Catholic, Muslim, Protestant, Gold, Oil, Diamond, the Colonizer indicators, and an interaction between Humidity and Temperature. All variables are defined in Section 2 and Online Appendix Table A1. In several specifications, I additionally control for GDP per capita and GDP per capita growth. My coefficient of interest is β, which measures the relationship between the TseTse fly and modern financial development. I use robust standard errors that allow heteroskedasticity in this specification. I summaries my results in Table 2.

As reported in Table 2 Panel A, $Country\_TSI$ is strongly, negatively associated with financial development today when either using Private credit to GDP or Deposit to GDP. For example, consider the Private credit to GDP regressions. $Country\_TSI$ enters all regressions negatively and significantly at

one percent level and the estimated coefficients are economically large. If Benin, which is roughly at the 75th percentile of the cross-country distribution of the TSI (0.479), were to move to the 25th percentile (-0.743), the coefficient estimate from column (2) implies that Private credit to GDP would surge by roughly 50%, from 19.702 to 29.75%. The increase is equivalent to a half of my sample mean. Furthermore, the results are robust when conditioning on GDP per capita and GDP per capita growth in column (3), suggesting that the TseTse fly has an independent impact on modern financial development other than through economic development. The TseTse effect on Deposit to GDP is smaller (around 40% of the impact on Private credit to GDP), but still economically significant.

In Table 2 Panel B, I present the results on information sharing institutions. I find that $Country\_TSI$ is strongly, negatively associated with private credit bureau coverage, but not with public credit registry development. This is consistent with my proposed long-term mechanism that the TseTse has reduced interpersonal trust and the tendency to share information with unfamiliar parties in the infested regions since the precolonial period. This impact therefore should only apply to private parties, and not to government agencies. Because public credit registries are initiated and managed by government agents, and are a rather recent phenomenon (relative to precolonial time), I do not expect the TseTse to have a material impact on its coverage. The impact of the TseTse on private credit bureaus coverage is economical large. For example, consider the estimates in column (2). If I were to move Benin from the 75th percentile of the TSI distribution to the 25th percentile (from 0.479 to -0.743), the coefficient estimate from column (2) suggests that Private Credit Bureau coverage (% of

adult population) would jump by 19.818 percentage points, more than four times of the sample mean. Similarly, the results are robust when including GDP per capita and GDP per capita growth as control variables in column (3), suggesting that the TseTse influenced modern information sharing systems other than through economic development.

3.3.2 TseTse Fly and Trust

This section assesses the impact of the TseTse fly on household trust in financial institutions, trust in general, and bank trust in firms. I exploit cross country variations in the TseTse fly prevalence when examining household trust in financial institutions, and cross ethnic location variations in the TseTse prevalence when assessing trust in general and bank trust in firms.

3.3.2.1 TseTse Fly and Household Mistrust in Financial Institutions

I use household level, OLS regressions to investigate the relationship between the precolonial prevalence of the TseTse fly and household trust in financial institutions today. Specifically, I use the following regression specification:

$$Outcome_{i,c} = \alpha + \beta Country\_TSI + \Gamma X_c' + \Lambda X_i' + \varepsilon_{i,c} \quad (2)$$

where the dependent variable, $Outcome_{i,c}$, is Mistrust in financial institutions for household i in country c. I use OLS regressions because they produce quantitatively similar results to a probit model, but easier to interpret (Angrist and Pischke, 2008), although the dependent variables are binary. With respect to the explanatory variables, $Country\_TSI$ and X_c' —are the same as those used in

equation (1). X_i' is a vector of household controls variables, including Education, Income, Gender, Age and Age squared. All variables are defined in Section 2 and Table A1 in the Online Appendix. My coefficient of interest is β, which measures the relationship between the TseTse fly and household mistrust in financial institutions. I cluster the standard errors at the country level.

As shown in Table 3, $Country\_TSI$ is strongly, positively associated with household trust in financial institutions. $Country\_TSI$ enters all regressions significantly at one percent level and the estimated coefficients are economically large. For example, consider the estimates in column (1). Using the same thought experiment, if I were to move Benin from the 75th to the 25th percentiles on the country level TSI distribution, the likelihood that a household reports not trusting the financial institutions would decrease by nearly 47 percentage points, more than three times of the sample mean. This relationship is not driven by household with low education levels. In fact, as shown in column (2) and (3), respondents with higher education level experience stronger impact of the TseTse fly.

3.3.2.2 TseTse Fly and Trust in General

In examining the impact of the TseTse fly on trust in general, I exploit the within country, cross ethnic location variation on the fly prevalence, using the following OLS regression:

$$Outcome_{i,e,c} = \alpha + \beta TSI_e + \gamma X_e' + \Lambda X_i' + \Psi_c + \varepsilon_{i,e,c} \quad (3)$$

where the dependent variable, $Outcome_{i,e,c}$, is either Trust in most people, Trust in relatives, Trust in neighbors, Trust in courts, and Trust in parliament, for

household respondent i, in ethnic location e, and country c. The key explanatory variable is TSI_e, the TseTse suitability index calculated at the ethnic location level. Regarding other explanatory variables, X'_e is a vector of ethnic location controls variables, including Slave exports, Longitude, Latitude, SI, Mean relative humidity, Mean average temperature, Tropical, Coast, River, Malaria index, and Missions. X'_i is a set of household respondent characteristics, including a gender indicator, a live-in-an-urban-area indicator, age, age squared, ten education fixed effects, five living conditions fixed effects, 18 religion fixed effects, and 25 occupation fixed effects. Because I are exploiting the within country variations in the TseTse fly suitability index, I also include country fixed effects, represented by Ψ_c. All variables are defined in Section 2 and Table A1 in the Online Appendix. My coefficient of interest is β, which measures the relationship between the TseTse fly and various measures of trust. I cluster the standard errors at the ethnic location level.

I present my results in Table 4. TSI_e enters all regressions with negative coefficients that are significantly at least at five percent level. This suggests that households sustain lower trust in general in historically highly infested subnational regions. The estimated effect size is economically non-trivial. For example, consider the coefficients in column (1), where my dependent variable is Trust in most people. A one standard deviation increase in the TSI_e (0.99) would reduce the probability that an average respondent agrees with that most people can be trusted by 3.1 percentage points. This reduction is 18.75% of the sample mean.

3.3.2.3 TseTse Fly and Bank Trust in Firms

I next examine the relationship between the TseTse fly and measures of bank trust in firms. In particular, I use the following OLS specification:

$$Outcome_{f,s,e,c} = \alpha + \beta TSI_e + \gamma X'_e + \delta X'_f + \Psi_c + \eta_s + \omega_y + \varepsilon_{f,s,e,c} \quad (4)$$

where the dependent variable, $Outcome_{f,e,c}$, is either High interest or Without line of credit, for firm f, in industry s, ethnic location e, and country c. The key explanatory variable is TSI_e, the TseTse suitability index constructed at ethnic location level. Similar to equation (3), X'_e is a vector of ethnic location controls variables, including Slave exports, Longitude, Latitude, SI, Mean relative humidity, Mean average temperature, Tropical, Coast, River, Malaria index, and Missions. X'_f includes a number of firm characteristics, including Firm size, Firm age, Sales growth, State, Foreign, Exports, Profit, CEO experience and Business group. Since I are focusing on the within country, cross ethnic location variations in the TseTse fly suitability index, I include country fixed effects, Ψ_c, in addition to survey year fixed effects, ω_y, and industry fixed effects (at the three digit ISIC level), η_s. I cluster the standard errors at the ethnic location level. All variables are defined in Section 2 and Table A1 in the Online Appendix. Same to previous analyses, my coefficient of interest is β.

As reported in Table 5, TSI_e is strongly, positively linked to measures of bank trust in firms. The coefficients of TSI_e are significant at least at five percent confidence level. This suggests that firms in historically high TseTse prevalence subnational regions receive less trust from banks, compared to otherwise similar

firms but located in low prevalence areas. The economic magnitude of my estimate is large. Consider the coefficients in column (4), my most conservative estimate. It suggests that a one standard deviation increase the TSI_e would boost the probability of firms reporting facing unfavourably high interest rates by almost 6 percentage points. This increase represents 43% of my sample mean.

I perform a large number of robustness and placebo tests to aid a causal interpretation of this finding, after presenting results on firm access to finance in the next subsection.

3.3.3 TseTse Fly and Firm Access to Finance

After presenting evidence on the relationship between the TseTse fly and trust, I investigate the TseTse impact on firm access to finance in this section. I begin my analyses by exploiting the cross ethnic location regressions with country fixed effects. I then present two sets of placebo and robustness tests to facilitate a causal interpretation of the results. Lastly, I perform a large set of cross-sectional tests, in which I also include ethnic location fixed effects, to further push for causality.

3.3.3.1 Evidence from Country Fixed Effects Regressions

I start by using equation (4) to estimate the relationship between the TseTse fly and firm access to external finance. In particular, the dependent variable, $Outcome_{f,e,c}$, is either Bank finance or External finance. The key explanatory variable is TSI_e, the TseTse suitability index calculated at ethnic location level.

Bank finance equals the proportion of working capital in a firm that is financed by borrowing from banks. External finance equals to the share of working capital financed by external creditors, including banks and non-bank financial institutions. On average, Bank finance represents 28% of External finance in my sample. All control variables remain the same and are defined in Section 2 and Table A1 in the Online Appendix. I cluster the standard errors at the ethnic location level.

As tabulated in Table 6, TSI_e is strongly, negatively associated with bank access to finance. The coefficients of TSI_e are significant at one percent confidence level across all regressions. This suggests that firms located in high TseTse-infested subnational places have less access to finances from banks and other external creditors than otherwise similar firms in low prevalence areas. The economic size of my estimate is substantial. Consider bank finance column (2). The estimate suggests that a one standard deviation increase the TSI_e would squeeze firm access to banking finance by about 8.31% percentage points, representing more than a half of the standard deviation of Bank finance in my sample.

Although I include country fixed effects in my specifications, my results are still subject to concerns of omitted variable and measurement error bias. The omitted variable concern is that some other variables may have co-determined the precolonial prevalence of the TseTse fly and measures of firm access to finance today. The measurement error concern is that the TSI index may capture

the effect of other factors on modern development, such as the tropical climate. I address these concerns in the next sections.

3.3.3.2 Placebo Tests in Americas and Asia Pacific

My first step to address the endogeneity concerns is to exploit a unique feature of the TseTse fly: it only exists in the African continent. A large amount of land areas covered by the Tropics of Capricorn and Cancer satisfy the requirements of the TseTse survival (i.e., tropical climate, temperature, humidity, etc.), but the TseTse is restricted to Africa due to geo-climate factors, such as climate change, continental drift and glacier advances (Lambrecht, 1964). This exogenous TseTse treatment on Africa creates an opportunity to perform a powerful placebo test. In particular, I replicate my firm level analyses in regions outside of Africa, but within the Tropics of Capricorn and Cancer (i.e., the Americas and Asia Pacific), using equation (4). The construction of the TSI for ethnic locations in these tropical regions is the same as for ethnic groups within Africa. Since the TseTse only exists within the African continent, I call the TseTse suitability index outside of Africa Pseudo TSI.

If the measure of the TseTse fly is only capturing the effects of factors associated with the tropical climate in Africa, then I expect the Pseudo TSI to have the same predictive power in tropical areas outside of Africa. On the other hand, if the TseTse suitability index is indeed capturing the effect of the fly and the associated disease, the Pseudo TSI should not have any predictive power outside of Africa. I tabulate my results in Table 7.

As reported in Table 7, Pseudo TSI does not have statistically meaningful relationships with measures of firm access to finance, and measures of bank trust in firms in tropical regions outside of Africa. This result suggests that the TSI, constructed for African ethnic groups, does not only capture the impact of the factors associated with the tropical climate (such as agriculture suitability, temperature, humidity, rainfall, etc.), but also the prevalence of the TseTse fly.

3.3.3.3 Placebo Tests within Africa

Next, I turn to a set of placebo tests within the African continent. In particular, I exploit another unique feature of the TseTse fly. That is, its viability critically depends on specific, non-monotonic temperature requirement. This suggests that if I manipulate the temperature inputs in the TSI formula in a quantitatively slight but physiologically important way, the index will no longer meet the requirement for the TseTse to survive. As a result, the manipulated TSI will no longer have the predictive power in my measures of firm access to finance and bank trust in firms. However, this prediction is based on the premise that the original TSI accurately captures the prevalence of the fly. If, on the contrary, the relationship between the original TSI and my outcome variables is just a reflection of some spurious correlation due to omitted variables, then slightly changing the temperature input in the TSI formula would not change such spurious relationship.

To test these predictions, I use equation (4). Specifically, I replace the original TSI with two perturbed alternatives. Perturb TSI shift left is obtained by decrease the temperature input in the TSI formula by one standard deviation

(about 3°C), while Perturb TSI shift Right is obtained when increasing the temperature input by one standard deviation. My results, using the manipulated indices, are presented in Table 8.

As presented in Table 8 column (1) and (2), none of the perturbed indices has any predictive power in measures of firm access to external credits and measures of bank trust in firms. This is consistent with my argument that the TSI is indeed capturing the effect of the TseTse fly.

3.3.3.4 Alternative TseTse Measures and Clustering Strategies

I consider three alternative measures of the TSI. Intrinsic rate of growth is constructed as the difference between the birth and death rates of the TseTse fly. Birth and death rates are derived from insect growth modelling, gridded climate data, and geospatial data for each ethnicity (Alsan, 2015). Because the TSI has a negatively skewness, Box-plot is constructed as the box plot transformation of the steady-state population of the fly. In addition, Optimal conditions is an indicator that equals to one if an ethnic location has above average conditions for the fly's survival and zero otherwise (Rogers and Randolph, 1986). I expect the Intrinsic rate of growth, Box-plot and Optimal conditions to have the same relationship with the outcome variables as TSI. The results, using these alternative measures, are presented in Table 8 column (3)-(5), respectively.

I also consider three alternative clustering strategies. First, I calculate results using Conley (1999) standard errors to account for spatial correlation with cut-offs of 10° latitude and 10° longitude. Second, I cluster my standard

errors at the country level to allow for within country correlations among observations. Lastly, I cluster standard errors at both the country and the ethnic location levels using a multiway clustering method developed by Cameron, Gerlach, and Miller (2011). This is a viable clustering strategy in Africa since some ethnic locations are divided by national borders. The results are tabulated in Table 8 column (6)-(8), respectively. As shown in Table 8, my results are robust to these robustness tests.

3.3.3.5 TseTse fly and Firm Access to Finance: Differentiating by Industry

I next examine whether the negative relationship between the precolonial prevalence of the TseTse fly and firm access to finance today differs across industries in a theoretically consistent manner. This strategy allows us to include ethnic location fixed effects which further alleviate the omitted variable concern. Particularly, if the TseTse fly and the associated disease influenced trust and institution to share information in ways that continue to impede firm access to finance, then the relationship between the fly and firm ability to borrow from external creditors should be more pronounced in industries that are more reliant on external finance for technological reasons.

I consider two measures that gauge the extent to which an industry "technologically" depends on external finance. The first measure, external finance dependence (EFD), is obtained from Rajan and Zingales (1998). They calculate it as the industry median share of capital expenditures not financed with internally generated cash flows in the United States during 1980s. Rajan and Zingales (1998)

argue that using U.S. data to construct this measure is appropriate since the U.S. financial markets are relatively frictionless and thus can more accurately represent the "technological" nature of the finance dependence. I use EFD_RZ, an indicator that equals one if an industry has above-median value of the EFD and zero otherwise. This helps us interpret the results. My second measure is obtained from Fisman and Love (2003). They calculate the measure of dependence on external finance as the industry median share of total assets not financed by retained earnings. Fisman and Love (2003) argue that while the measure of Rajan and Zingales (1998) captures the "flow" component of firm dependence on externa finance, their measure captures the "stock" part. Similarly, I use EFD_FL, an indicator that equals one if an industry has above-median value of the dependence on external finance variable constructed by Fisman and Love (2003) and zero otherwise.

I use the following regression specification to investigate the relationship between firm financing and the TseTse fly while differentiating by industry:

$$Outcome_{f,s,e,c} = \alpha + \beta TSI_e * EFD_s + \delta X_f' + \Psi_c + \theta_e + \eta_s + \omega_y + \varepsilon_{f,s,e,c} \quad (5)$$

where the dependent variable, $Outcome_{f,e,c}$, is either Bank finance or External finance, for firm f, in industry s, ethnic location e, and country c. The key explanatory variable is the intersection between TSI_e and EFD_RZ or EFD_FL. X_f' includes the same set of firm control variables, including Firm size, Firm age, Sales growth, State, Foreign, Exports, Profit, CEO experience and Business group. I include ethnic location fixed effects θ_e, in addition to country fixed effects, Ψ_c, survey year fixed effects, ω_y, and industry fixed effects (at the three digit ISIC

level), η_s. As a result of including these fixed effects, TSI_e and EFD_s are subsumed and thus dropped from the equation. I cluster the standard errors at the ethnic location level. All variables are defined in Section 2 and Table A1 in the Online Appendix.

As reported Table 9, the relationships between the TseTse fly and measures of firm access to finance vary across industries in a manner that is fully consistent with my theoretical prediction elaborated above. Specifically, $TSI_e * EFD_s$ enters negatively and significantly in all regressions, when my dependent variable is either Bank finance or External finance. This suggests that the relationship between the TseTse fly and firm access to external financing is especially strong in industries that rely heavily on funding from financial institutions. Regarding the magnitude, consider the estimates in column (4) of Table 9. The coefficient suggests that a one standard deviation increase the TSI_e would reduce external financing for industries that are more dependent on external finance by an additional 1.09 percentage point relative to industries that are less reliant on external credit. The effect size is economically non-trivial since it represents nearly 16% of my sample mean. Thus, the relationship between the precolonial prevalence of the TseTse fly and firm financing patterns today holds more strongly in industries that depend heavily, for technological reasons, on funding from bank and other external creditors, which is consistent with the view that the TseTse fly had enduring, deleterious influence on the operation of modern financial systems.

3.3.4 TseTse Fly and Household Finance

I next assess the relationship between the TseTse fly and various measures of household finance. A well-established literature shows that household finance is critical to economic stability and development (e.g., Campbell, 2006, Mian and Sufi, 2009, Mian, Rao and Sufi, 2013, Levine, et al., 2020). To do so, I use equation (2), which exploits cross-country variations in the TseTse suitability index. In particular, $Outcome_{i,c}$, is either Borrowed from financial institutions, Credit card or Mortgage in Table 10, and Remittance, Utility bills, School fees, Receive wage, Government transfers or Agriculture payments in Table 11. All explanatory variables, including the $Country\_TSI$ and control variables, are unchanged. I cluster the standard errors at the country level.

As reported Table 10, the $Country\_TSI$ enters all regressions negatively, and statistically significant at least at five percent level. This suggests that the TseTse fly is negatively associated with household financing today. This relationship is not affected by household income levels. If anything, higher income households are more affected by the TseTse fly. With respect to the economic sizes of the estimated coefficients, consider column (1) of Table 10 where my dependent variable is Borrow from financial institutions. The estimates imply that a one standard deviation increase in the country level TSI would reduce the probability that an average household borrows from financial institutions by about 6%. This is economically large given my sample mean is only 7%.

Table 11 shows the TseTse impact on household usage of financial institutions. The $Country\_TSI$ enters all regressions negatively, and statistically significant at 1% level, except for Receive wage. This indicates that the TseTse fly is negatively related to household using financial institutions to send/receive remittances, pay utility bills and school fees and receive government transfers as well as agriculture payments. In sum, the evidence presented in Table 10 and Table 11 suggest that the relationship between the precolonial prevalence of the TseTse fly is powerfully related to the current degree to which households borrow from formal financial institutions and use financial institutions for transactions.

3.3.5 TseTse Fly and the Tendency to Adopt Technology

I conjecture that the TseTse fly may have changed Africans' tendency to adopt new technology in infested areas. Many scholars stress that the precolonial prevalence of the TseTse fly precluded Africans to adopt domesticated animals and the associated technologies (Nash, 1969, Goody, 1971, Diamond, 1997, Gifford-Gonzalez, 2000). I hypothesize that the TseTse-induced reduction in people's willingness to adopt technology may persist till today and hinders household from adopting new financial technologies, such as mobile and internet finance. In this section, I test this conjecture using the equation (3), where I exploit within country, cross ethnic location variations in the TseTse suitability index. Particularly, $Outcome_{i,e,c}$, is Prepared to learn how to use new technology on money matters, for household respondent i, in ethnic location e, and country

c. The key explanatory variable is TSI_e, the TseTse suitability index calculated at the ethnic location level. X_e' is a vector of ethnic location controls variables, including Slave exports, Longitude, Latitude, SI, Mean relative humidity, Mean average temperature, Tropical, Coast, River, Malaria index, and Missions. X_i' is a vector of respondent characteristics, including a gender indicator, a live-in-an-urban-area indicator, age, age squared, seven education fixed effects, and nine income sources fixed effects. Ψ_c represents country fixed effects. All variables are defined in Section 2 and Table A1 in the Online Appendix.

As tabulated in Table 12, TSI_e is strongly, negatively associated with the degree to which people are prepared to learn new financial technologies. The coefficients of TSI_e are significant at one percent level across all regressions. This suggests that households' tendency to adopt new financial technologies are negatively related to the TseTse fly. Further, this relationship is robust in both urban and rural areas. The economic size of my estimate is large. Consider the estimates in column (1) of Table 12. The coefficient of TSI_e suggests that a one standard deviation increase the TSI_e would reduce the likelihood of an average respondent's tendency to learn new financial technologies by about 37 percentage points, which is equivalent to half of my sample mean (74%).

3.3.6 TseTse Fly and Financial Technology Penetration

Lastly, I examine the relationship between the TseTse fly and measures of financial technology adoption. In particular, I use equation (2), which uses the cross-country variations in the TSI. $Outcome_{i,c}$, is either Internet transactions or

Mobile transactions in Panel A of Table 13, and Remittance, Utility bills, School fees, Receive wage, Government transfers or Agriculture payments in Panel B. All explanatory variables, including the $Country\_TSI$ and control variables, are unchanged. I cluster the standard errors at the country level.

As reported Table 13 Panel A, the $Country\_TSI$ enters all regressions negatively, and statistically significant at one percent level. This suggests that the TseTse fly is negatively related to household adoption of new financial technologies today. This relationship is obtained in both high- and low-income households. If anything, higher income households are much more influenced by the TseTse fly. Regarding economic sizes of the coefficients, consider column (4) of in Panel A where my dependent variable is Mobile transactions. The estimates suggest that a one standard deviation increase in the $Country\_TSI$ would reduce the probability that an average household adopts mobile finance by nearly 21 percentage points, very close to the standard deviation of Mobile transactions in my sample (24%).

Panel B of Table 13 shows the TseTse impact on household usage of mobile money. The $Country\_TSI$ enters all regressions negatively, and statistically significant at 1% level. This is consistent with the view that the TseTse fly is negatively associated with household adoption of financial technologies. In particular, in high TseTse-infested countries, household are less likely to use mobile money to send/receive remittances, pay utility bills and school fees, receive wage, and receive government transfers as well as agriculture payments.

In sum, the evidence presented in Table 13 suggest that the precolonial prevalence of the TseTse fly has a profound, negative impact on household adoption of financial technologies. Based on results from Table 12, this negative impact is likely operating through the reduced general tendency to adopt new technologies.

3.4 Conclusion

In this paper, I study the impact of the historical TseTse fly and its associated disease on modern financial development. I provide original evidence that the TseTse fly has a deleterious effect firm and household access to external financing, and financial technology penetration in Africa. I also discover that the negative impact of the TseTse is likely operating through a reduction in the level of trust, the quality of information sharing institution, and the tendency to adopt new technology.

My paper advances the literature that studies the relationship between disease and finance. While the existing research mostly focuses on cross-country analyses (Beck, et al., 2003), I go beyond the cross-country relationship by investigating within country, cross ethnic location variations in firm and household access to finance, as well as financial technology penetration. This helps shed broader light on how disease influences modern financial markets. By focusing on a specific kind of disease (nagana), I exploit the precise transmission requirements and employ a better identification strategy. By focusing on the disease environment during a precolonial period, I emphasize, and provide

evidence on channels through which diseases influence modern finance, other than institutions developed by the colonizers.

My paper is also timely and relevant to policymakers faced with challenges in combating large scale infectious disease. By showing that communicable diseases have deleterious effects on trust, information sharing institutions, the tendency to adopt technologies, and ultimately the function of financial markets, I highlight the long-term damage of communicable diseases. My results are thus relevant to policymakers when considering the policies to combat infectious diseases.

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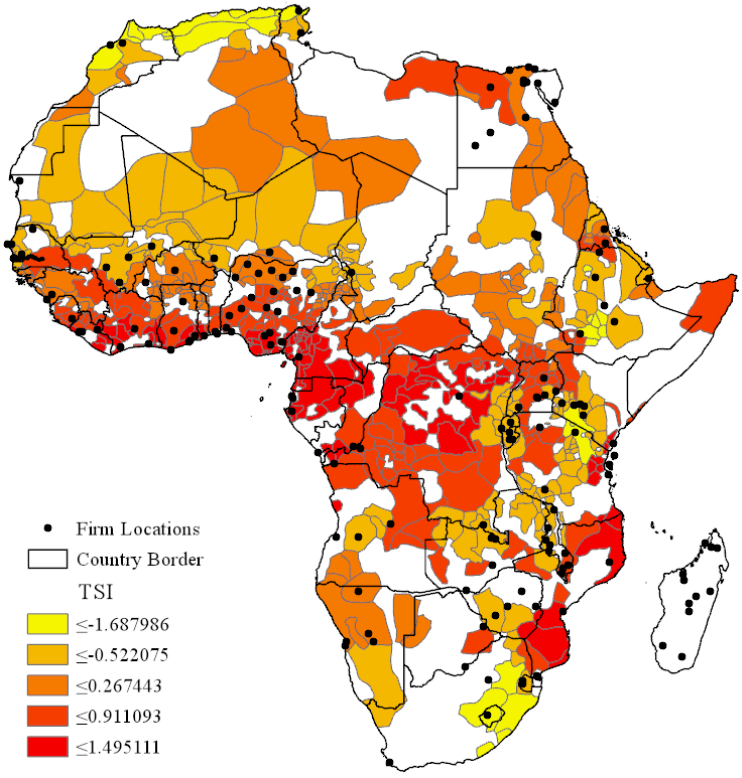
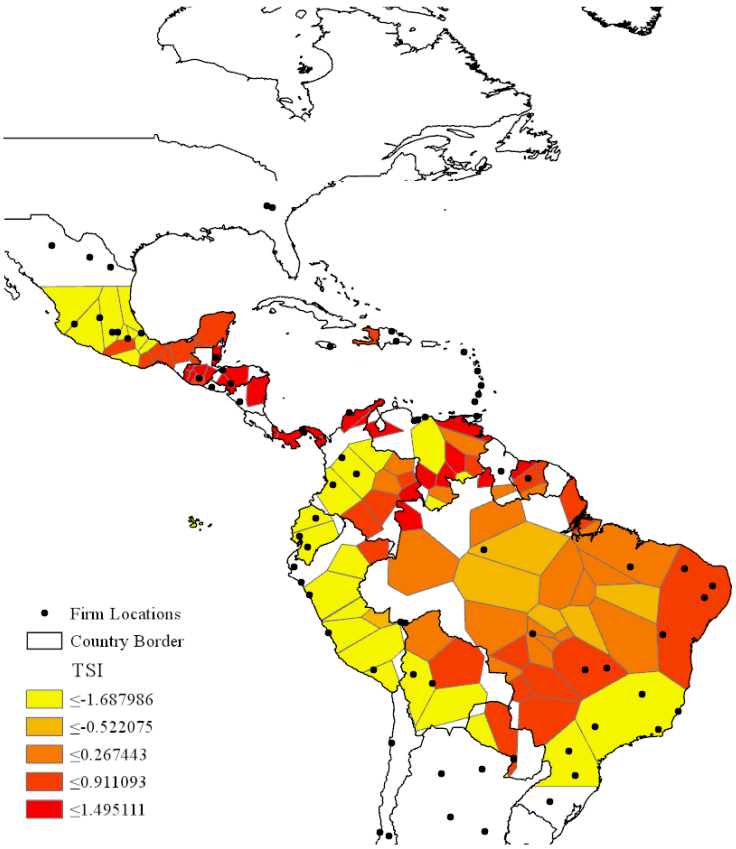
Figure 3.1: Firm locations and ethnicity-level TSI in Africa



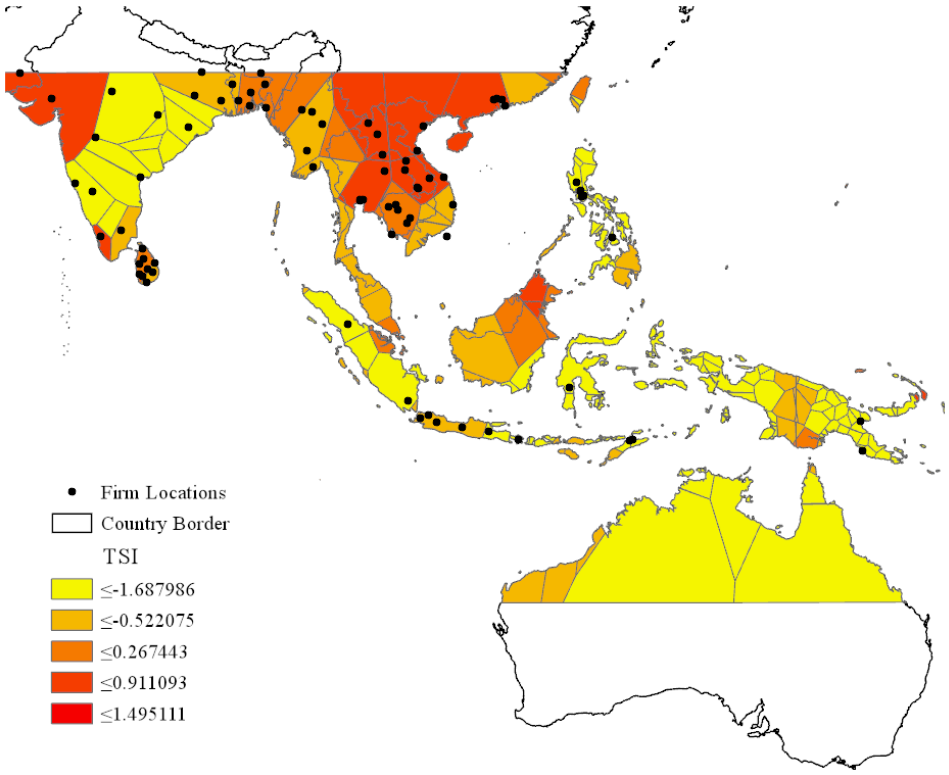
Notes: This figure shows geo-matched firm locations from the World Bank Enterprise Surveys during 2006-2018 and the geographic distribution of ethnicity-level TseTse fly index (TSI) in Africa. Darker (red) colour corresponds to higher prevalence of the TseTse fly. TSI is obtained from Alsan (2015).

Figure 3.2: Firm locations and ethnicity-level TSI in Americas



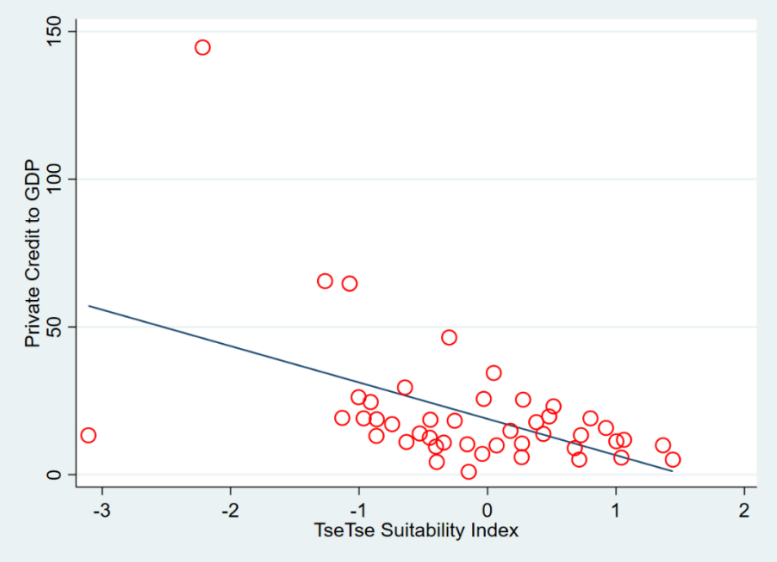
Notes: This figure shows geo-matched firm locations from the World Bank Enterprise Surveys during 2006-2018 and the geographic distribution of ethnicity-level TseTse fly index (TSI) in Americas. Ethnicity boundaries are drawn using Thiessen polygons based on ethnic location coordinates. Darker (red) colour corresponds to higher prevalence of the TseTse fly. TSI is obtained from Alsan (2015).

Figure 3.3: Firm locations and ethnicity-level TSI in Asia Pacific



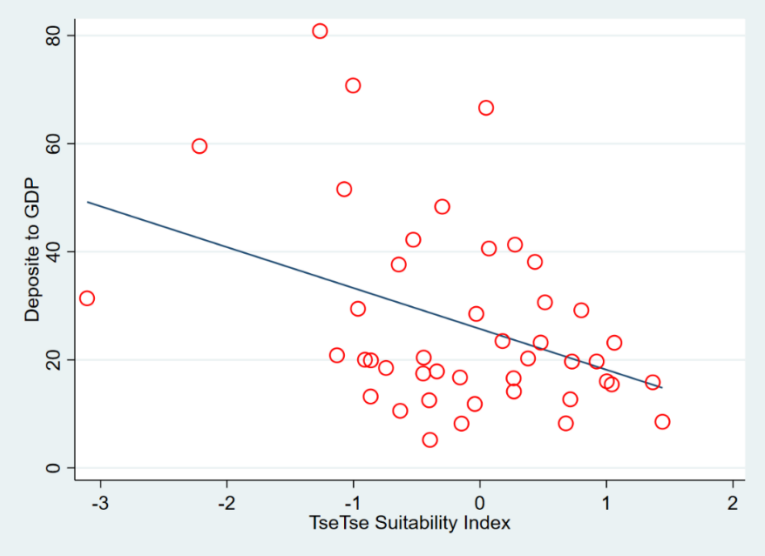
Notes: This figure shows geo-matched firm locations from the World Bank Enterprise Surveys during 2006-2018 and the geographic distribution of ethnicity-level TseTse fly index (TSI) in Asia Pacific. Ethnicity boundaries are drawn using Thiessen polygons based on ethnic location coordinates. Darker (red) colour corresponds to higher prevalence of the TseTse fly. TSI is obtained from Alsan (2015).

Figure 3.4: TSI and private credit to GDP



Notes: This figure shows the scatter plot between country-level TseTse fly index (TSI) and the average ratio of private credit to GDP over 2006-2015. TSI is obtained from Alsan (2015), while private credit to GDP is from Global Financial Development Database (2017).

Figure 3.5: TSI and deposit to GDP



Notes: This figure shows the scatter plot between country-level TseTse fly index (TSI) and the average ratio of deposit to GDP over 2006-2015. TSI is obtained from Alsan (2015), while deposit to GDP is from Global Financial Development Database (2017).

Table 3.1: Summary statistics

Variable	N	Mean	SD	Min	Median	Max
Country-level variables						
Private credit to GDP	30	22.61	27.23	4.31	14.40	144.62
Deposit to GDP	30	25.94	18.01	5.20	19.81	80.85
Private credit bureau	30	4.44	11.16	0.00	0.00	55.6
Public credit registry	30	4.27	10.41	0.00	0.95	51.1
Country_TSI	30	-0.13	0.83	-2.22	-0.19	1.37
Slave exports	30	4.53	3.28	-2.30	5.36	8.82
French legal origin	30	0.70	0.47	0.00	1.00	1.00
Settler mortality	30	5.50	1.14	2.74	5.63	7.99
Malaria index	30	11.62	8.94	0.06	10.54	30.65
SI	30	0.44	0.19	0.10	0.51	0.69
Latitude	30	12.45	10.35	0.20	11.00	36.00
Tropical	30	0.83	0.38	0.00	1.00	1.00
Independence	30	52.37	23.19	31.00	46.00	151.00
Coastline by land area	30	-0.74	2.59	-4.61	-0.01	4.53
Humid	30	71.37	10.75	41.00	72.50	87.00
Temperature	30	24.57	3.09	17.96	25.05	28.64
Longitude	30	11.22	17.09	-15.38	10.68	39.62
Gold	30	2.57	1.10	1.00	3.00	4.00
Oil	30	1.80	1.27	1.00	1.00	4.00
Diamonds	30	2.23	1.38	1.00	1.00	4.00
British colonizer	30	0.33	0.48	0.00	0.00	1.00
French colonizer	30	0.53	0.51	0.00	1.00	1.00
Catholic	30	20.68	23.79	0.10	11.25	78.30
Muslim	30	43.49	37.23	0.00	35.95	99.40
Protestant	30	9.72	12.68	0.00	4.25	50.00
GDP per capita growth	30	2.37	2.07	-2.35	2.09	7.68
GDP per capita (2005 US$)	30	1819.60	2045.06	232.26	1008.21	9077.19
Individual-level variables from Global Financial Inclusion						
Mistrust in financial institutions	17402	0.13	0.34	0.00	0.00	1.00
Borrowed from financial institutions	23862	0.07	0.25	0.00	0.00	1.00
Credit card	23569	0.03	0.17	0.00	0.00	1.00
Mortgage	23768	0.06	0.24	0.00	0.00	1.00
Internet transactions	23862	0.03	0.16	0.00	0.00	1.00
Mobile transactions	23862	0.06	0.24	0.00	0.00	1.00
Remittance (via banks)	23862	0.10	0.30	0.00	0.00	1.00
Utility bills (via banks)	23862	0.02	0.15	0.00	0.00	1.00
School fees (via banks)	23862	0.04	0.19	0.00	0.00	1.00
Receive wage (via banks)	23862	0.08	0.28	0.00	0.00	1.00
Government transfers (via banks)	23862	0.03	0.17	0.00	0.00	1.00
Agriculture payments (via banks)	23862	0.02	0.15	0.00	0.00	1.00
Remittance (via mobile)	23862	0.14	0.35	0.00	0.00	1.00
Utility bills (via mobile)	23862	0.03	0.17	0.00	0.00	1.00

School fees (via mobile)	23862	0.02	0.14	0.00	0.00	1.00
Receive wage (via mobile)	23862	0.01	0.12	0.00	0.00	1.00
Government transfers (via mobile)	23862	0.01	0.08	0.00	0.00	1.00
Agriculture payments (via mobile)	23862	0.03	0.17	0.00	0.00	1.00
Gender	23862	1.47	0.50	1.00	1.00	2.00
Age	23862	34.20	14.96	15.00	30.00	99.00
Age squared	23862	1393.39	1275.85	225.00	900.00	9801.00
Income	23862	3.25	1.43	1.00	3.00	5.00
Education	23862	1.47	0.58	1.00	1.00	3.00
Individual-level variables from Afrobarometer						
Trust in most people	14548	0.16	0.37	0.00	0.00	1.00
Trust in relatives	14856	2.19	0.95	0.00	3.00	3.00
Trust in neighbors	14831	1.73	1.01	0.00	2.00	3.00
Trust in court	14605	1.90	1.05	0.00	2.00	3.00
Trust in parliament	15076	1.75	1.10	0.00	2.00	3.00
Age	15076	35.86	14.44	18.00	32.00	130.00
Age squared	15076	1494.43	1275.95	324.00	1024.00	16900.00
Gender	15076	0.49	0.50	0.00	0.00	1.00
Urban	15076	0.39	0.49	0.00	0.00	1.00
Occupation	15076	17.01	81.20	0.00	8.00	995.00
Religion	15076	24.52	94.08	0.00	4.00	995.00
Living conditions	15076	2.63	1.22	1.00	3.00	5.00
Education	15076	3.20	2.00	0.00	3.00	9.00
Individual-level variables from FinScope						
Prepared to learn new technology	37182	0.74	0.44	0.00	1.00	1.00
Education	37182	2.14	0.89	1.00	2.00	8.00
Gender	37182	0.61	0.49	0.00	1.00	1.00
Age	37182	33.91	19.04	1.00	32.00	99.00
Age squared	37182	1512.54	1494.35	1.00	1024.00	9801.00
Income source	37182	3.62	6.63	1.00	2.00	99.00
Urban	37182	0.22	0.41	0.00	0.00	1.00
Firm-level variables						
Bank finance	7220	6.92	14.93	0.00	0.00	50.00
External finance	7216	24.54	26.65	0.00	20.00	80.00
Firm size	7220	1.58	0.72	1.00	1.00	3.00
Firm age	7220	16.91	13.23	2.00	13.00	53.00
Sales growth	7220	0.24	0.23	-0.13	0.32	0.69
State ownership	7220	0.85	6.82	0.00	0.00	100.00
Foreign ownership	7220	10.38	28.27	0.00	0.00	100.00
Export	7220	3.54	9.17	0.00	0.00	32.00
Profit	7220	0.42	0.31	-0.05	0.36	1.00
CEO experience	7220	15.13	9.42	3.00	13.00	35.00
Business group	7220	1.82	0.39	1.00	2.00	2.00
Without line of credit	7149	0.78	0.41	0.00	1.00	1.00
High interest	7220	0.14	0.34	0.00	0.00	1.00
Ethnicity location variables						

TSI	68	-0.11	0.99	-2.14	-0.08	1.50
Slave exports	68	0.31	0.82	0.00	0.00	3.66
Longitude	68	16.66	17.33	-17.00	15.50	42.00
Latitude	68	4.46	13.62	-27.00	6.00	37.00
SI	68	0.50	0.18	0.09	0.53	0.80
Malaria index	68	6.68	10.18	0.00	0.09	33.95
Humidity	68	57.20	14.74	31.26	58.74	83.96
Temperature	68	23.99	3.15	17.99	23.78	29.18
Tropical	68	0.90	0.31	0.00	1.00	1.00
Coast	68	0.34	0.48	0.00	0.00	1.00
River	68	0.78	0.42	0.00	1.00	1.00
Missions	68	0.46	0.50	0.00	0.00	1.00
Population density	54	2.27	1.49	-2.37	2.60	5.06
Perturb TSI shift left	68	0.07	1.13	-2.65	0.22	1.93
Perturb TSI shift right	68	-0.15	1.08	-1.87	-0.25	1.46
Intrinsic rate of growth	68	0.40	0.16	0.10	0.40	0.68
Box-plot	68	15.92	7.41	2.62	15.69	28.80
Optimal conditions	68	0.34	0.48	0.00	0.00	1.00
Industrial-level variables						
EFD RZ	7220	0.22	0.41	0.00	0.00	1.00
EFD FL	7220	0.56	0.50	0.00	1.00	1.00

Table 3.2: TseTse fly, financial development, and credit market institutions: Country-level analyses

This table reports OLS regression results of financial development (Panel A) and credit market institutions (Panel B) on historical TseTse fly prevalence. In Panel A, the dependent variable is either *Private credit to GDP* or *Deposit to GDP*. In Panel B, the dependent variable is either *Private bureau coverage* or *Public registry coverage*. The key explanatory variable, *Country_TSI*, measures historical TseTse fly prevalence in each country and equals to the average, weighted by land area, of the standardized value (Z-score) of the TseTse fly steady-state population in each ethnic group location (Alsan, 2015). Basic Country controls include *Slave exports* (the natural logarithm of the total number of slaves exported from each country between 1400 and 1900 normalized by land area), *French legal origin* (an indicator that equals one if a country's commercial code has a French legal origin, and zero otherwise), *Settler mortality* (annualized death rates faced by former European settlers in European colonies in the early 19th century), *Malaria index*, *SI* (a summary measure of agricultural suitability), *Humidity*, *Temperature*, *Latitude* (the logarithm of the absolute distance between each country and the equator), *Longitude*, *Tropical*, *Independence*, *Coastline by land area*, and *cultural controls* (percentage of population that follows (a) Catholic, (2) Muslim, and (3) Protestant religion in 1980). Additional controls include quantiles of gold, oil and diamonds production per capita, an interaction between *Humidity* and *Temperature* and Colonizer indicators. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Panel A: TseTse fly and financial development

	Private credit to GDP			Deposit to GDP		
	(1)	(2)	(3)	(4)	(5)	(6)
Country_TSI	-32.208***	-41.695***	-40.628***	-16.012***	-16.485**	-20.391**
	(7.357)	(4.538)	(6.519)	(4.713)	(5.678)	(6.951)
French legal origin	-9.054	-51.465	-52.350	-1.551	75.583	11.713
	(7.326)	(50.525)	(68.584)	(4.171)	(51.067)	(73.069)
Settler mortality	-1.036	-4.250	-6.323	2.835	4.469	4.644
	(3.781)	(7.177)	(7.173)	(1.962)	(4.574)	(4.770)
Malaria index	-0.505	0.568	0.288	0.124	-1.117	0.022
	(1.206)	(1.058)	(1.462)	(0.776)	(1.104)	(1.473)
SI	44.628	12.353	13.351	23.659	67.652	22.797
	(38.273)	(41.242)	(55.290)	(30.756)	(44.489)	(58.384)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	Yes	No	Yes	Yes
GDP per capita & growth	No	No	Yes	No	No	Yes
N	30	30	30	30	30	30
R-squared	0.911	0.978	0.984	0.915	0.962	0.970

Panel B: TseTse fly and credit market institutions

	Private Credit Bureau			Public Credit Registry		
	(1)	(2)	(3)	(4)	(5)	(6)
Country_TSI	-10.250**	-16.218***	-21.788**	-1.671	-0.682	8.504
	(3.446)	(3.513)	(6.759)	(6.657)	(4.992)	(7.944)
French legal origin	-10.214***	26.986	-19.103	3.580	-111.404**	-35.746
	(2.962)	(20.956)	(47.474)	(5.630)	(47.011)	(96.333)
Settler mortality	-1.707	-0.741	-0.313	0.745	3.449	2.720
	(1.458)	(2.905)	(3.393)	(3.656)	(4.319)	(5.043)
Malaria index	0.011	-0.956*	-0.462	0.673	2.343*	1.521
	(0.504)	(0.474)	(0.680)	(0.854)	(1.116)	(1.700)
SI	-4.392	37.860*	16.060	-16.621	-75.695	-39.813
	(15.950)	(16.239)	(24.418)	(29.395)	(43.219)	(66.602)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	Yes	No	Yes	Yes
GDP per capita & growth	No	No	Yes	No	No	Yes
N	30	30	30	30	30	30
R-squared	0.918	0.970	0.978	0.554	0.916	0.941

Table 3.3: TseTse fly and mistrust in financial institutions: Household analyses

This table reports OLS regression results of household mistrust in financial institutions on historical TseTse fly prevalence. The dependent variable, *Mistrust in financial institutions*, equals to one if a respondent does not have a bank account due to mistrust and zero otherwise. The key explanatory variable, *Country_TSI*, measures historical TseTse fly prevalence in each country. Results from the full sample are reported in column (1), and results from subsamples based on the level of education are reported in columns (2) and (3). Country controls include *Slave exports*, *French legal origin*, *Settler mortality, Malaria index*, *SI, Humidity*, *Temperature*, *Latitude*, *Longitude*, *Tropical*, *Independence*, *Coastline by land area*, *cultural controls*, quantiles of *Gold*, *Oil* and *Diamonds* production per capita, an interaction term between *Humidity* and *Temperature* and Colonizer indicators. Individual controls include a gender indicator, age, age squared, three respondent education fixed effects, and five household income level fixed effects (the omit group: Income (richest 20%)). See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the country level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Mistrust in financial institutions		
	Overall sample	Education: completed primary or less	Education: secondary or more
	(1)	(2)	(3)
Country_TSI	0.348***	0.340***	0.458***
	(0.006)	(0.004)	(0.014)
Education (secondary or more)	-0.015		
	(0.009)		
Income (second 20%)	-0.005	-0.008	-0.001
	(0.011)	(0.011)	(0.021)
Income (middle 20%)	-0.007	-0.009	-0.002
	(0.010)	(0.011)	(0.016)
Income (fourth 20%)	-0.019**	-0.015	-0.025
	(0.008)	(0.009)	(0.016)
Income (richest 20%)	-0.009	-0.007	-0.011
	(0.010)	(0.010)	(0.019)
Gender	-0.012**	-0.010	-0.016
	(0.005)	(0.007)	(0.012)
Age	0.003***	0.001	0.005***
	(0.001)	(0.001)	(0.001)
Age squared	-0.000**	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Country controls	Yes	Yes	Yes
Observations	17,459	11,628	5,831

R-squared	0.026	0.031	0.027
# of countries	24	24	24

Table 3.4: TseTse fly and household trust in general: Ethnicity location-level analyses

This table reports OLS regression results of household trust in general on historical TseTse fly prevalence. The dependent variable is either *Trust in most people, Trust in relatives, Trust in neighbors, Trust in courts, and Trust in parliament*. The key explanatory variable, *TSI*, measures historical TseTse fly prevalence in each ethnicity location. Individual controls include a gender indicator, a live-in-an-urban-area indicator, age, age squared, ten education fixed effects, five living conditions fixed effects, 18 religion fixed effects, and 25 occupation fixed effects. Ethnicity location-level control variables include *Slave exports, Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, *Malaria index*, and *Missions*. I also include country fixed effects in our specifications. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Trust in most people	Trust in relatives	Trust in neighbors	Trust in courts	Trust in parliament
	(1)	(2)	(3)	(4)	(5)
TSI	-0.031***	-0.103***	-0.110**	-0.083**	-0.079**
	(0.011)	(0.036)	(0.044)	(0.033)	(0.031)
Female	-0.010	-0.024	-0.047***	0.021	-0.022
	(0.008)	(0.015)	(0.015)	(0.016)	(0.017)
Age	0.001	-0.002	0.006**	-0.002	-0.001
	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)
Age squared	-0.000	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urban	-0.030**	-0.114***	-0.166***	-0.106***	-0.105***
	(0.011)	(0.022)	(0.029)	(0.025)	(0.023)
Education FE	Yes	Yes	Yes	Yes	Yes
Living condition FE	Yes	Yes	Yes	Yes	Yes
Religion FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes
Ethnicity location controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	15,477	15,822	15,792	15,254	15,076
R-squared	0.049	0.138	0.154	0.178	0.224
# of Ethnicities	129	129	129	129	129

Table 3.5: TseTse fly and measures of bank trust on firms: Ethnicity location-level analyses

This table reports OLS regression results of the effects of historical TseTse fly prevalence on firm's loan price. The dependent variable is either *Without line of credit* or *High interest*. *Without line of credit* equals to one if a firm does not have a credit line and zero otherwise. *High interest* is equal to one if a firm reports that it did not apply for a loan last year because of unfavourable interest rates. The key explanatory variable, *TSI*, is from Alsan (2015) and measures historical TseTse fly prevalence in each ethnic group location. Ethnicity location-level control variables include *Slave exports, Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, *Malaria index*, *Log population density, Missions*. Firm controls include *Firm size*, *Firm age*, *Sales growth*, *State*, *Foreign*, *Exports*, *Profit*, *CEO experience* and *Business group*. Survey year, industry, and country fixed effects are included in all models. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Without line of credit		High interest	
	(1)	(2)	(3)	(4)
TSI	0.058***	0.071***	0.062***	0.059**
	(0.016)	(0.021)	(0.011)	(0.024)
Firm size	-0.124***	-0.119***	-0.033***	-0.033***
	(0.014)	(0.015)	(0.010)	(0.011)
Firm age	0.000	-0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Sales growth	0.062	0.096**	-0.054	-0.063
	(0.043)	(0.040)	(0.117)	(0.118)
State ownership	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Foreign ownership	0.001	0.001*	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Export	-0.003***	-0.002***	-0.001**	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Profit	0.032	0.029	-0.053*	-0.047
	(0.025)	(0.024)	(0.031)	(0.031)
CEO experience	-0.001	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Business group	0.050***	0.037**	-0.023	-0.034
	(0.016)	(0.015)	(0.021)	(0.021)
Ethnic group controls	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes
Industry FE	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes
Observations	5,454	5,454	3,690	3,689
R-squared	0.171	0.209	0.054	0.070

# Ethnic groups	54	54	54	54

Table 3.6: TseTse fly and firm access to finance: Ethnicity location-level analyses

This table reports OLS regression results of the average impacts of historical TseTse fly prevalence on firm access to finance. The dependent variable is *Bank finance* (the proportion of working capital in a firm that is financed by banks), and *External finance* (the proportion of working capital in a firm that is financed by banks, non-bank financial institutions and credit suppliers). The key explanatory variable, *TSI*, is from Alsan (2015) and measures historical TseTse fly prevalence in each ethnic group location. Ethnicity location-level controls include *Slave exports, Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, *Malaria index*, *Log population density* and *Missions*. Firm controls include *Firm size*, *Firm age*, *Sales growth*, *State*, *Foreign*, *Exports*, *Profit*, *CEO experience* and *Business group*. Survey year, industry, and country fixed effects are included in all models. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Bank finance		External finance	
	(1)	(2)	(3)	(4)
TSI	-2.257***	-8.307***	-4.400***	-10.776***
	(0.796)	(1.203)	(1.447)	(1.688)
Firm size	2.810***	3.011***	3.915***	4.184***
	(0.405)	(0.435)	(0.785)	(0.910)
Firm age	0.040*	0.019	0.096**	0.111**
	(0.022)	(0.023)	(0.043)	(0.048)
Sales growth	-2.120	-1.176	-4.109	-4.764
	(1.757)	(1.947)	(3.401)	(3.946)
State ownership	0.067*	0.078*	0.139*	0.155*
	(0.037)	(0.043)	(0.077)	(0.089)
Foreign ownership	-0.008	-0.013*	-0.009	-0.019
	(0.007)	(0.007)	(0.012)	(0.015)
Export	0.124***	0.111***	0.228***	0.208***
	(0.024)	(0.030)	(0.054)	(0.067)
Profit	-0.415	-0.425	-4.297**	-4.921**
	(0.775)	(0.916)	(1.684)	(1.875)
CEO experience	0.008	0.063*	0.022	0.082
	(0.044)	(0.037)	(0.065)	(0.064)
Business group	-1.840***	-1.383**	-1.662	-1.231
	(0.626)	(0.649)	(1.036)	(1.257)
Ethnic group controls	No	Yes	No	Yes
Industry FE	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	7,220	5,325	7,216	5,322

R-squared	0.173	0.190	0.146	0.172
# Ethnic groups	68	54	68	54

Table 3.7: TseTse fly, bank trust and firm access to finance: Placebo analysis from Americas and Asia Pacific

This table reports OLS regression results of placebo tests using firm-level data from Americas and Asia Pacific. The dependent variable is either *Bank finance*, *External finance*, *Without line of credit* and *High interest*. The key explanatory variable, *Pseudo TSI*, is from Alsan (2015) and it is constructed using the same model and inputs as TSI, the TseTse fly index, but in Americas and Asia Pacific. Ethnicity location-level controls include *Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, and *Malaria index*. Firm controls include *Firm size*, *Firm age*, *Sales growth*, *State*, *Foreign*, *Exports*, *Profit*, *CEO experience* and *Business group*. Survey year, industry, and country fixed effects are included in all models. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Bank finance	External finance	No credit line	High interest
	(1)	(2)	(3)	(4)
Pseudo_TSI	0.637	-2.533	-0.078	-0.023
	(2.355)	(2.260)	(0.050)	(0.029)
Firm size	4.370***	5.032***	-0.112***	-0.030***
	(0.915)	(0.952)	(0.016)	(0.007)
Firm age	-0.022	-0.028	-0.000	-0.000
	(0.023)	(0.017)	(0.000)	(0.000)
Sales growth	-2.857	5.339	-0.059	-0.185*
	(4.693)	(6.673)	(0.091)	(0.096)
State ownership	0.047	0.068	-0.000	-0.000
	(0.058)	(0.065)	(0.001)	(0.001)
Foreign ownership	-0.101***	-0.098***	0.001***	-0.000
	(0.013)	(0.016)	(0.000)	(0.000)
Export	0.089***	0.087***	-0.001**	0.000
	(0.022)	(0.026)	(0.000)	(0.000)
Profit	1.597	0.676	-0.026	-0.040*
	(1.272)	(1.647)	(0.020)	(0.021)
CEO experience	0.104*	0.124*	-0.002**	0.000
	(0.059)	(0.067)	(0.001)	(0.001)
Business group	-3.631***	-0.950	0.041**	-0.014
	(1.251)	(1.263)	(0.018)	(0.025)
Ethnic group controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	19,095	18,824	19,114	11,954
R-squared	0.167	0.202	0.228	0.095

# Ethnic groups	29	29	29	29

Table 3.8: TseTse fly, bank trust and firm access to finance: Alternative measures of TseTse and clustering strategies

This table reports a range of robustness checks of the average impacts of historical TseTse fly prevalence on firm access to finance. The alternative measures of TseTse fly are *Perturb TSI shift left* and *Perturb TSI shift right* in column (1) and (2). They are constructed by manipulating the temperature inputs by one standard deviation (about 3°C) (to the left and right, respectively) in the construction of the TSI. Column (3) replaces the TSI with the intrinsic rate of growth of the fly. Column (4) is a box-plot transformation of the steady-state number of flies. Column (5) uses an alternative measure constructed by Rogers and Randolph (1986). In column (6) I report results using Conley (1999) standard errors to account for spatial correlation with cut-offs of 10° latitude and 10° longitude. In column (7) I cluster standard errors by country. In column (8), I cluster standard errors at country and ethnicity location levels using a multiway clustering method developed by Cameron, Gerlach, and Miller (2011). In all regressions, our dependent variable is either *Bank finance*, *External finance*, *Without line of credit* or *High interest*. In all regressions, I include ethnicity location-level controls, such as *Slave exports, Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, *Malaria index*, *Log population density,* and *Missions*. I also include firm controls, such as *Firm size*, *Firm age*, *Sales growth*, *State*, *Foreign*, *Exports*, *Profit*, *CEO experience* and *Business group*. Survey year, industry, and country fixed effects are also included in all models. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Alternative TseTse Indices					Alternative clustering		
	Perturb TSI shift left	Perturb TSI shift right	Intrinsic rate of growth	Box-plot	Optimal TseTse conditions	Conley SE	SE clustered by country	Multiway clustering
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank finance	-1.888	-3.483	-50.212***	-1.092***	-13.169***	-8.307***	-8.307***	-8.307***
	(1.850)	(2.843)	(7.142)	(0.154)	(1.629)	(1.273)	(1.382)	(1.387)
External finance	-3.684	-4.171	-65.009***	-1.414***	-16.722***	-10.776***	-10.776***	-10.776***
	(2.357)	(3.809)	(10.236)	(0.223)	(2.128)	(1.823)	(2.235)	(2.242)
High interest	-0.001	-0.047	0.426***	0.009***	0.142***	0.071***	0.071***	0.071***

	(0.031)	(0.061)	(0.130)	(0.003)	(0.051)	(0.015)	(0.019)	(0.019)
No credit line	-0.028	-0.002	0.371**	0.008***	0.119***	0.059**	0.059**	0.059**
	(0.026)	(0.051)	(0.140)	(0.003)	(0.023)	(0.018)	(0.027)	(0.027)

Table 3.9: TseTse fly and firm access to finance: Heterogeneous analyses

This table reports OLS regression results of the heterogeneous impacts of historical TseTse fly prevalence on firm access to finance. The dependent variable is either *Bank finance* (the proportion of working capital in a firm that is financed by banks) in (1)-(4), or *External finance* (the proportion of working capital in a firm that is financed by banks, non-bank financial institutions and credit suppliers) in in (5)-(8). The key explanatory variables are an interaction term between *TSI* and *EFD_RZ* and an interaction term between *TSI* and *EFD_FL*. *TSI* is from Alsan (2015) and measures historical TseTse fly prevalence in each ethnicity location. *EFD_RZ* is the fraction of capital expenditures not financed with internally generated cash flows in the 1980s United States and available from Rajan and Zingales (1998). *EFD_FL* is calculated as the fraction of total assets financed by retained earnings in the 1980s United States and available from Fisman and Love (2003). Column (1), (3), (5) and (7) report the results without ethnicity location fixed effects, while column (2), (4), (6) and (8) report the results with ethnicity fixed effects. Firm controls include *Firm size*, *Firm age*, *Sales growth*, *State*, *Foreign*, *Exports*, *Profit*, *CEO experience* and *Business group*. Country, industry (at the three digit ISIC version 2 level), and year fixed effects are included in all regressions. See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Bank finance				External finance			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TSI*EFD_RZ	-1.410**	-0.899*			-3.100***	-1.888*		
	(0.616)	(0.519)			(1.106)	(0.954)		
TSI*EFD_FL			-1.788***	-1.102**			-3.717***	-2.521***
			(0.554)	(0.460)			(0.953)	(0.780)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity location FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,897	7,895	7,897	7,895	7,890	7,888	7,890	7,888
R-squared	0.162	0.204	0.163	0.205	0.138	0.175	0.141	0.177
# of Ethnic groups	66	66	66	66	66	66	66	66

Table 3.10: TseTse fly and household access to finance

This table reports OLS regression results of household financial constraints on historical TseTse fly prevalence. The dependent variables in is either *Borrow from financial institutions*, which equals to one if a respondent borrowed money from a bank or other formal financial institutions in the past year and zero otherwise, *Credit card*, which equals one if the respondent is reported to own a credit card and zero otherwise, or *Mortgage*, which equals one if the respondent has a loan from a financial institution for house, apartment or land and zero otherwise. The key explanatory variable, *Country_TSI*, measures historical TseTse fly prevalence in each country. Country controls include *Slave exports*, *French legal origin*, *Settler mortality, Malaria index*, *SI, Humidity*, *Temperature*, *Latitude*, *Longitude*, *Tropical*, *Independence*, *Coastline by land area*, *cultural controls*, quantiles of *Gold*, *Oil* and *Diamonds* production per capita, an interaction term between *Humidity* and *Temperature* and Colonizer indicators. Individual controls include a gender indicator, age, age squared, three respondent education fixed effects, and five household income level fixed effects (the omit group: Income (richest 20%)). See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the country level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Borrowed from financial institutions			Credit card			Mortgage		
	Overall sample	Income bottom 60%	Income top 40%	Overall sample	Income bottom 60%	Income top 40%	Overall sample	Income bottom 60%	Income top 40%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country_TSI	-0.074***	-0.047***	-0.102***	-0.027***	-0.018**	-0.036***	-0.051***	-0.031***	-0.069***
	(0.008)	(0.010)	(0.007)	(0.007)	(0.007)	(0.008)	(0.005)	(0.008)	(0.004)
Income (second 20%)	0.008	0.009*		0.001	0.002		0.007	0.008	
	(0.005)	(0.005)		(0.002)	(0.002)		(0.005)	(0.005)	
Income (middle 20%)	0.016**	0.018***		-0.001	-0.000		0.015***	0.017***	
	(0.006)	(0.006)		(0.002)	(0.002)		(0.005)	(0.005)	
Income (fourth 20%)	0.023***			0.012**			0.022***		
	(0.008)			(0.005)			(0.006)		
Income (richest 20%)	0.051***		0.026***	0.032***		0.018***	0.054***		0.028***
	(0.010)		(0.007)	(0.009)		(0.005)	(0.009)		(0.006)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Observations	23,862	12,407	11,455	23,649	12,263	11,386	23,832	12,387	11,445
R-squared	0.054	0.037	0.065	0.057	0.026	0.078	0.043	0.027	0.049
# of countries	24	24	24	24	24	24	24	24	24

Table 3.11: TseTse fly and household usage of financial institutions service

This table shows OLS regression results of household use of financial services on historical TseTse fly prevalence. The dependent variable is either *Remittance*, *Utility bills*, *School fees*, *Receive wage*, *Government transfers*, or *Agriculture payments*. *Remittance* equals one if the respondent has used financial institutions to send or receive remittances and zero otherwise. *Utility bills* (*School fees*) equals one if the respondent has paid utility bills (school fees) via financial institutions, and zero otherwise. *Receive wage (Government transfers; Agriculture payments)* equals one if the respondent has received wage (government transfers; agriculture payments) via financial institutions and zero otherwise. The key explanatory variable, *Country_TSI*, measures historical TseTse fly prevalence in each country. Country controls include *Slave exports*, *French legal origin*, *Settler mortality, Malaria index*, *SI, Humidity*, *Temperature*, *Latitude*, *Longitude*, *Tropical*, *Independence*, *Coastline by land area*, *cultural controls*, quantiles of *Gold*, *Oil* and *Diamonds* production per capita, an interaction term between *Humidity* and *Temperature* and Colonizer indicators. Individual controls include a gender indicator, age, age squared, three respondent education fixed effects, and five household income level fixed effects (the omit group: Income (richest 20%)). See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the country level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Remittance	Utility bills	School fees	Receive wage	Government transfers	Agriculture payments
	(1)	(3)	(4)	(5)	(6)	(7)
Country_TSI	-0.045***	-0.044***	-0.044***	-0.005	-0.033***	-0.098***
	(0.010)	(0.006)	(0.010)	(0.016)	(0.007)	(0.004)
Education	0.004	-0.002	-0.004	0.005	-0.001	-0.001
	(0.005)	(0.002)	(0.003)	(0.003)	(0.004)	(0.001)
Income (second 20%)	0.010	0.002	-0.001	0.020**	0.002	0.006*
	(0.007)	(0.002)	(0.003)	(0.008)	(0.004)	(0.003)
Income (middle 20%)	0.036***	0.003	0.013*	0.040***	0.002	0.009***

	(0.011)	(0.003)	(0.007)	(0.010)	(0.004)	(0.003)
Income (fourth 20%)	0.104***	0.032***	0.033***	0.106***	0.010*	0.019***
	(0.016)	(0.011)	(0.009)	(0.014)	(0.005)	(0.004)
Income (richest 20%)	-0.005***	-0.023***	-0.050***	-0.017***	-0.008***	-0.020***
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.001)
Gender	-0.009*	-0.002	-0.000	-0.023***	0.004	-0.005***
	(0.005)	(0.002)	(0.003)	(0.004)	(0.006)	(0.002)
Age	0.007***	0.002***	0.003***	0.011***	0.000	0.002***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.000)
Age squared	-0.000***	-0.000***	-0.000***	-0.000***	0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Country controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,977	23,977	23,977	23,977	23,977	23,977
R-squared	0.157	0.074	0.091	0.151	0.107	0.026
# of countries	24	24	24	24	24	24

Table 3.12: TseTse fly and attitudes toward financial technology: Evidence from FinScope

This table reports OLS regression results of household attitudes toward technology on historical TseTse fly prevalence, using FinScope data. The dependent variables in is *Prepared to learn how to use new technology on money matters*. It equals to one if a respondent reports that she/he is prepared to learn how to use new technology on money matters, and zero otherwise. In all regressions, I include ethnicity location-level controls, such as *Slave exports, Longitude*, *Latitude*, *SI*, *Mean relative humidity*, *Mean average temperature*, *Tropical*, *Coast*, *River*, *Malaria index*, *Log population density* and *Missions* (the number of missions per square kilometre for each ethnic group). See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the ethnicity location level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

	Prepared to learn how to use new technology on money matters		
	Overall sample	Urban area	Rural area
	(1)	(3)	(4)
TSI	-0.380***	-0.451***	-0.363***
	(-4.827)	(-2.995)	(-5.368)
Female	-0.068***	-0.043***	-0.075***
	(-15.819)	(-3.744)	(-14.407)
Age	0.003**	-0.002	0.003***
	(2.307)	(-0.595)	(2.948)
Age squared	-0.000***	-0.000	-0.000***
	(-5.600)	(-1.012)	(-6.858)
Urban	0.028**		
	(2.662)		
Education FE	Yes	Yes	Yes
Income source FE	Yes	Yes	Yes
Ethnicity location controls	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	37,182	8,030	29,152
R-squared	0.215	0.210	0.221
# of Ethnicities	20	20	20

Table 3.13: TseTse fly and household adoption of financial technology

This table shows OLS regression results of household consumption of financial services on historical TseTse fly prevalence. The dependent variable in Panel A is either *Internet transactions*, which equals one if the respondent has made financial transactions through internet and zero otherwise; or *Mobile transactions* which equals one if the respondent has made financial transactions via mobile phone and zero otherwise. In Panel B, each cell reports a coefficient from a separate regression. The dependent variables is either *Remittance*, *Utility bills*, *School fees*, *Receive wage*, *Government transfers*, or *Agriculture payments*. *Remittance* equals one if the respondent has sent (received) remittances through mobile and zero otherwise. *Utility bills* (*School fees*) equals one if the respondent has paid utility bills (school fees) through mobile respectively and zero otherwise. *Receive wage (Government transfers; Agriculture pay)* equals one if the respondent has received wage (government transfers; agriculture payments) through mobile respectively and zero otherwise. The key explanatory variable, *Country_TSI*, measures historical TseTse fly prevalence in each country. Country controls include *Slave exports*, *French legal origin*, *Settler mortality, Malaria index*, *SI, Humidity*, *Temperature*, *Latitude*, *Longitude*, *Tropical*, *Independence*, *Coastline by land area*, *cultural controls*, quantiles of *Gold*, *Oil* and *Diamonds* production per capita, an interaction term between *Humidity* and *Temperature* and Colonizer indicators. Individual controls include a gender indicator, age, age squared, three respondent education fixed effects, and five household income level fixed effects (the omit group: Income (richest 20%)). See online appendix Table 1 for more detailed variable definitions and data sources. Heteroskedasticity robust standard errors clustered at the country level are reported in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Panel A: TseTse fly and adoption of internet and mobile banking

	Internet transactions			Mobile transactions		
	Overall sample	Income bottom 60%	Income top 40%	Overall sample	Income bottom 60%	Income top 40%
	(1)	(2)	(3)	(4)	(5)	(6)
Country_TSI	-0.049***	-0.046***	-0.054***	-0.249***	-0.098***	-0.414***
	(0.005)	(0.003)	(0.007)	(0.011)	(0.009)	(0.013)
Income (second 20%)	0.001	0.002		-0.003	-0.002	
	(0.002)	(0.003)		(0.004)	(0.004)	
Income (middle 20%)	0.002	0.003		0.013**	0.015***	
	(0.002)	(0.002)		(0.005)	(0.005)	
Income (fourth 20%)	0.011**			0.026***		
	(0.005)			(0.008)		
Income (richest 20%)	0.031***		0.018***	0.072***		0.043***
	(0.008)		(0.005)	(0.016)		(0.009)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Country controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,977	12,475	11,502	23,977	12,475	11,502
R-squared	0.034	0.012	0.051	0.111	0.062	0.134
# of countries	24	24	24	24	24	24

Panel B: TseTse fly and usage of mobile money

	Remittance	Utility bills	School fees	Receive wage	Government transfers	Agriculture payments
	(1)	(3)	(4)	(5)	(6)	(7)
Country_TSI	-1.404***	-0.156***	-0.116***	-0.056***	-0.017***	-0.178***
	(0.017)	(0.009)	(0.004)	(0.003)	(0.001)	(0.005)
Education	0.070***	0.030***	0.014***	0.009***	0.003*	0.005
	(0.014)	(0.009)	(0.004)	(0.002)	(0.002)	(0.005)
Income (second 20%)	0.015	-0.001	-0.001	0.001	-0.002	0.003
	(0.010)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
Income (middle 20%)	0.031**	0.003	0.005	0.005**	-0.001	0.013**
	(0.013)	(0.002)	(0.004)	(0.002)	(0.002)	(0.005)
Income (fourth 20%)	0.055***	0.009*	0.007*	0.009***	0.002	0.013**
	(0.018)	(0.005)	(0.004)	(0.003)	(0.002)	(0.005)
Income (richest 20%)	0.093***	0.039***	0.011*	0.015***	0.004*	0.022***
	(0.027)	(0.012)	(0.005)	(0.004)	(0.002)	(0.007)
Gender	-0.016***	-0.002	0.001	-0.005*	0.000	-0.007*
	(0.005)	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Age	0.007***	0.002***	0.001***	0.001***	0.000	0.001**
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Age squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Country controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,977	23,977	23,977	23,977	23,977	23,977
R-squared	0.276	0.096	0.052	0.035	0.009	0.075

# of countries	24	24	24	24	24	24

Appendix Table 3.1: Variable definition and data sources

Variable	Definition	Source
Country-level variables		
Country_TSI	This index measures the TseTse fly suitability for a country. TseTse fly suitability index is constructed as the standardized value (Z-score) of the TseTse fly steady-state population in each ethnicity location derived using insect population growth modelling, gridded climate data, and geospatial software. The exact functional forms relating TseTse birth and death rates to climate are derived from the experimental data. I use the area-weighted average of the index at the country level.	Alsan (2015)
Private credit to GDP	The financial resources provided to the private sector by domestic money banks as a share of GDP, averaged over 2006-2014. Domestic money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	Global Financial Development Database (2017), Cihák, Demirgüç-Kunt, Feyen, and Levine (2012)
Deposit to GDP	Demand, time and saving deposits in deposit money banks and other financial institutions as a share of GDP, averaged over 2006-2014. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	

Private credit bureau	The percentage of the adult population (age above 15) covered by a private credit bureau, averaged over 2006-2014. A credit bureau is defined as a private firm or non-profit organization that maintains a database on the creditworthiness of borrowers (individuals or firms) in the financial system and facilitates the exchange of credit information among creditors.	Doing Business, Djankov, McLiesh, and Shleifer (2007)
Public credit registry	The percentage of the adult population (age above 15) covered by a public credit registry, averaged over 2006-2014. A public credit registry is a database that is managed by the public sector, usually by the central bank or the superintendent of banks, and that collects information on the creditworthiness of borrower in the financial system and facilitates the exchange of credit information among banks and other regulated financial institutions.	
GDP per capita (2005 US$)	Gross domestic product per capita in 2005 US dollars.	World Development Indicators.
GDP per capita growth	Annual growth rate in gross domestic product per capita, averaged over 2006-2014.	
Slave exports	Natural logarithm of the total number of slaves exported from each country between 1400 and 1900 in the four slave trades normalized by land area.	Nunn (2008)
Gold	Quantiles of gold production per capita.	
Oil	Quantiles of oil production per capita.	
Diamonds	Quantiles of diamonds production per capita.	
British colonizer	Indicator that equals to one if a country was colonized by Britain and zero otherwise.	

French colonizer	Indicator that equals to one if a country was colonized by France and zero otherwise.	
Settler mortality	Annualized death rates faced by former European settlers in European colonies in the early 19th century.	Acemoglu, Johnson, and Robinson (2001)
French legal origin	An indicator that equals one if a country implants laws from the French civil law traditions, and zero otherwise.	La Porta, Lopez deSilanes, Shleifer, and Vishny (1999)
Catholic	Percentage of population that follows the Catholic religion in 1980.	
Muslim	Percentage of population that follows the Muslim religion in 1980.	
Protestant	Percentage of population that follows the Protestant religion in 1980.	
Independence	The first year of a country's independence from colonization.	
Latitude	The logarithm of the absolute distance between each country and the equator.	Alsan (2015, AER)
Longitude	Longitude.	
SI	The agriculture suitability index that measures the average land quality for cultivation within each country. The index is the product of two components capturing the climatic and soil suitability for farming.	
Malaria index	An index representing the contribution of regionally dominant vector mosquitoes to the force of transmission of malaria in each country. The key temperature inputs were based on data draw from the period of 1901-1990.	
Coastline by land area	The ratio of the length of a country's coastline to its land area.	

Humid	The average of daily mean relative humidity in 1871.	
Temperature	The average of daily mean temperature in 1871.	
Tropical	The proportion of land area in the tropics.	
Household traits from Global Financial Inclusion		
Mistrust in financial institutions	An indicator that equals one if a respondent does not trust banks or other financial institutions, and zero otherwise.	Global Financial Inclusion Database (2014)
Borrowed from financial institutions	An indicator that equals one if a respondent borrowed any money from a bank or another formal financial institution, and zero otherwise.	
Credit card	An indicator that equals one if the respondent is reported to own a credit card issued by a financial institution and zero otherwise.	
Mortgage	An indicator that equals one if the respondent has a loan from a bank or another type of formal financial institution to purchase a home, an apartment, or land, and zero otherwise.	
Internet transactions	An indicator equal to one if a respondent has made transactions online using the internet and zero otherwise. The transactions include paying bills and purchasing goods and services.	
Mobile transactions	An indicator equal to one if a respondent has made transactions via mobile phones and zero otherwise. The transactions include paying bills and purchasing goods and services.	
Remittance (via banks)	An indicator that equals one if the respondent has sent or received money to or from a relative or friend living in a different area inside a country through banks and zero otherwise.	

Utility bills (via banks)	An indicator that equals one if the respondent has paid utility bills through banks and zero otherwise.
School fees (via banks)	An indicator that equals one if the respondent has paid school fees through banks and zero otherwise.
Receive wage (via banks)	An indicator that equals one if the respondent has received wages through banks and zero otherwise.
Government transfers (via banks)	An indicator that equals one if the respondent has received government transfers through banks and zero otherwise.
Agriculture payments (via banks)	An indicator that equals one if the respondent has received agriculture payments through banks and zero otherwise.
Remittance (via mobile)	An indicator that equals one if the respondent has sent or received money to or from a relative or friend living in a different area inside a country through mobile phones and zero otherwise.
Utility bills (via mobile)	An indicator that equals one if the respondent has paid utility bills through mobile phones and zero otherwise.
School fees (via mobile)	An indicator that equals one if the respondent has paid school fees through mobile phones and zero otherwise.
Receive wage (via mobile)	An indicator that equals one if the respondent has received wages through mobile phones and zero otherwise.
Government transfers (via mobile)	An indicator that equals one if the respondent has received government transfers through mobile phones and zero otherwise.
Agriculture payments (via mobile)	An indicator that equals one if the respondent has received agriculture payments through mobile phones and zero otherwise.
Gender	An indicator that equals to one if a respondent is female and zero otherwise.

Age	Respondent's age	
Age squared	Respondent's age squared	
Income	Household income quintile indicators within each country.	
Education	An indicator that equals one if an individual's educational attainment is secondary or more, and zero otherwise.	
Household variables from Afrobarometer		
Trust in most people	An indicator that ranges from zero to four. It is constructed from the answer to the question of how much does a respondent trust most people in general. Zero represents not at all, one corresponds to just a little, three means somewhat, and four represents a lot.	Afrobarometer (2008)
Trust in relatives	An indicator that ranges from zero to four. It is constructed from the answer to the question of how much does a respondent trust his/her relative. Zero represents not at all, one corresponds to just a little, three means somewhat, and four represents a lot.	
Trust in neighbors	An indicator that ranges from zero to four. It is constructed from the answer to the question of how much does a respondent trust his/her neighbor. Zero represents not at all, one corresponds to just a little, three means somewhat, and four represents a lot.	
Trust in court	An indicator that ranges from zero to four. It is constructed from the answer to the question of how much a respondent trusts the court. Zero represents not at all, one corresponds to just a little, three means somewhat, and four represents a lot.	

Trust in parliament	An indicator that ranges from zero to four. It is constructed from the answer to the question of how much a respondent trusts the parliament. Zero represents not at all, one corresponds to just a little, three means somewhat, and four represents a lot.
Age	Respondent's age
Age squared	Respondent's age squared
Gender	An indicator that equals to one if a respondent is female and zero otherwise.
Urban	An indicator the equals to one if a respondent is living in an urban area and zero otherwise.
Occupation	25 indicators of the respondent's main occupation, see the Afrobarometer manual for more detail.
Religion	18 indicators of the respondent's religion, see the Afrobarometer manual for more detail.
Living conditions	Five indicators of the respondent's view of their present living conditions: (1) very bad, (2) fairly bad, (3) neither good nor bad, (4) fairly good, or (5) very good.
Education	Ten indicators of the respondent's education categories, including (1) no formal schooling, (2) informal schooling only, (3) some primary schooling, (4) primary school completed, (5) some secondary school/high school, (6) secondary school completed/high school, (7) post-secondary qualifications, but no university, (8) some university, (9) university completed, and (10) post-graduate.
Household variables from FinScope	

Prepared to learn new technology	An indicator equals to one if a respondent is prepared to learn new technologies to manage his/her money matters and zero otherwise.	FinScope (2016)
Education	Six indicators of the respondent's education categories: (1) no formal education, (2) primary education, (3) secondary education, (4) vocational/specialized training, (5) tertiary education, and (6) other.	
Gender	An indicator that equals to one if a respondent is female and zero otherwise.	
Age	Respondent's age	
Age squared	Respondent's age squared	
Income source	Nine indicators of the respondent's income sources, including (1) farming and fishing, (2) self-employed, (3) formally employed by government, (4) formally employed by private, (5) informally employed, (6) remittance dependent, (7) government dependent, (8) other, and (9) no income.	
Urban	An indicator the equals to one if a respondent is living in an urban area and zero otherwise.	
Firm-level variables		
Working capital financed from banks	The proportion of working capital in a firm that is financed by banks.	Enterprise Survey, World Bank
Working capital financed externally	The proportion of working capital in a firm that is financed by external creditors, including banks and other non-bank financial institutions.	
Firm size	Tertiles of the number of employees in a firm.	

Firm age	The difference between the survey year and the first year when a firm started its operations.	
Sales growth	The median value of firms' sales growth within an industry in each year.	
State ownership	Percentage of government ownership.	
Foreign ownership	Percentage of foreign ownership.	
Export	Percentage of sales made as direct export.	
Profit	Firm's profit margin.	
CEO experience	Number of years of experience a CEO has in the industry.	
Business group	An indicator that equals to one if a firm belongs to a business group formed by other firms and zero otherwise.	
Without line of credit	An indicator that equals to one if a firm does not have a line of credit from financial institutions and zero otherwise.	
High interest	An indicator equals to one if a firm reports that it did not apply for loan due to unfavorable interest rates offered by financial institutions.	
Ethnicity location variables		
TSI	This index measures the TseTse fly suitability for an ethnicity location. TseTse fly suitability index is constructed as the standardized value (Z-score) of the TseTse fly steady-state population in each ethnicity location derived using insect population growth modelling, gridded climate data, and geospatial software. The exact functional forms relating TseTse birth and death rates to climate are derived from the experimental data.	Alsan (2015)
Longitude	Longitude of the centroid of an ethnic location	
Latitude	Latitude of the centroid of an ethnic location	

SI	The agriculture suitability index that measures the average land quality for cultivation within an ethnicity location. The index is the product of two components capturing the climatic and soil suitability for farming.
Malaria index	An index representing the contribution of regionally dominant vector mosquitoes to the force of transmission of malaria in ethnic location. The key temperature inputs were based on data draw from the period of 1901-1990.
Humidity	The average of daily mean relative humidity in1871.
Temperature	The average of daily mean temperature in1871.
Tropical	The proportion of land area in the tropics.
Coast	The distance between the centroid of an ethnic location and the nearest coast.
River	The distance between the centroid of an ethnic location and the nearest river.
Perturb TSI shift left	This index is constructed by manipulating the temperature inputs in the TseTse suitability index formula by one standard deviation (about 3°C) to the right.
Perturb TSI shift right	This index is constructed by manipulating the temperature inputs in the TseTse suitability index formula by one standard deviation (about 3°C) to the left.
Intrinsic rate of growth	It equals to the birth minus the death rate of the TsTse fly. The exact functional forms relating TseTse birth and death rates to climate are derived from the experimental data.
Box-plot	It is the box plot transformation to the variable *Intrinsic rate of growth since* the TseTse suitability index has a negative skew.

Optimal conditions	It equals to one if an ethnic location meets the optimum environment for the survival of the TseTse fly, as defined in Alsan (2015). The optimum climatic conditions for the fly's survival are obtained from field research by Rogers and Randolph (1986) and are transformed into this binary indicator.	
Slave exports	Natural logarithm of the total number of slaves exported from each country between 1400 and 1900 in the four slave trades normalized by land area.	Nunn and Wantchekon (2011)
Missions	An indicator that equals to one if an ethnicity had European missionary contact during the colonial period and zero otherwise.	
Population density	The natural logarithm of population density in each ethnic location at early twentieth century.	
Industrial-level variables		
EFD RZ	An indicator that equals to one if an industry has an above median value of dependence on external finance, calculated as a flow measure. Dependence on external finance is the fraction of capital expenditures not financed with internally generated cash flows in the United States. It is constructed using U.S. data over the 1980s, at the three-digit ISIC level.	Rajan and Zingales (1998)

EFD FL	An indicator that equals to one if an industry has an above median value of dependence on external finance, calculated as a stock measure. Dependence on external finance (stock) here is the fraction of total assets not financed with retained earnings in the United States. It is constructed using U.S. data over the 1980s, at the three-digit ISIC level.	Fisman and Love (2003)

Chapter 4: Gender Norms and Trade Credits

4.1 Introduction

A key function of financial markets is to identify investment opportunities with positive net present value (NPV) and allocate credits efficiently among them (Levine 1997). In practice, however, this allocation process is often distorted by various frictions, such as information asymmetry (Jaffee and Russell 1976; Stiglitz and Weiss 1981; Djankov, McLiesh and Shleifer 2007), moral hazard (La Porta et al. 1997, 1998, 2000) and culture (Stulz and Williamson 2003; Guiso, Sapienza and Zingales 2004).

In particular, an important culture dimension, gender beliefs favoring males, has been emphasized by many recent studies that examine the function of financial markets (Alesina, Lotti and Mistrulli 2013; Aterido, Beck and Iacovone 2011). Ongena and Popov (2016), for example, document that female entrepreneurs are more reluctant to apply for bank loans and are more likely to rely on informal finance, even though banks do not appear to discriminate against them. While insightful, these studies have mainly focused on gender bias against female managers. Given that female workers accounts for more than 40% of labor market participants in a representative international sample,[33] and given that gender bias is a social phenomenon rather than a constraint on managerial

[33] The number is calculated using the World Bank Enterprise Survey in 2018. The sample includes 133,731 firms from 137 countries across the world.

occupations, it is important to ask whether there is an employee-based gender gap in credit markets.

Using data on around 31,000 firms from the World Bank Enterprise Survey, I examine the impact of female production workers on manufacturing firms' access to trade credits across 81 countries. I find that, in high gender-biased countries, firms with a larger fraction of female production employees have less access to trade credits. My results offer an important complement to existing research that focuses on the gender gap in formal credit markets, and taken together are highly relevant to policymakers and regulators of financial markets. Specifically, recent evidence show that formal financial institutions do not appear to discriminate against female entrepreneurs and managers (Aterido, Beck and Iacovone 2011; Beck, Behr and Madestam 2018), yet females are less likely to use banking finance and are more reliant on informal finance (Cavalluzzo, Cavalluzzo and Wolken 2002; Richardson, Howarth and Finnegan 2004; Ongena and Popov 2016). My results indicate that there exists a gender gap in the trade credit market, thus informing policymakers on regulations and affirmative actions that help direct firms led by female and/or hire more female employees to formal financial systems.

Conceptually, gender bias can distort the allocation of trade credits through two channels. First, in a gender biased environment, suppliers may misperceive buyer's ability based on the sex composition of its workforce, and therefore misallocate credits accordingly (Sarsons 2017; 2019; Duflo 2012). Since trade credit markets often involve frequent site visits by credit suppliers

(Petersen and Rajan 1997), firms with higher shares of female production employees in factories or plants may be perceived as incompetent and less likely to succeed in the product market (i.e., statistical discrimination). As a result, they are offered less trade credit relative to firms with lower shares of female production workers.[34] This does not imply that female workers underperform their male peers in manufacturing industries but emphasizes the misperception held by lenders due to gender bias. Second, gender norms favoring males may affect trade credit allocation through altering suppliers' preferences or "tastes" (Becker 1957; Goldin 2014). [35] Jayachandran (2015) and Dhar, Jain and Jayachandran (2018) show that deeply-held preferences that discriminate against women can explain a non-trivial part of the gender gap in many economic

[34] Petersen and Rajan (1997) stress that the supplier of trade credit may visit the buyer's plant or factories more often than formal financial institution would in order to obtain information on buyers' credit quality. Although financial institutions may also collect similar information, trade credit supplier can get such information faster and at lower cost via the normal course of business.

[35] Becker's taste-based discrimination model is actively debated in the literature. For example, one of main findings from Becker's model is that perfect competition would drive discriminatory employers out of the market. Arrow (1972) criticizes that Becker's model essentially predicts the absence of the phenomenon that the model is set to explain in the first place. Arrow (1973) and Phelps (1972), based on rational behavior optimization and information asymmetry, propose statistical discrimination models, which offer another important way of thinking discrimination. In our study, I do not attempt to distinguish between the two branches of theories. Both can be at work that links gender bias to trade credit market frictions.

outcomes. Therefore, suppliers may choose to allocate more credit to firms with a larger fraction of male employees simply due to preferences. Note that these channels stress that suppliers may allocate trade credit based on misperceptions and biased preferences, rather than customer (borrowing) firms' ability.

Identifying the causal impact of gender bias on firms' access to trade credits is challenging. First, contemporaneous components of gender bias, such as those extracted from the World Value Survey, and the patterns of firms' access to informal finance may be codetermined by the current stage of economic development, the quality of institutions and other unobservable country characteristics. In addition, the specific patterns of firm financing and performance may further exacerbate the gender beliefs held by a society. Both problems can make it difficult to draw causal inferences from gender bias to firm access to trade credits. Indeed, results from existing studies are largely mixed. While Asiedu et al. (2013) document a negative link between female entrepreneurs and access to finance in Sub-Saharan Africa, for example, Aterido, Beck and Iacovone (2011) show that such relationship disappears once firm or individual characteristics are added.

I exploit two distinct sources of plausibly exogenous variations in gender bias in attempt to establish causality. The first is based on a well-established insight in economics that countries with a heritage of plough agriculture exhibit weaker beliefs about the equality of men and women today (Alesina, Giuliani and Nunn 2013; 2018; Boserup 1970). The economic reasoning is that the practice of plough agriculture generated a division of labor along gender lines where men

specialized in work outside home in the fields and women specialized in housework. This is because plough agriculture requires substantial upper body strength and the bursts of power to control the plough, which gives men an advantage relative to women. Societies featuring traditional plough agriculture have thus developed beliefs that the natural place for women is at home and such beliefs have persisted even if societies moved out of agriculture. Alesina, Giuliani and Nunn (2013) construct a measure of ancestral plough agriculture from the Ethnographic Atlas (Murdock 1967), which reports information on whether societies traditionally used the plough on 1,265 ethnic groups prior to industrialization. I use population-weighted country average of this measure, provided in Alesina, Giuliani and Nunn (2013), as my first proxy for gender bias. Since the adoption of plough agriculture may be endogenous to the pre-industrial level of economic development, I supplement this measure with: (1) a predicted probability of plough adoption using land suitability for crops that benefit more from the plough agriculture, and (2) a measure of aboriginal plough adoption prior to the European contact (Alesina, Giuliani and Nunn 2013, 2018).

My second measure of gender bias is extracted from survey responses by descendants of U.S. immigrants on a question about the appropriate role of women in a society. In particular, I use gender beliefs that U.S descendants have inherited from their ancestors who immigrated to the U.S. as a proxy of gender bias in their country of origin. As emphasized by Putnam (2000) and Guiso, Sapienza and Zingales (2006) that social capital is transmitted by family from parents to children, gender beliefs of a U.S. descendent is a good proxy for gender beliefs of their immigrant ancestors, and by extension a good proxy for the

inherited component of gender beliefs in the country of origin today. This methodology is pioneered by Algan and Cahuc (2010) to study the effects of inherited trust on growth and first applied to research on gender bias by Ongena and Popov (2016). While this measure is not confounded by home countries' time-invariant characteristics, it may suffer from the selective migration problem. That is, the initial conditions in the home country at the time of immigration, such as war, political turmoil and economic depression, could codetermine both the current financing patterns of firms in the home country and the inherited gender beliefs of descendants of U.S. immigrants. To address this concern, I focus on gender beliefs of descendants that are at least two generations apart from the first immigrants. This mitigates the effect of specific country of origin shocks and allows us to construct a cleaner measure of inherited gender bias. As stressed by Paulson and Osili (2008), ancestral beliefs of US immigrants decline over time, implying that the results from using this measure provide a lower bound of the effects of inherited gender bias on the function of informal credit markets.

I then use these plausibly exogenous measures of gender bias in a cross-sectional analysis framework that compares access to trade credits of manufacturing firms with high and low shares of female production employee in countries with strong or weak gender bias. This framework allows us to flexibly include country-year and industry-year fixed effects to control for country and industry time trends, as well as the influence of time invariant factors such as legal origins (La Porta et al. 1997, 1998, 2000), the quality of institutions (Hall and Jones 1999; Acemoglu, Johnson and Robinson 2001), the extent of

fractionalization (Alesina et al. 2003) and geography (Sachs 2003; Rodrik, Subramanian and Trebbi 2004).

I discover that, in high gender-biased countries, manufacturing firms with more female production workers have less access to trade credits. My estimates imply that, moving from low (e.g., Czech Republic) to high gender-biased countries (e.g., Slovenia), access to trade credits (as a share of purchased material inputs or services) of firms that have a higher share of female production workers is 6.33 percentage points lower than that of their otherwise similar counterparts with less female production employees.[36] Given that my sample mean of trade credits, defined as the ratio of material inputs or services paid after delivery, is 44%, this estimate is economically substantial. My results are robust to different model specifications, sample selection, alternative measures of gender bias, and various assumptions about the variance-covariance matrix.

An important threat to my identification strategy is that firms may endogenously choose their workforce composition. For example, if firms with little demand for trade credits hire more female employees in countries with higher gender bias, then my estimates are not capturing the effects of gender bias. I employ five strategies to address this concern. First, I saturate my model with a large set of firm characteristics that may be correlated with both access to trade credits and share of female employees, such as firm age, size, CEO gender and

[36] This interpretation is based on the estimates in column (4) Table 13.

experience, measures of firm demand for external credits, sales growth, profit margin, credit quality, operating efficiency, ownership concentration and product market competition. Second, I employ propensity score matching (PSM) to construct a sample where, for each treated firm (i.e., a firm with high female share), I assign a controlled firm (i.e., a firm with low female share) that is very similar to the treated in terms of observable characteristics. Results from this propensity score matched sample are similar to my main estimates. While PSM is useful to flexibly control for observable firm traits, it does not address omitted variable concern arising from unobservable firm characteristics. My next strategy aims to address this concern.

The third strategy relies on unexpected credit shortages due to exogenous price reductions in international commodity markets. As emphasized by a large body of literature on development economics, the impact of gender bias is stronger when resources become scarce (e.g., Jayachandran and Pande 2017; Jayachandran and Kuziemko 2011). This suggests that if firms with more female workers receive less trade credits due to gender bias, then this relationship should be more pronounced in industries that face higher unexpected credit shortages. From the International Monetary Fund Primary Commodity Price System, I obtain and match time-series data on major international commodity price indices to my sample. I find that my results are mainly driven by firms in industries that have just suffered from unexpected price reductions from international commodity markets. Since the unexpected credit shortages are not correlated with, and therefore exogenous, to firm characteristics and decisions, this evidence supports my main results that firms with more female production

workers have less access to trade credits in high gender-biased countries. The next strategy relies on similar economic reasoning from the finance-growth literature (e.g., Rajan and Zingales 1998). In particular, I conjecture, and find, that the relationship between gender bias and access to trade credits is driven by industries that are more dependent on external credits for technological reasons.[37]

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[37] Following Rajan and Zingales (1998), we construct a measure of industrial dependence on external finance (EFD). It is calculated as the fraction of capital expenditures not financed with firm's internally generated cash flows. Rajan and Zingales (1998) invent and calculate this measure at the 3-digit ISIC level using data from the United States during 1980s. They argue that the financial markets are relatively frictionless in the United States and therefore EFD calculated this way measures the varying degrees to which firms depend on external finance across industries for technological reasons.

It is important to note that dependence on external finance is used to measure a relatively more resource-limited environment where the effects of gender bias are found to be particularly strong (Jayachandran and Pande 2017; Jayachandran and Kuziemko 2011). Dependence on external finance is well-suited in this setting because it incorporates both long- and short-term financing needs of a firm. Specifically, capital expenditures (the first component) capture a firm's long-term investment needs, while cash flows from operation (the second component) cover short-term liquidity needs. Indeed, as emphasized by Petersen and Rajan (1997), variables that proxy for a firm's finance demand should incorporate its investment opportunities, liquidity and access to finance from financial institutions. Measures that only capture one part of the financing needs therefore are less suitable in this study.

My fifth strategy is based on a well-established insight in social psychology that the impact of gender diversity (i.e., having more female in corporate board or workforce) on firm outcomes may vary depending on the industry involved (e.g., Cejka and Eagly 1999; Glick 1991). In a recent study, for example, Cumming, Leung and Rui (2015) find that female board directors reduce corporate fraud, and more importantly, this relationship is largely driven by firms in male-dominated industries where a masculine personality is viewed as necessary for success. I relate this finding to my setting and conjecture that if firms receive less trade credits due to gender bias, then this link should be more pronounced in male-dominated industries where gender prejudice is supposedly stronger (Cejka and Eagly 1999; Glick 1991). This is indeed what I find: my results are largely driven by firms operating in male-dominated industries. Taken together, the evidence thus far suggest that my main estimates are unlikely to be completely driven by endogenous female employees share due to the presence of omitted variables and reverse causality.

A remaining concern relates to potential measurement errors in the share of female production workers. That is, suppliers of trade credits may not obtain accurate information on firms' workforce composition. The presence of such measurement errors can bias my estimates in either direction if they are systematically correlated with firm characteristics. To alleviate this concern, I first note that suppliers of trade credits frequently visit borrowing firms' plants or factories to collect information that are relevant to their business decision-making (Petersen and Rajan 1997), including those on workforce composition. I then argue, and provide empirical support from three different sets of analyses,

that suppliers in high gender-biased countries use such information in decisions on trade credit allocation. In the first set of analyses, I differentiate firms based on the frequency at which they interact with their suppliers. I conjecture that if suppliers interact more frequently with borrowing firms, they would have more accurate information on borrowers' workforce composition, and thus I should observe a stronger impact of female workers on access to trade credits.[38] This is indeed what I find. My results suggest that the link between female share and access to trade credit is largely driven by firms that interact with their suppliers more frequently. I also perform differential analyses based on the size of firm locations. I predict that suppliers face relatively low transportation costs of site visits if a firm is located in a large city, and therefore they can obtain workforce information of borrowers at a relatively low cost should they need to. I find that my results are mainly driven by firms located in large cities, consistent with my prediction.

My third sets of tests focus on bank financing. As emphasized in Petersen and Rajan (1997), supplier of trade credit may visit the buyer's plant or factories more often than formal financial institution would in order to obtain information on buyers' credit quality. If suppliers of trade credits obtain borrowers'

[38] If, on the other hand, suppliers obtain information on borrowers' workforce composition from directly asking for the information, then we should not observe such differential impact of female work force on access to trade credits.

workforce information via site visits, then I would expect the impact of female workers on firm access to external finance is stronger in trade credit markets. In other words, I would not expect to see similar empirical patterns in bank financing. This is what I find. My evidence suggests that firms with higher share of female production workers have similar level of bank financing relative to their otherwise similar peers, even in high gender-biased countries. In sum, results from these three sets of analyses provide empirical support that (a) suppliers obtain borrowers' information via frequent business interactions; and (b) my baseline findings are not completely driven by measurement errors in the share of female workers.

Although I use two largely exogenous measures of gender bias and include country fixed effects in my empirical analyses, it is worthwhile to stress that my results are not driven by other country-level characteristics that are found to be important to trade credits in the literature, such as national culture (Ghoul and Zheng 2016; Zheng et al. 2012, 2013), the quality of legal system (Johnson et al. 2002; La Porta et al. 1997, 1998, 2000), property rights protection (Johnson, McMillan and Woodruff 2002; Beck and Demirgüç-Kunt 2003), and financial development (Demirgüç-Kunt and Maksimovic 2001; Beck, Demirgüç-Kunt and Maksimovic 2008). In a robustness check, I control for these country-level characteristics and allow them to have differential impact on access to trade credits in high- and low-female-share firms. My results after controlling for the effect of these variables remain unchanged.

A natural question to ask, following the results, is why manufacturing firms hire female production employees if they are associated with less access to trade credits. I propose several potential explanations. First, firms may be trading off access to trade credits for lower labor costs and less managerial burden. Across the world, women are often offered a lower salary compared to their otherwise similar male peers (Blau and Kahn 2004; Blau and DeVaro 2007), because reproductive and domestic responsibilities, such as childcare, lower their bargaining power against their employers.[39] A closely related explanation is that hiring female workers reduces managerial burden. In a report by Clean Clothes Campaign,[40] for example, a Bangladeshi factory worker states that firms do not care demands raised by female employees, while they must give some consideration for demands raised by men. This can increase managerial tasks and work-related costs to the firms, therefore directing firms to hire female workers. I assemble data on the unit cost of labor, measured as a firm's total cost of labor divided by total number of employees, to test whether firms with a higher share of female production workers are related with lower costs of labor. I discover that firms with more female workers indeed have a smaller amount of unit cost of

[39] A U.S. survey conducted by Pew Research Center on working-age adults reveals that 35% of women are reportedly paid a lower salary compared to their male colleagues. For more details, see https://www.pewresearch.org/fact-tank/2018/03/07/women-in-majority-male-workplaces-report-higher-rates-of-gender-discrimination/.

[40] See https://cleanclothes.org/issues/gender.

labor. I also test the employee-based gender effects on other firm outcomes, and I find no detectable impact on firm sales growth, profit margin and capacity utilization. These results imply that on average, the impacts of female employees on firm access to trade credit and on labor costs cancel each other out, generating a sustainable dynamic equilibrium among female employees, access to trade credits and labor costs.

The rest of the paper is organized as follows. Section 2 discusses this paper's relation to the existing literature and contributions. Section 3 describes data and empirical methodology. Section 4 presents results. Section 5 performs various robustness checks and presents some suggestive evidence on firm outcomes, while section 6 concludes the paper.

4.2 Related literature and contributions

This paper is closely related to the literature on the cross-country determinants of access to trade credits. While the literature mainly focuses on the impact of formal institutions, such as the legal environment (e.g., Demirgüç-Kunt and Maksimovic, 2002; Johnson et al., 2002b), property rights protection (e.g., Beck et al., 2008) and the extent of political control over private economy (e.g., Chen et al., 2020), El Ghoul and Zheng (2016) show that national cultural factors, such as collectivism, power distance, uncertainty avoidance and masculinity, plays a key role in shaping the function of trade credit markets. I build on this literature by documenting that a social norm that favors males, another important informal

institution, also determines the operation of trade credit markets, and such impact operates through employees, a previously ignored firm aspect.[41]

This paper differs from, but complements, a growing body of empirical literature on the gender gap in financial markets. While insightful, existing studies only focus on formal financial markets.[42] In particular, scholars find that female entrepreneurs and owners are less likely to apply for bank loans (Cavalluzzo et al., 2002; Buvinic and Berger, 1990) and more likely to rely on informal finance (Richardson et al., 2004; Ongena and Popov, 2016), even though banks do not appear to discriminate against females (Carter et al., 2007, Aterido et al., 2011; Bruhn, 2009). Our study complements this literature by examining the gender gap in access to trade credits, which is the most important source of short-term finance for manufacturing firms (Petersen and Rajan, 1997; Fisman and Love, 2003; Klapper et al., 2012).

Our study is also closely related to recent work by Ongena and Popov (2016). Using a similar identification strategy, the authors find that firms led by female entrepreneurs are less likely to use bank loans and more likely to resort to informal finance. Our paper is distinct in two important aspects. First, while Ongena and Popov (2016), like many others, focus on female entrepreneurs, we study the impact of female workers. Since gender norms are an aspect of society (Stulz and Williamson, 2003; Guiso et al., 2004), it is important to expand the

[41] There is a large number of influential studies on trade credits that focus on a single country; for example, the US (e.g., Petersen and Rajan, 1997; Giannetti et al., 2011), the UK (e.g., Atanasova, 2007; Cunat, 2007), China (e.g., Cull et al., 2009; Ge and Qiu, 2007) and Vietnam (e.g., McMillan and Woodruff, 1999).

[42] Another related stream of literature studies the impact of female directors on firm outcomes (e.g., Adams and Funk, 2012; Adams and Ferreira, 2009; Sila et al., 2016; Chen et al., 2019).

investigation from focusing only on managers and business owners to a wider scope of occupations, such as employees. According to the latest statistics from the World Bank,[43] female employees account for more than 47% of the global labor market, whereas only 16% of managers are female.[44] Second, our findings shed light on the supply side impact of gender bias, while Ongena and Popov (2016) highlight the demand side effects. In particular, an important insight from Ongena and Popov (2016) is that female entrepreneurs choose to opt out of loan applications and rely on informal finance. Our results, on the other hand, show that firms with more female workers are offered fewer trade credits, regardless of their demand for finance.[45] Our paper also adds to this literature by providing additional causal evidence on gender gap and firm financing outcomes. While Ongena and Popov (2016) establish causality by extracting an exogenous component of gender bias from survey responses by

[43] See https://data.worldbank.org/indicator/SL.TLF.CACT.FE.ZS.

[44] Focusing on gender bias based on employee composition is also more relevant in our setting because one of our key measures of gender bias, the historical adoption of the plough, is founded on the notion that women should stay home while men work on production jobs outside home (Alesina et al., 2013a, 2018; Boserup, 1970).

[45] Furthermore, even if firms' demands for informal finance are kept constant, female entrepreneurs may still be offered more trade credits in high gender-bias countries, because they may be perceived to be very highly skilled due to tougher selection rules for executive positions compared to otherwise similar male counterparts. The differential selection rules for females versus males may be less of a concern for regular, rank-and-file positions, which is consistent with our findings. Indeed, an extensive literature on gender gaps documents that female managers are more likely to face tougher selection rules compared to average female employees (e.g., Blau and DeVaro, 2007; Blau and Kahn, 2016).

descendants of US immigrants, we exploit historical plough adoption as an additional exogenous measure of gender bias. Based on the well-established insight in economics (Alesina et al., 2013a, 2018; Boserup, 1970), this measure is not confounded by the impact of modern economic and institutional determinants.

To the extent that we measure gender bias using country-level inherited gender beliefs and plough agriculture, this paper is related to an important strand of literature that studies the impact of institutional characteristics on the function of credit markets (e.g., El Ghoul and Zheng, 2016; Zheng et al., 2012, 2013; Johnson et al., 2002a, b; La Porta et al., 1997, 1998, 2000; Beck et al., 2008, 2003; Demirguc-Kunt and Maksimovic, 2002). In an insightful work, for example, Ghoul and Zheng (2016) show that firm access to trade credits is positively associated with several dimensions of national culture, such as collectivism, power distance, uncertainty avoidance and masculinity. We add to this literature by documenting the independent impact of gender beliefs, another important dimension of national culture, on trade credit provision.[46]

This paper also speaks to the literature that examines various frictions on the function of the financial market. For example, Djankov et al. (2007) investigate the role of information asymmetry in shaping the function and development of financial markets (Jaffee and Russell, 1976; Stiglitz and Weiss, 1981). La Porta et al. (1997, 1998, 2000) assess the relationship between the

[46] Relatedly, our study also speaks to the literature that investigates the impacts of cultural beliefs on economic outcomes. While the majority of the line of research focuses on trust (e.g., Guiso et al., 2006, 2009; Algan and Cahuc, 2010; Aghion et al., 2010; Tabellini, 2008) and social capital in general (Putnam et al., 1994; Barr and Serra, 2010), we add to this literature by addressing another important cultural dimension, unequal gender belief, and its impact on the financial markets.

extent of the legal constraints on managerial moral hazards and firm financing patterns across the world. We, consistent with Ongena and Popov (2016), Stulz and Williamson (2003) and Guiso et al. (2004), show that gender bias exerts a significant impact on the function of credit markets, and offer relevant policy implications to alleviate this friction.

Lastly, we contribute to the literature on the consequences of unequal gender beliefs.[47] For example, Blau and Kahn (2004) show that labor market discrimination towards females had deleterious effects on closing the US gender pay gap in the 1990s. Using a unique employer survey, Blau and DeVaro (2007) reveal that women across occupations have a lower probability of being promoted than men, even conditional on job-specific ratings of performance and ability. This paper extends this line of work by providing evidence that gender bias favoring males can also disrupt the allocative function of financial markets.

4.3 Data and empirical strategy

4.3.1 Plough-based measures of gender bias

My first set of gender bias measures are obtained from Alesina, Giuliani and Nunn (2013; 2018) and based on a well-established economic insight that countries with a plough agriculture heritage have weaker beliefs about the equality of men

[47] Jayachandran and Pande (2017) find that gender beliefs that favor males can lead to differential allocation of food between daughters and sons, and this in turn contributes to the gender gap in stunting globally. Ramakrishnan et al. (2011) show that girls with congenital heart disease receive less treatment than boys due to gender bias. For literature reviews, see Duflo (2012) and Jayachandran (2015).

and women today (Alesina, Giuliani and Nunn 2013; 2018; Boserup 1970). The underlying economic mechanism is the following: (1) plough agriculture requires significant upper body strength and the bursts of power to control the plough; (2) men have an advantage in terms of upper body strength and therefore tend to work outside home while women work at home; (3) this generated gender beliefs that the natural place for women is within the home and such beliefs have persisted even if societies move out of agriculture. Alesina, Giuliani and Nunn (2013, 2018) construct a measure of historical adoption of plough agriculture from the Ethnographic Atlas (Murdock, 1967), which has information on whether societies traditionally used the plough on 1,265 ethnic groups prior to industrialization. I use a population-weighted country-level version of this measure (Plough) as my first proxy for pre-determined gender bias.

However, the historical adoption of plough may be endogenous to the level of economic development and/or the quality of institutions at adoption. I address this concern by using two additional plough-based measure that are arguably less confounded by the economic, institutional and political factors. Firstly, I follow Alesina, Giuliani and Nunn (2013; 2018) to construct a predicted plough adoption using land suitability for cultivating crops that potentially benefit more or less from the plough agriculture. According to Pryor (1985), crops that require large tracts of solid and flat land to be prepared in a short period of time benefit more from the use of plough relative to crops that can be cultivated on shallow, sloped or rocky soils over a longer period of time. Based on this insight, Alesina, Giuliani and Nunn (2013) construct two variables, Plough positive crops and Plough negative crops, which measure the average land suitability for crops that benefit

more and less from adopting the plough, respectively. I regress the historical plough adoption (Plough) on the suitability of these crops, along with other important covariates such as a measure of agriculture suitability (Agriculture suitability), an index of tropical climate (Tropical climate), an indicator of the existence of large domestic animals (Large animals), and measures of pre-industrial political institutions (Political hierarchies) and economic development (Economic complexity). Following Alesina, Giuliani and Nunn (2013), I then use the linear prediction from this model as my first complementary measure (Predicted plough) of gender bias. I also use a measure of aboriginal plough adoption prior to the European contact as my second alternative (Alesina, Giuliani and Nunn 2013, 2018). Table 1 presents the summary statistics on the plough related variables (panel A) and shows the results of the predicting regression.[48] Note that after merging with the World Bank Enterprise Survey, I have these measures for 91 countries. I then drop the countries with less than 30 firm observations to ensure meaningful estimations. This leaves us with 81 countries. Figure 1 shows the distributions of these measures on a world map. Table A2 in the online appendix presents a list of these countries, and tabulates the number of observations in each country and the value of these plough-based measures of gender bias.

[48] As discussed later, after merging with the World Bank Enterprise Survey, we have observations for 90 countries.

4.3.2 Construction of inherited gender bias from descendants of U.S. immigrants

To construct my second measure of gender bias, I use the General Social Survey (GSS) over the period of 1972-2016. In particular, I exploit the survey responses by descendants of U.S. immigrants on question about the appropriate role of women in a society. Following Ongena and Popov (2016), I focus on the variable "FEFAM", which reports the survey responses to the question "It is much better for everyone involved if the man is the achiever outside the home and the women takes care of the home and family." The answers are given on a scale from 1 to 4, denoting "Strongly agree", "Agree", "Disagree" and "Strongly disagree", respectively. I construct an indicator, Traditional gender roles, that equals to 1 if the respondent answered "Strongly agree" or "Agree", and 0 if the respondent answered "Disagree" and "Strongly disagree".

As in Ongena and Popov (2016), I construct a measure of inherited gender bias (Inherited gender bias) by regressing Traditional gender roles on an assortment of individual specific factors including age, age squared, education, gender, religion, employment status, and country-of-ancestry indicators. I then use the estimated coefficients on the country of origin dummy variables as the measure for inherited gender bias. I focus on gender beliefs of descendants that are at least two generations apart from the first immigrants to mitigate the concern that the initial political and institutional conditions in the home country at the time of immigration could codetermine both the current financing patterns of firms in the home country and the inherited gender beliefs of descendants of

U.S. immigrants. Paulson and Osili (2008) emphasize that ancestral beliefs of US immigrants decline over time, suggesting that the results from using this measure provide a lower bound of the effects of inherited gender bias. My results are also robust to the use of answers of all respondents in the survey, regardless of what generation immigrants they are as in Ongena and Popov (2016).

Table 2 reports the pooled ordinary least squares (OLS) estimates of the inherited gender bias in the first two columns, with standard errors clustered at the country-of-origin level. These estimates are largely consistent with Ongena and Popov (2016). I find that the inherited gender bias decreases with education and income. Males have a more biased gender beliefs than female respondents. Protestant, Jewish and Muslim groups have a higher gender bias than atheists (the reference group), while Catholic and other religious groups have a lower gender bias. Finally, employed people in general hold more biased gender beliefs, while unemployed and retired people have less gender bias than the reference group (inactive persons).

4.3.3 Sample and key firm-level variables

My firm level variables are from the World Bank Enterprise Survey over 2009-2018. The Survey provides detailed information on a pooled cross-sectional sample of 136,887 firms in 139 countries. After restricting to manufacturing firms, merging with the plough data in Alesina, Giuliani and Nunn (2013), the inherited gender bias data, and other industrial characteristics data, my sample

reduces to 30,559 manufacturing firms in 81 countries.[49] I conduct most of my analyses in this sample. Table A2 in the online appendix provides a list of these countries, and presents the number of observations in each country and the value of my plough-based measures of gender bias. For the sample that uses the inherited gender bias measure, I have around 9,900 firm-level observations from 15 countries. This is comparable to the 17 countries used in Ongena and Popov (2016). Table A3 in the online appendix shows a list of these countries, and tabulates the number of observations in each country and the value of the inherited gender bias. In Table 3, I report the summary statistics for all variables used in the analysis.

My key interest variable, Female, is calculated as the share of female production employees in a firm. As shown in Table 3, the share of female production employees ranges from 0 to 1, with a mean of 0.17 and a standard deviation of 0.24. Across my sampled countries, Pakistan and Iraq have the lowest average share of female production employees (0.01 and 0.03), while Albania and Cambodia have the highest shares of female employees[50] (mean 0.44 and 0.48). The share of female non-production employees (Female_non) also

[49] Since our sample does not include important western economics such as the United Kingdom and the United States, we caution the readers about extrapolating our results outside our sample. In other words, our results may not apply to those important western countries.

[50] See Table A1 in the online appendix.

exhibits great variations, with a mean of 0.08 and a standard deviation of 0.11. I also construct a dummy indicator, Female_DV, that equals to 1 if firms have above median value of Female, and 0 otherwise. Figure 2 presents the world distributions of these measures.

I use account payable from the Enterprise Survey as the main measure of trade credit. It is calculated as the fraction of material inputs or services paid after delivery last year. As stressed by Petersen and Rajan (1997), this measure provides clean information on trade credit supplies that is not confounded by demand factors. To illustrate, trade credit contracts typically state a discount date, a due date and the amount of discount for payment by the discount date.[51] If firms make payment by the discount date, they would receive a discount price on the purchase. Because accepting trade credits that can be repaid within the discount date incurs no cost for firms, it dominates paying cash. Thus, account payable is a proper measure for the supply of trade credits. As shown in Table 3, Account payable has a mean of 43.87% and a standard deviation of 36.54%. This suggests that on average, 43.87% of material inputs or services purchased by my sampled

[51] For example, a contract that specifies 2%, 10 days and 30 days means the buying firm receives a 2% discount if they make payment within 10 days (the discount date); payments made after 10 days, but within 30 days, will be the full amount; additional penalties may apply after 30 days (Smith 1987; Petersen and Rajan 1997).

firms are offered as trade credits. Figure 3 plots the distribution of country-level average of trade credit provision.

The Enterprise Survey also provides information on other firm attributes. Whenever feasible, I condition my analyses on the following firm-specific traits: Firm size indicates whether a firm has less than 20, between 20 and 99, and more than 100 total number of employees; Firm age equals the number of years since a firm starts operation; CEO experience equals the tenure of a firm's CEO; Ownership concentration equals the share of a firm owned by the largest owner; State (Foreign) equals the fraction of a firm owned by the state (foreign investors); Business group is an indicator that equals 1 if a firm belongs to a business group and 0 otherwise; Export is an indicator that equals 1 if a firm has a positive share of sales exported outside the country and 0 otherwise; Industry sales growth is the median value of firms' sales growth within an industry in each year; Product competition equals the number of competitors of a firm's main product; Female CEO is an indicator that equals 1 if a firm's CEO is female and 0 otherwise; Profit margin is the ratio of profit over total sales last year; Collateral share equals to the value of collaterals over the value of loans; Credit line is an indicator that equals to 1 if a firm has at least one credit line open from a financial institution and 0 otherwise.

I also use the following firm characteristics from Enterprise Survey to examine various alternative explanations of the results: Interaction frequency, is an indicator that equals 1 if firms purchase inputs from and interact with their suppliers every 20 days, the sample median value, or more frequent, and 0 if they

do so at a longer time interval; Unit labor cost is calculated as the total labor costs divided by total number of employees in a firm and it is measured in 2010 US dollars; Sales growth equals the rate of sales growth for a firm in the last three years; Applied for a loan is an indicator that equals 1 if a firm applied a loan from a financial institutions last year and 0 otherwise; No need for a loan is an indicator that equals 1 if a firm reports that it did not apply for a loan last year because it did not need it and 0 otherwise; Working capital financed by banks is the share of a firm's working capital currently financed by banks; Investment financed by banks is the share of a firm's financial investment currently financed by banks; Capacity utilization is the share of current output over the maximum output possible using the current inputs.

Table A4 in the online appendix presents the summary statistics by female share and shows the differences between high and low female share firms. Many of the differences are statistically significant and are possibly correlated with access to trade credits. For example, high female share firms tend to be larger, younger, and are more likely to have a female CEO and involved in exporting. I make sure to control for these firm characteristics in my analyses and, as I discuss later, I employ four additional strategies to mitigate the influence of these variables on my main results, including the use of a propensity score matched sample, an exogenous macro credit shock, and two industrial heterogenous analyses that are consistent with theoretical predictions.

4.3.4 Industry-level characteristics

I measure industry-level characteristics using data from multiple sources. My first variable, Commodity price shock, which measures unexpected credit shortage in an industry, is constructed in the following steps. I firstly obtain time-series data on major international commodity price indices from the International Monetary Fund Primary Commodity Price System (IMF-PCPS). I then match the available price indices, and their respective percentage change from previous year, to industries in my sample, based on the industry descriptions[52] and survey year. For example, I match the food price index from the IMF-PCPS to "Food manufacturing industry" in my sample (ISIC code 311-312). Similarly, I match beverage and iron ore price indices to "Beverage industries" (ISIC code 313) and "Iron and steel basic industries" (ISIC code 371), respectively. In sum, I successfully matched the international commodity price indices to 24 out of 29 manufacturing industries to my sample.[53] Table A5 in the online appendix provides detailed matching between the IMF-PCPS prices indices

[52] Our industry-level measures are calculated based on the 3-digit International Standard Industrial Classification (ISIC) system, revision 2.

[53] We cannot find appropriate global commodity price indices for "Manufacture of pottery, china and earthenware", "Manufacture of glass and glass products", "Manufacture of other non-metallic mineral products", "Manufacture of electrical machinery apparatus, appliances and supplies" and "Manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods". Their ISIC codes are 361, 362, 369, 383 and 385, respectively.

and my sampled industries. In the last step, I let Commodity price shock equals to 1 if an industry has experienced a price reduction relative to the previous year based on the matched price index and 0 otherwise. This indicator captures the unexpected price changes in international commodity markets and therefore creates a source of time-variant, exogenous variations in credit shortages of firms in a given industry. As shown in Table 3, 48% of manufacturing industries in my sample have experienced a credit shortage during 2009-2018.

I next construct two variables that measure female/male dominance in an industry following Cumming, Leung and Rui (2015). Specifically, I let Female dominated equal to 1 if an industry has been characterized as female-dominated in Cumming, Leung and Rui (2015), and 0 otherwise. The female-dominated industries include manufacturers of textile, manufacturers of biological and medicine, foods and beverages, hotels, tourism, retails, radio, film and television, and publishing. Another measure, Female industry, equals to 1 if an industry has a higher than sample median value of female share and 0 otherwise.

Following the finance-growth literature (e.g., Rajan and Zingales 1998), I also construct a variable, EFD, that measures an industry's dependence on external finance. Dependence on external finance is calculated as the fraction of capital expenditures not financed with firm's internally generated cash flows. Rajan and Zingales (1998) first construct this measure at the 3-digit ISIC level using data from the United States during 1980s. They argue that the financial markets are relatively frictionless in the United States and therefore the measure calculated this way captures the varying degrees to which firms depend on

external finance across industries for technological reasons. I obtain the measure of industrial dependence on external finance from Rajan and Zingales (1998) and let EFD equal to 1 if an industry has an above median value and 0 otherwise.

4.3.5 Country-level characteristics

When I assess the relationship between cross-country variations in gender bias and firm access to trade credits, I control for many country-level characteristics. In particular, I focus on institutional factors that are found to be important to trade credits in the literature, so that I can examine the independent link between gender bias and the function of informal credit markets. My first country level variable is Masculinity. It measures the degree to which a country values male assertiveness over female nurturance. In an important study, Ghoul and Zheng (2016) find that trade credit provision is significantly higher in countries with strong masculinity. Following Ghoul and Zheng (2016) and Zheng et al. (2012), I obtain the Masculinity index from Hofstede (2001). My second measure is Formalism, which measures the efficiency of a country's court system. Johnson, McMillan and Woodruff (2002) find that well-functioning courts encourage firms to develop new relationships with suppliers, therefore facilitating the function of informal credit markets. The third variable is Creditor rights, which measures of the quality of legal protection on creditors. A large literature finds that better legal protection of creditors promotes the development of financial markets (e.g., Djankov, McLiesh and Shleifer, 2007; La Port et al. 1998). I obtain data on Formalism and Creditor rights from La Porta, Lopez-de-Silanes and Shleifer (2008). Next, Property rights measures the quality of a country's private property

rights protection. An extensive strand of research shows that property rights protection facilitates the function of financial markets (e.g., Johnson, McMillan and Woodruff 2002; Beck, Demirgüç-Kunt and Levine 2003; Levine 2005). I obtain the data on property rights protection (Property rights) from The Heritage Foundation.[54] Lastly, Private credits is the ratio of a country's private credit to GDP and is obtained from the World Bank's World Development Indicators. Summary statistics are presented in Table 3.

4.3.6 Empirical strategy

My empirical question is: do firms with a larger share of female production employees have less access to trade credits in high gender biased countries? To test this proposition, I compare access to trade credits of manufacturing firms (1) with more or less female production employee, and (2) in countries with high or low gender bias. In particular, I estimate the following OLS regression:

$$Trade\ credit_{f,i,c,t} = \alpha + \beta_1 Female_{f,i,c,t} \times Gender\ bias_c + \beta_2 Female_{f,i,c,t} + X'_{f,t}\Phi + \Psi + \varepsilon_{f,i,c,t} \quad (1)$$

where $Trade\ credit_{f,i,c,t}$ is access to trade credit, measured as the share of material inputs or services paid after delivery last year, of firm f in industry i in country c at time t. $Female_{f,i,c,t}$ is the number of female production workers as a

[54] See https://www.heritage.org/index/.

share of total number of employees in a firm. $Gender\ bias_c$ is either the plough-based measures of gender bias or inherited gender bias extracted from the descendants of US immigrants. I am interested in estimating β_1, the coefficient on the interaction term. I control for various firm characteristics ($X'_{f,t}$) including Firm size, Firm age, CEO experience, Female CEO, Profit margin, Collateral share, Credit line, Ownership concentration, Product competition, Business group, Industry sales growth, Export, State, and Foreign. In addition, I flexibly include country, industry (at 3-digit ISIC level), survey year, country by survey year and industry by survey year fixed effects (Ψ) in the model. Table A1 in the online appendix provides detailed definition and data sources.

Regarding inference, I cluster the standard errors at the country level where my measure of gender bias varies.[55] Since my measure of trade credits is bounded between 0 and 100 (as a percentage of inputs or services paid after delivery), I also use a Tobit model with exactly the same control variables and fixed effects. As placebo tests, I also conduct similar tests on female non-production employees whenever possible. Given that the biased gender beliefs I specifically test in this paper are based on the notion that male should work on

[55] Our results are robust to other clustering strategies such as at the country-industry level. Since our variation mainly comes from country-level, we do not report these results but they are available upon request.

production work outside home while women should stay home, I expect less pronounced impact of gender bias on female non-production workers.

4.4 Results

My main results can be briefly summarized in Figure 4, which shows that in high gender-biased countries, firms with more female production employees, on average, receive substantially less trade credits, relative to their peers with less female workers.

Figure 5 Panel A presents the results based on a sample of firms in industries that have just experienced unexpected credit shortages. It depicts a similar pattern as in Figure 4. That is, firms with more female workers have less access to trade credits in high gender-biased countries. Panel B of Figure 5, based on firms that do not face unexpected credit constraints, does not exhibit similar patterns. This suggests that my results are mainly driven by firms under credit constraints.

Note that after presenting my main results—that is, from section 4.3 onward—I only report results from the plough-based gender bias measure, since it has more observations (30599) from a larger number of countries (81). The results based on inherited gender bias are qualitatively similar, and are tabulated in my online appendix.

4.4.1 Evidence from plough-based gender bias measures

Table 4 confirms the empirical patterns shown in Figure 4. I find that firms with a higher share of female production workers have less access to trade credits in high gender bias countries. As shown in Table 4, $Female_{f,i,c,t} \times Plough_c$ enters all regressions with negative and statistically significant coefficients at 5% confidence level. In column (1), I report the results from OLS regressions with my full set of control variables and fixed effects that aim to capture country-, industry-, and year-level common factors that may affect both gender-bias and firm access to trade credits. In column (2)-(4), I vary the inclusion of fixed effects to account for industry- and/or country-level time trends, which may also confound my results. In column (5), I report the results from a Tobit model, where I include the full set of control variables in addition to country-year, and industry-year fixed effects. Across all specifications, my estimated coefficients are very stable. The estimated economic magnitudes are also large. For example, consider the coefficient reported in column (4), my most conservative estimate. They suggest that moving from the lowest to highest gender-biased countries (e.g., from Slovenia to Czech Republic), firms that hire 75% production workers from female labor participants, relative to those with only 25% workforce as female, receive 3.94 (=7.88×0.5) percentage points less trade credits. This is a nearly 9% drop when evaluated at sample mean (43.87%).

4.4.2 Evidence from inherited gender bias

Table 5 presents the results from regressions using inherited gender bias. I find, again, that in high gender-biased countries, firms with more female production

workers have less access to trade credits. As shown in Table 5, all coefficients of $Female_{f,i,c,t} \times Plough_c$ are negative and statistically significant at least at 5% confidence level. Similar to Table 4, I report the results from OLS regressions in column (1)-(4), with different sets of fixed effects in addition to the full set of firm characteristics. In column (5), I report the results from a Tobit regression, where I include the full set of control variables in addition to country-year, and industry-year fixed effects. The economic magnitudes of my estimates are substantial and comparable to those estimated using the plough-related gender bias measure. For instance, consider my preferred estimates reported in column (4) and using the same representative countries as an example. They imply that if firms move from the Slovenia, a relatively high gender-biased country, to Czech Republic, a relatively low gender-biased country, firms that hire 75% production workers from female labor participants, compared with those with only 25% workforce as female, receive 4.28 (=39.96×0.214×0.5) percentage points less trade credits, which is about 10% drop relative to sample mean (43.87%). This magnitude is similar to the one I estimated using the plough-related gender bias measure.[56] It is important to note that since I are using two distinct sources of plausibly

[56] As in Ongena and Popov (2016), we matched the coefficient on the Yugoslavia dummy from the regression in which we predicted the inherited gender bias score to all five countries in the sample that by 2006 former Yugoslavia had broken into (i.e., Bosnia, Croatia, Macedonia, Slovenia, and Yugoslavia). Our results remain similar when removing Yugoslavia from the sample.

exogenous variation in gender bias, these estimates add further confidence to my findings.

4.4.3 Heterogenous analyses by unexpected credit shortages

An important concern to my identification strategy is that firms may endogenously choose how many female workers to hire. For example, if firms with little demand for trade credits hire more female production employees in countries with higher gender bias, then my estimates are not capturing the effects of gender bias. To alleviate this concern, I exploit an exogenous shock on firm credit constraints. As stressed by an extensive body of literature on development economics, the impact of gender bias is stronger when resources become scarce (e.g., Jayachandran and Pande 2017; Jayachandran and Kuziemko 2011). This implies that if firms with more female workers receive less trade credits due to gender bias, then this relationship should be more pronounced in industries that face higher unexpected credit shortages. I test this conjecture by dividing my sample based on Commodity price shock, which equals to 1 if an industry has experienced an exogenous price reduction in international commodity markets relative to the previous year and 0 otherwise. I re-run model (1) in the two subsamples and tabulate my results in Table 6.

Column (1)-(4) shows the results from industries that have just experienced unexpected credit shortages, while column (5)-(8) presents the results from the rest of the sample. Clearly, my results from are mainly driven by firms that face exogenous credit constraints (column (1)-(4)), which is consistent

with my hypothesis that the impact of gender bias is stronger when resources become scarce. In fact, my evidence from column (5)-(8) suggests that firms with more female workers do not appear to be disadvantaged in the informal credit markets when credits are not constrained.

4.4.4 Heterogenous analyses by female dominance

I perform another set of heterogenous analyses based on whether an industry is characterized as male or female dominated. These tests provide further evidence that my estimated relationship between female production workers and trade credits is indeed driven by gender bias. As stressed in the social psychology literature, the impact of gender diversity (i.e., having more female in corporate board or workforce) on firm outcomes may vary depending on the industry involved (e.g., Cejka and Eagly 1999; Glick 1991). In an important study, for instance, Cumming, Leung and Rui (2015) document that female directors reduce corporate fraud, and this relationship is largely driven by firms in male-dominated industries where a masculine personality is seen as necessary for success. Relating this result to my paper, I conjecture that if firms receive less trade credits due to gender bias, then this relationship should be more pronounced in male-dominated industries where gender prejudice is supposedly stronger (Cejka and Eagly 1999; Glick 1991). I divide my sample based on whether an industry is featured by female-dominance, and re-do my analyses in the subsamples. My results are presented in Table 7.

As shown in Table 7, the coefficients on $Female_{f,i,c,t} \times Plough_c$ are negative, statistically significant only in column (2) and (4), where the results are based on firms in male-dominated industries. In female-dominated industries (column (1) and (3)), this relationship is no longer statistically meaningful. Taken together, the evidence thus far suggest that my main estimates are unlikely to be completely driven by endogenous female share due to the presence of omitted variables and reverse causality.

4.4.5 Measurement error in female share

A remaining concern is whether, and to what extent, my results are influenced by potential measurement errors in Female (i.e., the share of female production workers). Because suppliers of trade credits may not have accurate information on firms' workforce composition, my estimates may be biased in either direction depending on whether and how potential measurement errors are systematically correlated with other firm characteristics.

To alleviate this concern, I firstly note that suppliers frequently visit borrowing firms' factories to collect information that are later used in their business decision-making (Petersen and Rajan 1997), including those on workforce composition. I then conduct three sets of empirical analyses to further assess to what extent my estimates are affected by such measurement errors. In the first set of analyses, I differentiate firms based on the frequency at which they interact with their suppliers. I argue that if suppliers interact more frequently with borrowing firms, they would have more accurate information on borrowers'

workforce composition, and thus I expect a stronger impact of female workers on access to trade credits. If, on the other hand, suppliers obtain information on borrowers' workforce composition in ways other than site visits, then I should not observe such differential impact of female work force on access to trade credits. To test this conjecture, I divide my sample based on Interaction frequency, which is an indicator that equals 1 if firms purchase inputs from and interact with their suppliers every 20 days, the sample median value, or more frequent, and 0 if they do so at a longer time interval. I then re-run model (1) and tabulate my results in Table 8.

As shown in Table 8, my results are mainly driven by firms that interact with their suppliers at a higher frequency (column (1)-(4)). The economic magnitude is larger than my baseline estimates. For example, consider the coefficient on $Female_{f,i,c,t} \times Plough_c$ in column (4). It suggests that moving from the lowest to highest gender-biased countries (e.g., from Slovenia to Czech Republic), firms that hire 75% production workers from female labor participants, relative to those with only 25%, have 5.4 (=10.79×0.5) percentage points less trade credits. This is more than 10% of my sample mean (43.87%).

My second sets of analyses focus on access to bank financing. As stressed in Petersen and Rajan (1997), suppliers of trade credit may visit the borrowers' plants more often than formal financial institution would in order to obtain information on borrowers' credit quality. If suppliers of trade credits indeed obtain borrowers' workforce information via frequent site visits, then I would expect the impact of female workers on firm access to external finance is stronger

in trade credit markets. Similarly, I would not expect to see similar empirical patterns in bank financing. To test this conjecture, I re-run model (1), but with firm access to bank credits as my dependent variables. As shown in Table 9, all the coefficients on $Female_{f,i,c,t} \times Plough_c$ are small and statistically insignificant. This suggests that firms with more female workers have similar level of bank financing relative to their otherwise similar peers, even in high gender-biased countries.

Lastly, I perform differential analyses based on the size of firm locations. I conjecture that suppliers of trade credits face relatively low transportation costs in site-visiting if a borrowing firm is located in a large city, and therefore they can obtain workforce information at a relatively low cost should they need to. To test this conjecture, I split my sample based on the size of firm-located cities. In particular, I define large cities if they have a population higher than 250,000 (the median size of cities in my sample), and small cities if they have a smaller population. I re-run model (1) in these subsamples and present the results in Table 10. As shown in the table, my results are largely from firms located in large cities (column (1)-(4)). The economic size is similar to my baseline results. Consider the coefficients in column (4). Using the sample country example, moving from Slovenia to Czech Republic, firms that hire 75% production workers from female labor participants, relative to those with only 25% female workers, receive 4.82 (=9.64×0.5) percentage points less trade credits. In sum, results from these three sets of analyses provide empirical support that (a) suppliers obtain borrowers' information via frequent business interactions; and (b) my

baseline findings are not completely driven by measurement errors in the share of female workers.

4.4.6 Suggestive evidence on firm outcomes

What are the possible consequences on firm performance? If there is an employee-based gender gap in the trade credit market, and firms with more female production employees have less access to trade credit, why firms are still hiring female production workers? In this section, I provide some suggestive evidence on these questions.

A potential explanation for why manufacturing firms hire female production employees in high gender biased places is that firms are trading off access to trade credit for lower labor costs. Anecdotal evidence suggests that female workers are often offered a lower salary compared to their otherwise similar peers. For example, a U.S. survey conducted by Pew Research Center on working adults reveals that 35% of women are reportedly paid a lower salary compared to their male colleagues. Relatedly, as shown in a report by Clean Clothes Campaign,[57] firms do not often care demands raised by female employees in gender biased environment, while they must give some consideration for demands raised by men. This can increase managerial tasks, labor and work

[57] See https://cleanclothes.org/issues/gender.

environment related costs to the firms, therefore leading firms to hire female workers. I assemble data on Unit labor cost, measured as the total labor costs divided by total number of employees in a firm, to test whether firms with a higher share of female production workers are related with lower labor costs. As shown in Table 11, I discover that this is indeed the case: firms with a higher share of female production workers have a significantly smaller amount of unit cost of labor and this effect is homogenous across high and low gender-biased countries.

I also test the effects of gender gap in informal credit market on firm performance. As shown in Table 11, I find no impact of female employees on firm profit margin, sales growth, and capacity utilization. While suggestive, these results imply that on average, the impacts of female production employees on firm's access to trade credit and labor costs may cancel each other out, generating a sustainable dynamic equilibrium among female employees, access to trade credits and labor costs.

4.5 Robustness Checks

4.5.1 National characteristics

In this section, I conduct an extensive set of robustness checks on my main results. Since my measures of gender bias vary at the country-level, I start with including interaction terms between female share and other important country-level characteristics. I focus on institutional factors that are found to be important to

the allocation of trade credits in the literature. In particular, I run the following OLS model:

$$Trade\ credit_{f,i,c,t} = \alpha + \beta_1 Female_{f,i,c,t} \times Gender\ bias_c + \beta_2 Female_{f,i,c,t} \times Country\ characteristic_c + \beta_3 Female_{f,i,c,t} + X'_{f,t}\Phi + \Psi + \varepsilon_{f,i,c,t} \quad (2)$$

where $Country\ characteristic_c$ is either Masculinity, Formalism, Creditor rights, Property rights and Private credits. All variables are defined in the data section and Table A1 in the online appendix. The rest of the model is the same as model (1). I tabulate my results in Table 12.

As shown in Table 12, my results are not changed due to the inclusion of additional country-level variables. In column (1)-(8), I control for various interaction terms between female share and country characteristics, while in column (9), I include all relevant country-level variables together. The coefficients on $Female_{f,i,c,t} \times Plough_c$ remain negative, and statistically significant at conventional confidence levels. This suggests that the results I find in my baseline estimates are independent of these important country-level factors.

4.5.2 Propensity score matching

In this subsection, I employ propensity score matching (PSM) technique (e.g., DeFond, Erkens and Zhang, 2017) to construct a matched sample and re-estimate model (1). In particular, I first predict a firm's probability of being treated (i.e., high female share) with my full set of control variables in addition to country, industry and survey-year fixed effects using a probit model. I then match each

treated firm with a control firm that has the closest ex ante probability of being treated without replacement. My results are tabulated in Table 13. In column (1), I report the regression coefficients for all the variables used in calculating the propensity score. In column (2)-(4), I present the results of estimating model (1) in this propensity score matched sample, with flexibly controlled fixed effects as in my main regressions.

As shown in Table 13, my estimates are in general smaller in size, but are more precise relative to my baseline results. Specifically, all coefficients on $Female_{f,i,c,t} \times Plough_c$ are negative and statistically significant at 1% confidence level. Regarding economic size, consider the estimate in column (4). It suggests that moving from Slovenia to Czech Republic, firms that employ 75% production workers from female labor participants, relative to those with only 25%, receive 3.12 (=6.24×0.5) percentage points less trade credits. These estimates suggest that, even after flexibly control for firm observable characteristics, my results remain qualitatively robust.

4.5.3 Alternative measures of gender bias

Table A6 and A7 in the online appendix present the results from estimating model (1) using two alternative plough-based gender bias measures. This is because the historical adoption of plough may be endogenous to the level of economic development and/or the quality of institutions at adoption. As discussed on the data section, Predicted plough is predicted using the average land suitability for crops that would benefit more and less from adopting the plough following

Alesina, Giuliani and Nunn (2013; 2018). I also use a measure of aboriginal plough adoption prior to the European contact as my second alternative (Alesina, Giuliani and Nunn 2013, 2018). The results from these alternative measures are similar to my baseline estimates, if not stronger.

4.5.4 Alternative measures of credit constraints

Following the finance-growth literature (e.g., Rajan and Zingales 1998), I perform split sample tests by firms' natural dependence on external finance. Dependence on external finance is calculated as the share of capital expenditures not financed with firm's internally generated cash flows. Drawing insights from the development economics (e.g., Jayachandran and Pande 2017; Jayachandran and Kuziemko 2011), I conjecture that if firms with more female workers receive less trade credits due to gender bias, then this relationship should be more pronounced in industries that depend more on external finance for technological reasons. In Table A8 in the online appendix, I find that my results are mainly driven by firms in industries that are more dependent on external credits, consistent with my prediction.

It is worth-noting that the measure of industry-level dependence on external finance is meant to capture, in relative terms, a credit-constrained environment that is not influenced by firm decisions. While the existing literature offers various important, more precise firm-level measures of credit constraints, such as the Kaplan and Zingales (1997) index, the Whited and Wu (2006) index, and the Hadlock and Pierce (2010) index, they are more or less co-determined

and therefore confounded by firm decisions. Dependence on external finance, on the other hand, measures whether an industry needs external credits for technological reasons, which is unlikely to be affected by firms' choices. For example, the pharmaceutical industry is more reliant on external financing because it needs a very long period of, and a large amount of initial investments for, research and development compared to the textile industry. In addition, the fact that this measure is calculated using data from United States highlights two additional advantages for my empirical setting: (a) the financial markets are relatively frictionless in the United States and therefore the measure captures firm natural dependence on external finance, and (b) my sample does not contain observations from the United States and thus this measure is more exogenous to firms in my sample.

4.5.5 Non-production female employees

I also perform a set of placebo tests using female non-production employees in model (1). Given that the biased gender beliefs I specifically test in this paper are based on the notion that male should work on production work outside home while women should stay home, I expect no effects on female non-production workers. This placebo test can add further confidence to my main results, since it looks at the same sample with exactly the same firm characteristics to my main tests. If my baseline estimates are capturing a spurious relationship between gender bias and trade credits, this relationship should show up here as well. My results are tabulated in Table A9 in the online appendix. I find that none of the

coefficients on $Female_{f,i,c,t} \times Plough_c$ is statistically different from zero, consistent with my hypothesis.

Given that CEO/owner plays a key role in shaping firm access to finance (e.g., Ongena and Popov, 2016), it is important to note that gender bias may have heterogenous impact on female CEO/owner and female (non-production) rank-and-file employees, although both types of occupations seem to fit the non-production category. For female owner or CEO, gender bias in theory may not inhibit, or perhaps even promote, access to trade credits, since an extensive literature on gender gaps documents that female managers face tougher selection rules compared to their male counterparts and average female employees (e.g., Blau and DeVaro 2007; Blau and Kahn 2016), and therefore are more competent. This may be one of the reasons that some studies find that banks do not bias against female-led firms (Aterido, Beck and Iacovone 2011; Bruhn 2009; Carter et al. 2007). This is less true for average, female employees. Although they may also face stronger selection rules compared to similar male peers, the extent is arguably smaller.

4.6 Conclusion

Using two plausibly exogenous sources of gender bias and unexpected credit shortages from international commodity markets, my study identifies a gender gap in access to trade credits for manufacturing firms across 81 countries. In particular, I find that, in high-gender-biased countries, manufacturing firms with a higher share of female production employees have less access to trade credits.

I also show that these empirical patterns are not completely driven by firms' endogenous hiring decisions. Finally, I document that firms that hire a higher proportion of female employees, on average, have lower unit costs of labor, suggesting that firms in high gender-biased countries are trading off access to trade credit for lower labor costs.

Combining my results with existing evidence offers important policy implications. In particular, since female are less likely to use bank loans and are more reliant on informal finance, my finding informs policymakers on regulations that direct firms led by female and/or with more female employees to formal financial systems, which do not appear to discriminate against female. This can potentially correct an important friction in the financial markets, and potentially promote economic growth.

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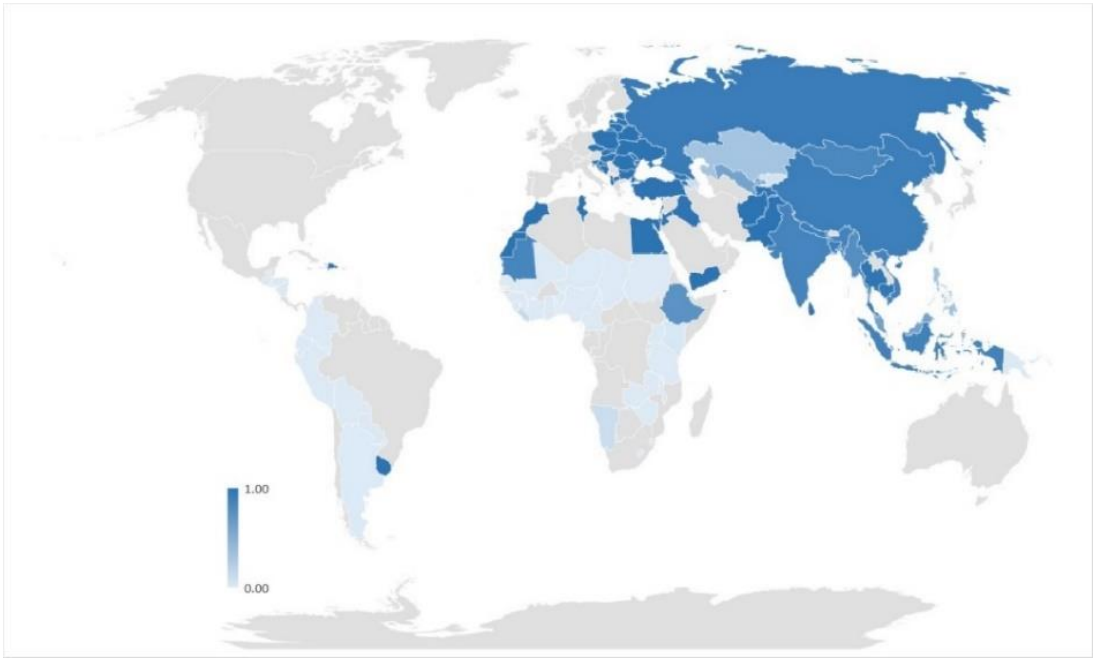
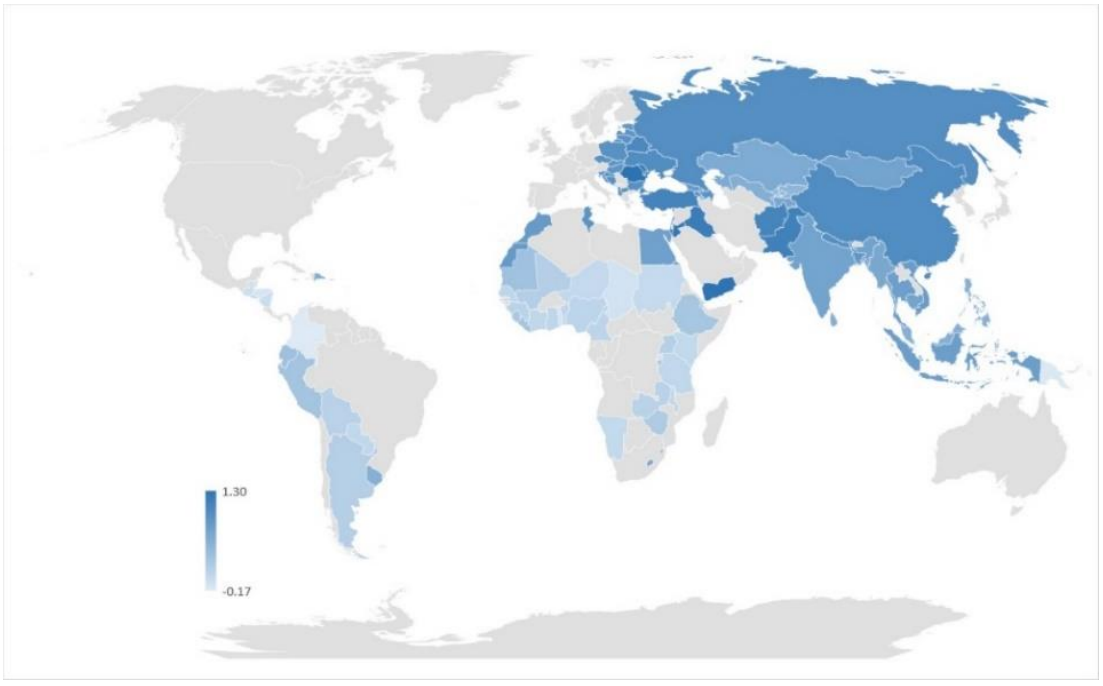
Figure 4.1: Distributions of plough adoption

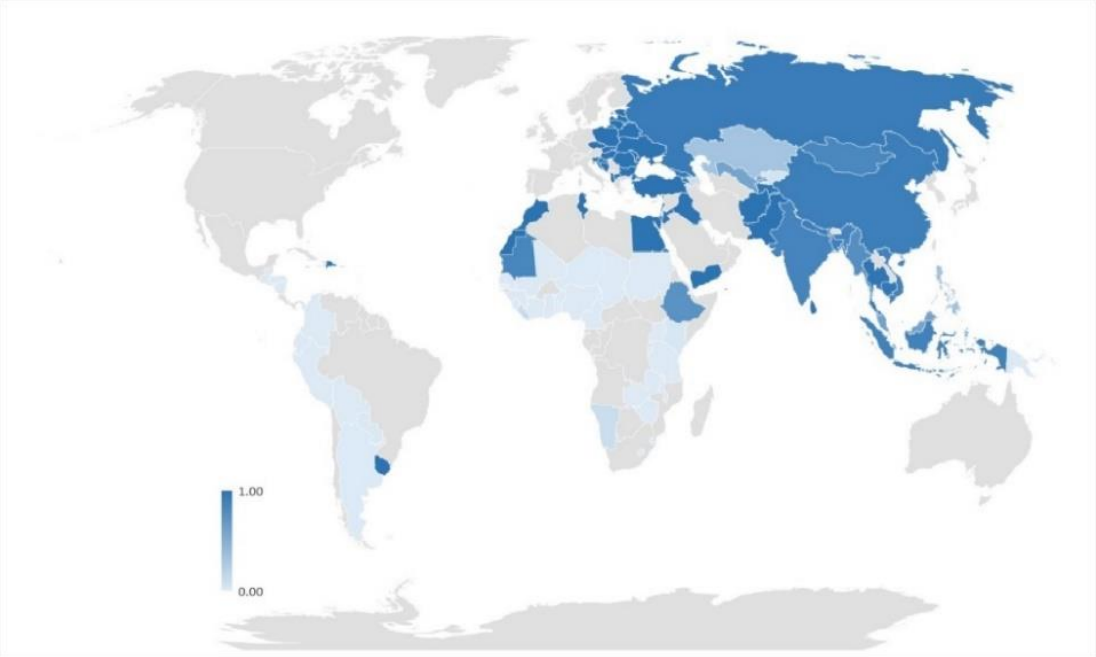
Panel A: Distribution of historical plough adoption



Panel B: Distribution of predicted plough adoption



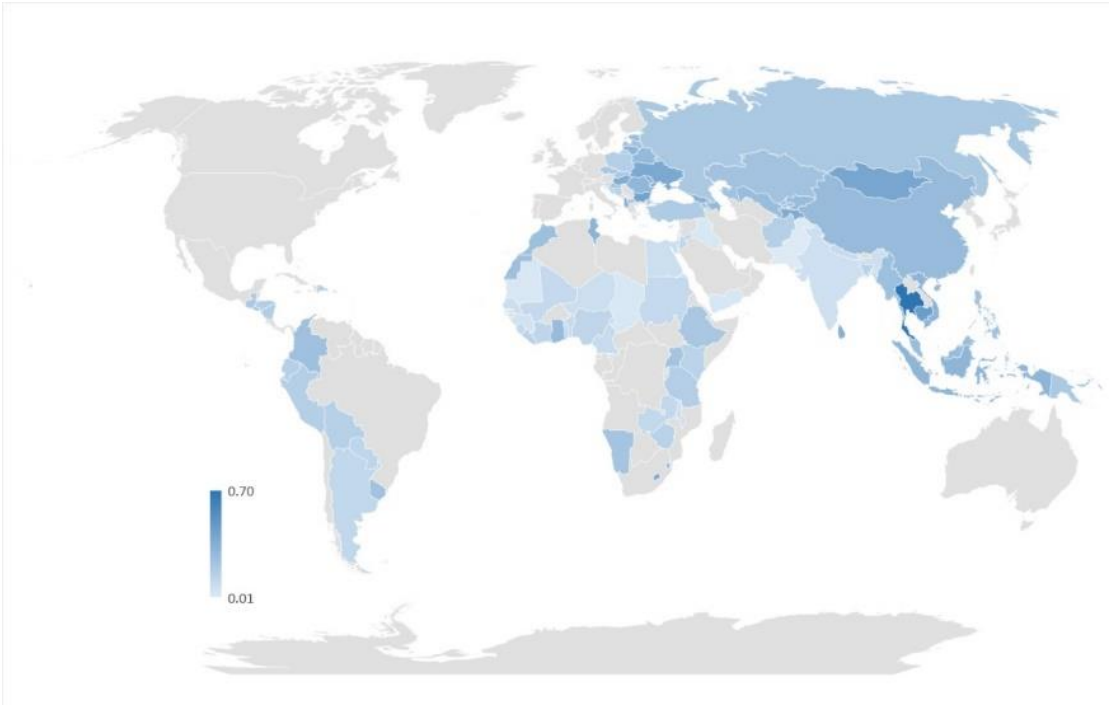
Panel C: Distribution of aboriginal plough adoption



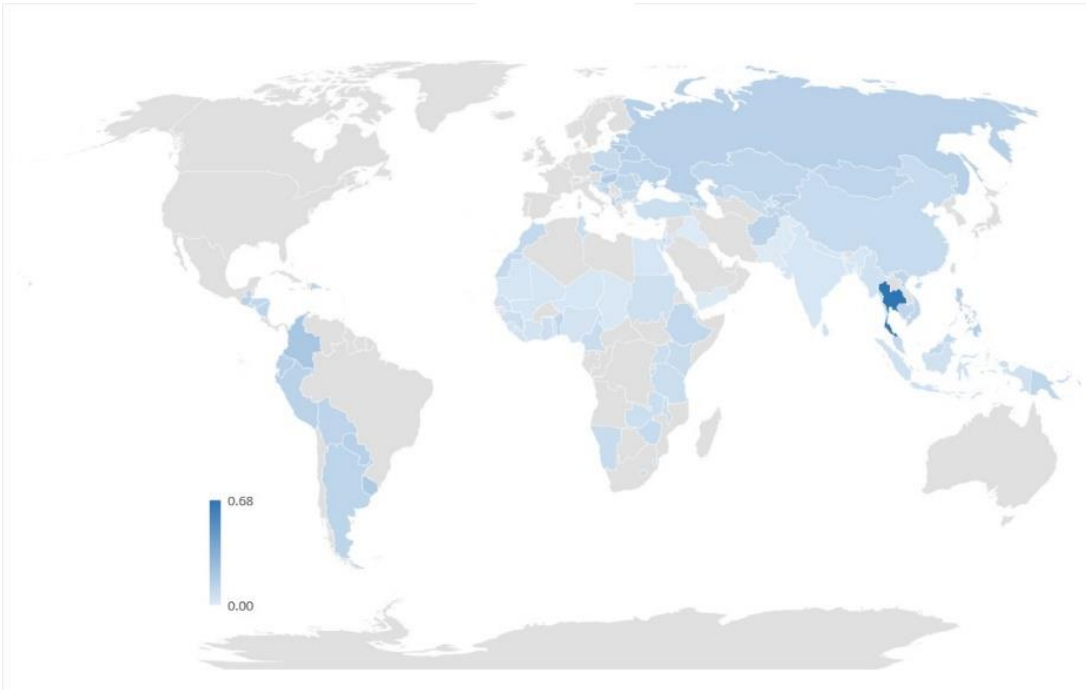
Notes: These figures plot the world distribution of plough-based measures. Panel A plots the country-average historical adoption of plough; Panel B plots the predicted plough adoption using the average land suitability for crops that would benefit more and less from adopting the plough; Panel C plots the aboriginal plough adoption prior to the European contact. Table A1 and the data section in the main text provide detailed variable definitions.

Figure 4.2: Distributions of plough adoption

Panel A: Distribution of the share of female production employees

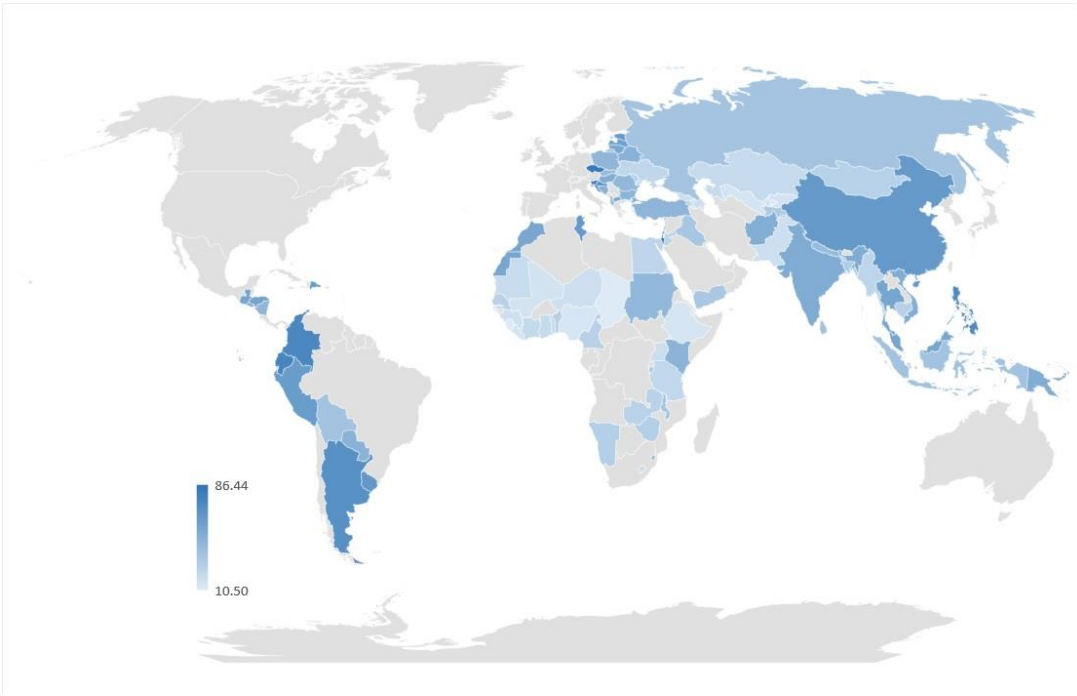


Panel B: Distribution of the share of female non-production employees



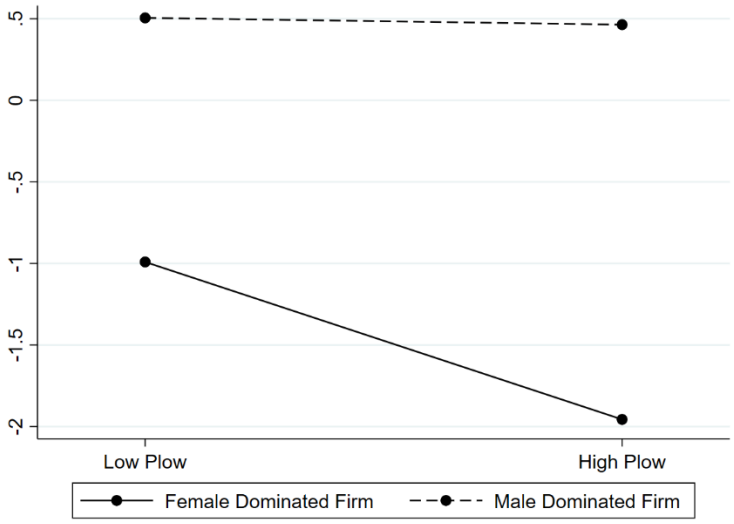
Notes: These figures plot the world distribution of female employee share. Panel A plots the distribution of shares of female production workers; Panel B plots the distribution of shares of female non-production employees. Table A1 and the data section in the main text provide detailed variable definitions.

Figure 4.3: Distribution of trade credit provision



Notes: These figures plot the world distribution of trade credit provision. It is calculated as the fraction of material inputs or services paid after delivery last year. Table A1 and the data section in the main text provide detailed variable definitions.

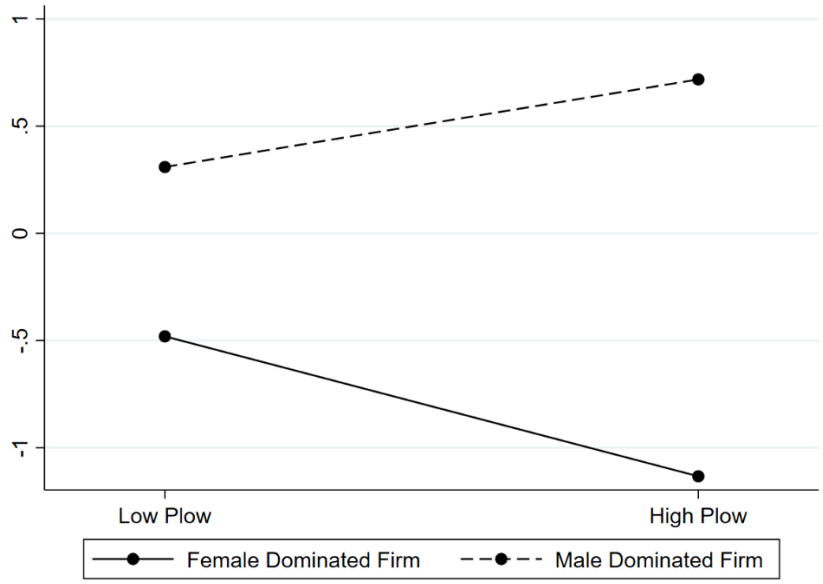
Figure 4.4: Female production employee, plough and trade credit



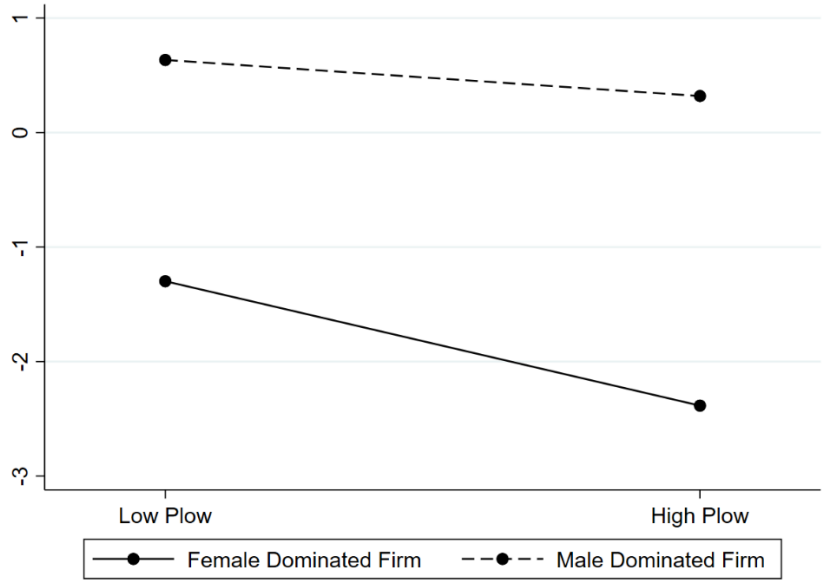
Notes: This figure summaries the main findings of the paper. The y-axis represents _rms' access to trade credits, conditional on a wide range of firm characteristics and country, industry, and survey year fixed effects. These firm level control variables include Firm size, Firm age, CEO experience, Female CEO, Profit margin, Collateral share, Credit line, Ownership concentration, Product competition, Business group, Industry sales growth, Export, State, and Foreign. High plow includes countries with a legacy of historical plough agriculture while Low plow includes countries without historical plough adoption. Female Dominated Firms include firms with an above-median share of female production workers while Male Dominated Firms include those with a below-median share of female production employees. Table A1 and the data section in the main text provide detailed variable definitions.

Figure 4.5: Female production employee, plough and trade credit: by credit constraints

Panel A. Firms with unexpected credit shortages



Panel B. Firms without credit shortages



Note: This figure summaries the main findings of the paper, by whether firms face unexpected credit shortages. The y-axis represents firms' access to trade credits, conditional on a wide range of firm characteristics and country, industry, and survey year fixed effects. These firm level control variables include Firm size, Firm age, CEO experience, Female CEO, Profit margin, Collateral share, Credit line, Ownership concentration, Product competition, Business group, Industry sales growth, Export, State, and Foreign. High plow includes countries with a legacy of historical plough agriculture while Low plow includes countries without historical plough adoption. Female Dominated Firms include firms with an above-median share of female production workers while Male Dominated Firms include those with a below-median share of female production employees. Panel A presents the results from firms that face unexpected credit shortages, while Panel B shows the results from firms without such shortages. Table A1 and the data section in the main text provide detailed variable definitions.

Table 4.1: Summary statistics

Panel A of this table reports the summary statistics on plough related measures, while Panel B reports the OLS results of regressing historical plough adoption on Plough positive crops, Plough negative crops, as well as control variables including Agriculture suitability, Tropical climate, Large animals, Political hierarchies and Economic complexity. I include continent fixed effects in the model. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. *, **, and *** indicate significance at 10%, 5%, and 1%. Table A1 and the data section in the main text provide detailed variable definitions.

Panel A: Summary statistics on plough related measures

	Obs	Mean	Std. Dev.	Min	Max
Plough	81	0.59	0.46	0.00	1.00
Aboriginal plough	81	0.56	0.47	0.00	1.00
Plough negative crops	81	0.47	0.18	0.02	0.85
Plough positive crops	81	0.52	0.40	0.00	1.00
Agriculture suitability	81	0.56	0.31	0.00	0.98
Tropical climate	81	0.72	0.43	0.00	1.00
Large animals	81	0.95	0.14	0.03	1.00
Political hierarchies	81	3.39	0.99	1.04	5.00
Economic complexity	81	6.15	1.48	1.29	8.00
Predicted plough	81	0.59	0.40	-0.24	1.27

Panel B: Summary statistics on plough related measures

	Coefficient	Standard error
Plough positive crops	0.66***	[0.00]
Plough negative crops	0.10	[0.59]
Agriculture suitability	-0.30*	[0.61]
Tropical climate	0.14	[0.32]
Large animals	-0.05	[0.84]
Political hierarchies	0.14***	[0.00]
Economic complexity	0.06*	[0.93]
Continent FE	Yes	
adj. R-square	0.78	
N	81	

Table 4.2: Country of origin and inherited gender bias

This table reports the estimates of inherited gender bias, using pooled OLS regression, following Ongena and Popov (2016). The dependent variable is extracted from the answers to the survey question in GSS "It is much better for everyone involved if the man is the achiever outside the home and the women takes care of the home and family". The answers range from 1 to 4, corresponding to "Strongly agree", "Agree", "Disagree", and "strongly disagree". The dummy variable Traditional gender roles equals 1 if the respondent agrees or strongly agrees, and zero otherwise. The reference group in religion is "Atheist." The reference group in employment is "Inactive." Data come from the General Social Survey. The regressions are based on male and female respondents (columns (1) and (2)) on male respondents (columns (3) and (4)), and on female respondents (columns (5) and (6)). Standard errors are clustered at the country-of-origin level. *, **, and *** indicate significance at 10%, 5%, and 1%. Table A1 and the data section in the main text provide detailed variable definitions.

	Traditional gender roles					
	Full sample		Male sample		Female sample	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
	(1)	(2)	(3)	(4)	(5)	(6)
Demographic characteristics						
Age	0.00	[0.004]	-0.01	[0.007]	0.01	[0.005]
Age squared	0.00	[0.000]	0.00**	[0.000]	0.00	[0.000]
Education	-0.06***	[0.010]	-0.05***	[0.012]	-0.06***	[0.015]
Male	0.10***	[0.022]	-		-	
Catholic	-0.01**	[0.004]	-0.02***	[0.007]	-0.01	[0.005]
Protestant	0.13***	[0.029]	0.10***	[0.036]	0.15***	[0.037]
Jewish	0.15***	[0.036]	0.13**	[0.049]	0.17***	[0.041]
Muslim	0.14**	[0.058]	0.26***	[0.089]	0.08	[0.093]
Other	-0.25***	[0.073]	-0.18***	[0.062]	0.00	[.]
Employed	0.10*	[0.056]	-0.08	[0.087]	0.22***	[0.074]
Unemployed	-0.12***	[0.028]	0.08	[0.059]	-0.19***	[0.028]
Retired	-0.14**	[0.067]	0.03	[0.065]	-0.19*	[0.109]
Income	-0.13***	[0.034]	-0.07	[0.062]	-0.11**	[0.044]
Country of origin						
China	0.16***	[0.047]	0.39***	[0.069]	-0.08	[0.075]
Czech	-0.04	[0.029]	0.06	[0.067]	-0.11**	[0.045]
Hungary	0.04	[0.031]	0.38***	[0.064]	-0.15***	[0.048]
Mexico	-0.01	[0.031]	0.12	[0.071]	-0.13***	[0.046]
Philippines	-0.42***	[0.034]	-0.34***	[0.065]	0.00	[.]
Poland	0.04	[0.031]	0.11	[0.070]	-0.02	[0.045]
Russia	-0.11**	[0.043]	-0.16*	[0.081]	-0.11	[0.073]
India	0.15***	[0.039]	0.00	[.]	0.12**	[0.049]
Lithuania	-0.19***	[0.033]	-0.24***	[0.068]	-0.21***	[0.053]

Yugoslavia	0.18***	[0.031]	0.21***	[0.068]	0.15***	[0.046]
Romania	0.34***	[0.034]	0.06	[0.085]	0.73***	[0.079]
Observation	2131		999		1132	
R-squared	0.108		0.125		0.114	

Table 4.3: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Firm characteristics					
Female	30,559	0.17	0.24	0	1
Female_DV	30,559	0.50	0.50	0	1
Female_non	30,188	0.08	0.11	0	1
Account payable	30,559	43.87	36.54	0	100
Firm size	30,559	1.88	0.78	1	3
Firm age	30,559	20.08	13.79	3	55
CEO experience	30,559	18.17	10.44	3	40
Ownership concentration	30,559	76.50	27.02	0	100
State	30,559	0.65	6.29	0	100
Foreign	30,559	5.85	21.63	0	100
Business group	30,559	1.82	0.38	1	2
Export	30,559	8.16	19.65	0	70
Industry sales growth	30,559	0.16	0.06	0.07	0.5
Product competition	30,559	22.74	27.53	4.17	122.59
Female CEO	30,559	0.12	0.32	0	1
Sales growth	27,149	0.38	0.96	-0.6	4.23
Applied for a loan	30,112	0.27	0.44	0	1
No need for a loan	21,999	0.52	0.50	0	1
Working capital financed by banks	29,792	15.63	23.99	0	70
Investment financed by banks	12,251	20.57	34.27	0	100
Collateral share	30,559	15.87	2.76	1	17
Credit line	30,559	0.38	0.49	0	1
Interaction frequency	24,425	0.51	0.50	0	1
Unit labor cost	29,937	4440.30	5601.54	0	22167.1
Capacity utilization	29,530	75.24	21.33	0	100
Profit margin	30,559	0.36	0.30	-0.11	1
Industry characteristics					
Commodity price shock	239	0.48	0.50	0	1
Female dominated	43	0.40	0.49	0	1
Female industry	43	0.53	0.50	0	1
EFD	43	0.39	0.50	0	1
Country characteristics					
Masculinity	47	46.28	10.52	9.00	66.00
Formalism	51	3.97	0.87	2.13	5.91
Creditor rights	73	1.81	1.11	0.00	4.00
Property rights	77	37.72	14.42	13.53	85.43
Private credits	71	38.41	23.44	6.08	140.70

Table 4.4: Female employee, plough and trade credit

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias Plough, using OLS regression in column(1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Plough	-8.91**	-8.74**	-8.19**	-7.88**	-7.88**
	[-2.37]	[-2.30]	[-2.22]	[-2.10]	[-2.11]
Female	1.40	1.39	0.67	0.53	0.53
	[0.71]	[0.70]	[0.34]	[0.26]	[0.26]
Firm size	4.61***	4.65***	4.53***	4.54***	4.54***
	[8.18]	[8.12]	[7.62]	[7.55]	[7.59]
Firm age	0.06***	0.05***	0.05**	0.05**	0.05**
	[2.87]	[2.84]	[2.41]	[2.36]	[2.38]
Export	0.01	0.01	0.01	0.01	0.01
	[0.30]	[0.30]	[0.38]	[0.39]	[0.39]
State	-0.05	-0.05	-0.05	-0.05	-0.05
	[-1.43]	[-1.34]	[-1.54]	[-1.48]	[-1.49]
Foreign	0.08***	0.08***	0.08***	0.08***	0.08***
	[6.35]	[6.24]	[6.41]	[6.25]	[6.29]
Industry sales growth	4.20	5.55	3.42	3.77	3.77
	[0.46]	[0.61]	[0.36]	[0.38]	[0.38]
Product competition	-0.00	-0.00	-0.01	-0.01	-0.01
	[-0.92]	[-0.91]	[-1.48]	[-1.44]	[-1.45]
Business group	-1.50	-1.64	-1.54	-1.66	-1.66
	[-1.45]	[-1.63]	[-1.45]	[-1.59]	[-1.60]
CEO experience	-0.01	-0.01	-0.00	-0.00	-0.00
	[-0.26]	[-0.18]	[-0.11]	[-0.01]	[-0.01]
Ownership concentration	-0.02	-0.02	-0.02	-0.03	-0.03
	[-1.34]	[-1.41]	[-1.46]	[-1.54]	[-1.55]
Profit margin	-0.79	-0.75	-0.88	-0.84	-0.84
	[-0.73]	[-0.69]	[-0.80]	[-0.76]	[-0.77]
Female CEO	-0.31	-0.37	-0.50	-0.53	-0.53
	[-0.40]	[-0.46]	[-0.66]	[-0.69]	[-0.70]
Collateral share	-0.11	-0.07	-0.11	-0.08	-0.08
	[-0.83]	[-0.53]	[-0.87]	[-0.62]	[-0.62]

Credit line	4.31*	4.42*	4.29*	4.39*	4.39*
	[1.74]	[1.76]	[1.74]	[1.75]	[1.76]
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.255	0.257	0.261	0.263	0.032
N	30559	30559	30559	30559	30559

Table 4.5: Female employee, inherited gender bias and trade credit

This table reports results of regressing Account payable on the interaction term of Female and Inherited gender bias, using OLS regression in column(1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Inherited gender bias	-35.21**	-35.21**	-39.96***	-39.96***	-39.96***
	[0.02]	[0.02]	[0.00]	[0.00]	[0.00]
Female	-7.54**	-7.54**	-8.60**	-8.60**	-8.60***
	[0.02]	[0.02]	[0.01]	[0.01]	[0.00]
Firm size	2.70***	2.70***	2.44***	2.44***	2.44***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Firm age	0.04	0.04	0.04	0.04	0.04
	[0.39]	[0.39]	[0.40]	[0.40]	[0.39]
Export	0.01	0.01	0.02	0.02	0.02
	[0.79]	[0.79]	[0.58]	[0.58]	[0.57]
State	-0.10***	-0.10***	-0.11***	-0.11***	-0.11***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Foreign	0.07***	0.07***	0.08***	0.08***	0.08***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Industry sales growth	18.19	18.19	13.55	13.55	13.55
	[0.32]	[0.32]	[0.57]	[0.57]	[0.56]
Product competition	0.02*	0.02*	0.07***	0.07***	0.07***
	[0.08]	[0.08]	[0.00]	[0.00]	[0.00]
Business group	-4.64***	-4.64***	-4.73***	-4.73***	-4.73***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
CEO experience	-0.03	-0.03	-0.03	-0.03	-0.03
	[0.76]	[0.76]	[0.77]	[0.77]	[0.76]
Ownership concentration	-0.04	-0.04	-0.04	-0.04	-0.04
	[0.27]	[0.27]	[0.20]	[0.20]	[0.17]
Profit margin	1.05	1.05	1.39	1.39	1.39
	[0.36]	[0.36]	[0.20]	[0.20]	[0.17]
Female CEO	2.94**	2.94**	2.68**	2.68**	2.68***

	[0.01]	[0.01]	[0.02]	[0.02]	[0.01]
Collateral share	-0.19	-0.19	-0.20	-0.20	-0.20
	[0.57]	[0.57]	[0.58]	[0.58]	[0.57]
Credit line	-3.66**	-3.66**	-3.65**	-3.65**	-3.65***
	[0.02]	[0.02]	[0.01]	[0.01]	[0.00]
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.101	0.101	0.111	0.111	0.013
N	9921	9921	9921	9921	9921

Table 4.6: Gender bias and trade credit: Heterogeneous analyses by unexpected credit shortages

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Plough, by whether firms face unexpected credit shortages. Commodity price shock equals to 1 if an industry has experienced a price reduction relative to the previous year based on the matched price index and 0 otherwise. In column(1)-(4), I report the results from firms in industries that face unexpected credit shortages, while in column(5)-(8), I present the results from firms in industries that do not face such credit shortages. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	Negative commodity price shock				Positive commodity price shock			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-10.62**	-10.43**	-12.12***	-11.94**	-6.75	-6.15	-5.16	-4.36
	[-2.40]	[-2.32]	[-2.71]	[-2.62]	[-1.60]	[-1.42]	[-1.27]	[-1.05]
Female	2.61	2.59	2.69	2.61	0.11	-0.29	-0.42	-0.99
	[1.24]	[1.22]	[1.30]	[1.24]	[0.04]	[-0.11]	[-0.17]	[-0.39]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.236	0.237	0.241	0.241	0.290	0.293	0.292	0.295

N	17473	17473	17473	17473	13086	13086	13086	13086

Table 4.7: Gender bias and trade credit: Heterogeneous analyses by female dominance

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Plough, by the extent to which an industry is represented by female. Female dominated equals to 1 if an industry has been characterized as female-dominated in Cumming et al. (2015), and 0 otherwise. Female industry equals to 1 if an industry has a higher than sample median value of female share and 0 otherwise. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country by year and industry by year fixed effects in all specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable			
Sample =	Female dominated = 1	Female dominated = 0	Female industry = 1	Female industry = 0
	(1)	(2)	(3)	(4)
Female*Plough	-5.74	-17.49**	-5.86	-16.96**
	[-1.40]	[-2.48]	[-1.48]	[-2.10]
Female	-1.16	8.36*	-0.94	7.07
	[-0.46]	[1.73]	[-0.41]	[1.48]
Firm Controls	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes
R-squared	0.280	0.250	0.276	0.243
N	15996	14563	19042	11517

Table 4.8: Gender bias and trade credit: The role of interaction frequency with suppliers

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Plough, by firms' interaction frequency with suppliers. Interaction frequency is an indicator that equals 1 if firms purchase inputs from and interact with their suppliers every 20 days, the sample median value, or more frequent, and 0 if they do so at a longer time interval. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Frequency of inputs purchase =	Interaction frequency = 1				Interaction frequency = 0			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-10.18***	-10.17***	-10.75***	-10.79***	-7.94	-7.83	-3.46	-3.34
	[-2.66]	[-2.66]	[-2.75]	[-2.76]	[-1.42]	[-1.40]	[-0.60]	[-0.58]
Female	1.52	1.48	1.54	1.49	2.65	2.72	-1.16	-1.15
	[0.69]	[0.66]	[0.69]	[0.66]	[0.68]	[0.70]	[-0.27]	[-0.27]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.233	0.234	0.239	0.240	0.250	0.250	0.258	0.258
N	12509	12509	12509	12509	11916	11916	11916	11916

Table 4.9: Gender bias and bank credit

This table reports heterogeneous results of regressing Working capital financed by banks and Investment financed by banks on the interaction term of Female and Plough, respectively. Working capital financed by banks is the share of a firm's working capital currently financed by banks, while Investment financed by banks is the share of a firm's financial investment currently financed by banks. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Working capital financed by banks				Investment financed by banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-1.41	-1.33	-0.62	-0.53	-3.38	-3.41	-3.46	-3.39
	[-0.92]	[-0.86]	[-0.45]	[-0.38]	[-0.88]	[-0.88]	[-0.88]	[-0.85]
Female	-0.27	-0.41	-0.61	-0.74	0.38	0.40	0.29	0.24
	[-0.22]	[-0.34]	[-0.57]	[-0.69]	[0.13]	[0.14]	[0.11]	[0.09]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.338	0.339	0.340	0.340	0.246	0.246	0.243	0.244
N	29792	29792	29792	29792	12251	12251	12251	12251

Table 4.10: Gender bias and trade credit: The role of firms' location size

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Plough, by firms' city size. I define large cities if they have a population higher than 250,000 (the median size of cities in our sample), and small cities if they have a smaller population. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	Firms located in large cities				Firms located in small cities			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-10.19**	-9.95**	-9.89**	-9.64**	-5.59	-4.75	-2.13	-1.39
	[-2.34]	[-2.26]	[-2.19]	[-2.11]	[-0.94]	[-0.76]	[-0.36]	[-0.22]
Female	1.95	1.80	1.46	1.23	-0.44	-1.19	-3.22	-3.90
	[1.07]	[0.96]	[0.81]	[0.67]	[-0.09]	[-0.23]	[-0.66]	[-0.76]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.269	0.270	0.273	0.275	0.238	0.240	0.249	0.251
N	22728	22728	22728	22728	7831	7831	7831	7831

Table 4.11: Gender gap and firm behaviors and outcomes: Suggestive evidence

This table reports OLS results of regressing a firm's outcomes on the interaction term of Female and Plough. The dependent variable is either Unit cost of labor, Profit margin, Sales growth or Capacity utilization. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country by year and industry by year fixed effects in all specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Unit cost of labor	Profit margin	Sales growth	Capacity utilization
	(1)	(2)	(3)	(4)
Female*Plough	370.52	-1.51	-0.06	0.52
	[0.56]	[-0.74]	[-0.95]	[0.35]
Female	-1909.96***	-1.88	0.01	-0.68
	[-3.14]	[-1.25]	[0.13]	[-0.70]
Firm Controls	Yes	Yes	Yes	Yes
Country FE	No	No	No	No
Industry FE	No	No	No	No
Year FE	No	No	No	No
Country by Year FE	Yes	Yes	Yes	Yes
Industry by Year FE	Yes	Yes	Yes	Yes
R-squared	0.415	0.118	0.082	0.137
N	29937	30559	27149	29530

Table 4.12: Gender gap and firm behaviors: Controlling country-level factors

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Plough), while controlling for a wide range of other country-level characteristics. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable						
	(1)	(2)	(3)	(6)	(7)	(8)	(9)
Female*Plough	-7.88**	-9.58**	-8.45*	-7.68*	-7.97**	-7.91**	-11.11***
	[-2.10]	[-2.45]	[-1.96]	[-1.88]	[-2.20]	[-2.04]	[-3.06]
Female*Masculinity		-2.50					-4.25*
		[-1.34]					[-1.86]
Female*Formalism			0.83				-1.30
			[0.45]				[-0.61]
Female*Creditor rights				-1.71			-2.65
				[-1.03]			[-1.26]
Female*Property rights					-0.76		1.23
					[-0.28]		[0.44]
Female*Private credits						0.48	1.65*
						[0.34]	[2.01]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No	No
Industry FE	No	No	No	No	No	No	No

Year FE	No	No	No	No	No	No	No
Country by Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry by Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.263	0.265	0.258	0.266	0.264	0.250	0.251
N	30559	26324	26534	29133	29663	27976	22848

Table 4.13: Gender gap and firm behaviors: Propensity score matching

This table reports results of regressing Account payable on the interaction term of Female_DV and the measure of gender bias (Plough) in a propensity score matched sample. Female_DV is a dummy variable that equals to 1 if a firm has a higher than median value of Female and 0 otherwise. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. I include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. I report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Female_DV	Account Payable			
	PSM	OLS after PSM			
	(1)	(2)	(3)	(4)	(5)
Female_DV*Plough	-	-7.19***	-7.16***	-6.33***	-6.24***
	-	[-3.86]	[-3.78]	[-3.70]	[-3.61]
Female_DV	-	2.78***	2.80***	2.19***	2.15***
	-	[3.28]	[3.23]	[2.76]	[2.68]
Firm size	0.53***	4.70***	4.73***	4.60***	4.62***
	[24.85]	[8.46]	[8.42]	[7.99]	[7.94]
Firm age	-0.01***	0.06***	0.05***	0.05**	0.05**
	[-4.61]	[2.80]	[2.77]	[2.38]	[2.34]
Export	0.01***	0.01	0.01	0.01	0.01
	[8.42]	[0.27]	[0.27]	[0.33]	[0.34]
State	0.01***	-0.05	-0.05	-0.05	-0.05
	[3.29]	[-1.36]	[-1.27]	[-1.47]	[-1.41]
Foreign	-0.00	0.08***	0.08***	0.08***	0.07***
	[-1.5]	[6.06]	[5.95]	[6.18]	[6.03]
Industry sales growth	-0.14	3.99	5.39	3.14	3.48
	[-0.50]	[0.45]	[0.61]	[0.34]	[0.36]
Product competition	-0.00***	-0.00	-0.00	-0.01	-0.01
	[-4.09]	[-0.79]	[-0.78]	[-1.41]	[-1.37]
Business group	0.04	-1.53	-1.67	-1.57	-1.69
	[0.94]	[-1.49]	[-1.66]	[-1.49]	[-1.63]
CEO experience	-0.00	-0.01	-0.01	-0.00	-0.00
	[-0.06]	[-0.24]	[-0.16]	[-0.10]	[-0.00]
Ownership concentration	0.00***	-0.02	-0.02	-0.02	-0.02
	[3.84]	[-1.38]	[-1.46]	[-1.52]	[-1.60]
Profit margin	-0.08*	-0.77	-0.73	-0.86	-0.82
	[-1.69]	[-0.71]	[-0.67]	[-0.78]	[-0.74]

Female CEO	0.62***	-0.53	-0.58	-0.71	-0.74
	[13.48]	[-0.63]	[-0.68]	[-0.89]	[-0.92]
Collateral share	0.00	-0.11	-0.07	-0.12	-0.08
	[0.25]	[-0.86]	[-0.56]	[-0.90]	[-0.64]
Credit line	0.19***	4.43*	4.54*	4.40*	4.50*
	[5.28]	[1.81]	[1.83]	[1.79]	[1.81]
Country FE	Yes	Yes	No	Yes	No
Industry FE	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	No
Country by Year FE	No	No	Yes	No	Yes
Industry by Year FE	No	No	No	Yes	Yes
R-squared	0.071	0.256	0.258	0.262	0.264
N	30559	30484	30484	30484	30484

Appendix Table 4.1: Variable definition and data sources

Variable	Definition	Source
Firm-level variables		
Female	The share of female production workers in a firm.	Enterprise Survey by World Bank, 2006-2018
Female_DV	A dummy indicator that equals to one if a firm has an above median value of female shares and zero otherwise.	
Female_non	The share of female non-production workers in a firm.	
Account payable	The fraction of material inputs or services paid after delivery last year.	
Firm size	An indicator that equals to one if the number of employees in a firm is less than 20, two if between 20 and 99, and three if more than 100.	
Firm age	The number of years since a firm starts operation.	
CEO experience	The tenure of a firm's CEO.	
Ownership concentration	The share of a firm owned by the largest owner.	
State	The fraction of a firm owned by the state.	
Foreign	The fraction of a firm owned by foreign investors.	
Business group	An indicator equals to one if a firm belongs to a business group, and zero otherwise.	
Export	An indicator equals to one if a firm has a positive share of sales exported outside the country.	
Industry sales growth	The median value of firms' sales growth within an industry in each year.	

Product competition	The number of competitors of a firm's main product.
Female CEO	An indicator that equals one if a firm's CEO is female and zero otherwise.
Sales growth	The rate of sales growth for a firm in the last three years.
Applied for a loan	An indicator that equals one if a firm applied a loan from a financial institution last year and zero otherwise.
No need for a loan	An indicator that equals one if a firm reports that it did not apply for a loan last year because it did not need it and zero otherwise.
Working capital financed by banks	The share of working capital financed by banks.
Investment financed by banks	The share of financial investment financed by banks.
Collateral share	The value of collaterals over the value of loans.
Credit line	An indicator that equals one if a firm has ever had a credit line and zero otherwise.
Interaction frequency	An indicator that equals 1 if firms purchase inputs from and interact with their suppliers every 20 days, the sample median value, or more frequent, and 0 if they do so at a longer time interval.
Unit labor cost	Total labor costs divided by total number of employees in a firm and it measured in 2010 US dollars
Capacity utilization	The share of current output over the maximum output possible using the current inputs.
Profit margin	The ratio calculated as one minus total cost over sales.

Country-level variables		
Plough	A country-level population-weighted average measure of an indicator that equals to one if an ethnic group has traditionally adopted plough agriculture either before the European contact or after.	Alesina, Giuliani and Nunn (2013); Ethnographic Atlas
Aboriginal plough	A country-level population-weighted average measure of an indicator equals to one if a society has traditionally adopted plough agriculture before the European contact.	
Predicted plough	A country-level predicted probability of historical adoption of plough agriculture.	
Plough negative crops	A country-level average land suitability for crops that benefit more from adopting the plough. These crops are wheat, barley and rye.	
Plough positive crops	A country-level average land suitability for crops that do not benefit much from adopting the plough. These crops are sorghum, foxtail millet and pearl millet.	
Agriculture suitability	The share of a country's land that is suitable for cultivating crops in general.	
Tropical climate	The fraction of land of a country that is located in tropical area.	
Large animals	An indicator that measures the proportion of all subsistence activities that are accounted for by herding of large animals.	
Political hierarchies	An indicator that measures a society's number of jurisdictional hierarchies.	

Economic complexity	An indicator that measures a society's settlement patterns.

Variable	Definition	Source
Country-level variables		
Traditional gender roles	An indicator that equals to 1 if the respondent answered "Strongly agree" or "Agree" and 0 if the respondent answered "Disagree" and "Strongly disagree" to the question "It is much better for everyone involved if the man is the achiever outside the home and the women takes care of the home and family".	General Social Survey (GSS)
Masculinity	A scale variable that measures the degree to which a country values male assertiveness over female nurturance.	Hofstede (2001)
Formalism	An indicator that measures the efficiency of a country's court system.	La Porta, Lopez-de-Silanes and Shleifer (2008)
Creditor rights	An indicator that measures of the quality of legal protection on creditors.	
Property rights	An indicator that measures the quality of a country's private property rights protection, averaged over 2009-2018.	The Heritage Foundation
Private credits	The ratio of a country's private credit to GDP, averaged over 2009-2018.	World Bank
Industry-level variables		

Commodity price shock	An indicator that equals to 1 if an industry has experienced a price reduction relative to the previous year based on the matched price index and 0 otherwise.	International Monetary Fund Primary Commodity Price System
Female dominated	An indicator that equals to 1 if an industry has been characterized as female-dominated	Cumming, Leung and Rui (2015)
Female industry	An indicator that equals to 1 if an industry has a higher than sample median value of female share and 0 otherwise.	Authors calculation
EFD	An indicator that equals to one if dependence on external finance is higher than the mean value and zero otherwise. Dependence on external finance is calculated as the fraction of capital expenditures not financed with internally generated cash flows in the United States during 1980s calculated at the three-digit ISIC level.	Rajan and Zingales (1998)

Appendix Table 4.2: Plough-based measures, female shares, and trade credits: Country distribution

Continent	Country	Observations	Plough	Aboriginal plough	Predicted plough	Female share	Trade credits
Africa	Senegal	137	0.00	0.00	0.11	0.06	28.66
Africa	Malawi	93	0.00	0.00	0.11	0.07	34.10
Africa	Burundi	53	0.00	0.00	0.30	0.08	33.15
Africa	Benin	56	0.00	0.00	0.10	0.09	26.96
Africa	Zambia	270	0.00	0.00	0.17	0.11	21.57
Africa	Nigeria	588	0.00	0.00	0.13	0.11	13.99
Africa	Sierra Leone	76	0.00	0.00	0.26	0.11	10.55
Europe	Czech Republic	73	0.00	0.00	0.08	0.11	25.12
Africa	Djibouti	30	0.00	0.00	0.14	0.12	16.27
Africa	Ghana	243	0.00	0.00	0.09	0.14	26.91
Africa	Tanzania	173	0.00	0.00	0.09	0.16	25.53
South America	Ecuador	195	0.00	0.00	0.39	0.16	74.82
North America	Nicaragua	182	0.00	0.00	0.07	0.18	43.22
North America	El Salvador	427	0.00	0.00	0.14	0.24	50.57
South America	Colombia	1125	0.00	0.00	-0.24	0.25	74.58
Africa	Zimbabwe	588	0.00	0.00	0.29	0.15	28.64
North America	Guatemala	333	0.00	0.00	0.07	0.19	55.57
Africa	Mali	100	0.00	0.00	0.20	0.20	18.69
Africa	Cameroon	157	0.01	0.00	0.08	0.10	26.59

Africa	Chad	58	0.01	0.00	-0.11	0.03	10.00
North America	Honduras	168	0.01	0.01	-0.05	0.17	57.04
South America	Argentina	1194	0.01	0.01	0.15	0.12	69.57
South America	Paraguay	168	0.01	0.01	0.02	0.13	47.40
Africa	Kenya	304	0.03	0.03	0.01	0.14	50.22
South America	Peru	1134	0.04	0.00	0.34	0.17	61.95
Asia	Kyrgyz Republic	63	0.05	0.05	0.44	0.29	15.11
Africa	Uganda	182	0.05	0.00	0.16	0.25	20.95
Africa	Namibia	59	0.10	0.10	0.06	0.23	36.44
Asia	Azerbaijan	63	0.10	0.10	0.73	0.27	12.22
Africa	Liberia	66	0.13	0.13	0.32	0.15	15.18
Asia	Kazakhstan	121	0.32	0.32	0.64	0.23	20.86
Asia	Philippines	547	0.34	0.33	0.42	0.23	71.93
South America	Bolivia	134	0.44	0.00	0.20	0.17	34.10
Asia	Uzbekistan	107	0.60	0.60	0.51	0.27	13.83
Africa	Ethiopia	434	0.73	0.73	0.28	0.22	14.22
Asia	Myanmar	601	0.81	0.77	0.61	0.25	24.72
Asia	Mongolia	96	0.83	0.83	0.69	0.42	26.84
Africa	Mauritania	33	0.85	0.85	0.34	0.03	19.24
Asia	India	6240	0.87	0.87	0.66	0.07	49.96
Asia	Vietnam	1048	0.87	0.87	0.74	0.32	50.22
Asia	Indonesia	1877	0.87	0.87	0.73	0.31	35.74
Asia	China	1446	0.91	0.91	1.09	0.28	62.16

Asia	Nepal	360	0.91	0.91	0.91	0.10	40.65
Asia	Bangladesh	1112	0.93	0.90	0.85	0.15	29.50
Europe	Russia	856	0.93	0.93	1.04	0.21	35.75
Asia	Cambodia	35	0.96	0.96	0.65	0.48	28.51
Asia	Georgia	78	0.97	0.97	0.86	0.35	18.88
Asia	Armenia	75	0.98	0.98	1.00	0.24	25.77
Africa	Lesotho	56	0.98	0.00	0.74	0.39	19.02
Asia	Tajikistan	65	0.98	0.98	0.54	0.38	32.74
Asia	Jordan	226	0.99	0.99	1.15	0.11	23.23
Asia	Sri Lanka	286	0.99	0.99	0.55	0.35	36.31
Asia	Iraq	437	0.99	0.99	1.06	0.03	33.95
Asia	Turkey	536	1.00	1.00	1.07	0.20	40.75
Africa	Eswatini	50	1.00	0.00	0.42	0.31	37.70
North America	Dominican Republic	144	1.00	1.00	0.78	0.14	62.97
Africa	Egypt	1857	1.00	1.00	0.67	0.07	25.10
Asia	Yemen	241	1.00	1.00	1.19	0.03	33.52
Asia	Israel	153	1.00	1.00	1.08	0.12	87.64
Asia	Lebanon	172	1.00	1.00	0.96	0.10	37.01
Asia	Pakistan	424	1.00	1.00	1.11	0.01	14.22
Europe	Slovenia	63	1.00	1.00	1.02	0.11	82.81
Europe	Bosnia and Herzegovina	91	1.00	1.00	1.02	0.16	48.48
Europe	Poland	97	1.00	1.00	0.91	0.17	43.64
Europe	Croatia	102	1.00	1.00	0.91	0.19	83.10
Europe	Fyr Macedonia	91	1.00	1.00	1.01	0.20	50.43
Europe	Slovak Republic	49	1.00	1.00	0.92	0.22	48.00

South America	Uruguay	260	1.00	1.00	0.64	0.23	64.44
Europe	Latvia	72	1.00	1.00	0.86	0.26	60.11
Africa	Morocco	109	1.00	1.00	0.86	0.27	56.50
Africa	Côte d'Ivoire	113	1.00	1.00	1.02	0.28	56.69
Europe	Estonia	45	1.00	1.00	0.94	0.28	62.02
Europe	Belarus	91	1.00	1.00	1.02	0.29	46.84
Europe	Romania	132	1.00	1.00	1.27	0.32	42.58
Europe	Lithuania	64	1.00	1.00	0.86	0.32	54.06
Africa	Tunisia	279	1.00	1.00	0.99	0.32	62.59
Europe	Bulgaria	80	1.00	1.00	0.99	0.35	36.69
Europe	Hungary	48	1.00	1.00	0.94	0.35	52.90
Europe	Moldova	66	1.00	1.00	1.26	0.39	29.65
Europe	Ukraine	441	1.00	1.00	1.09	0.40	23.81
Europe	Albania	61	1.00	1.00	0.83	0.44	36.52

Appendix Table 4.3: Inherited gender bias: Country distribution

Continent	Country	Observations	Inherited gender bias
Asia	Philippines	547	-0.42
Europe	Lithuania	64	-0.193
Europe	Russia	856	-0.107
Europe	Czech Republic	73	-0.037
Europe	Slovak Republic	49	-0.037
Europe	Hungary	48	0.039
Europe	Poland	97	0.044
Asia	India	6240	0.153
Asia	China	1446	0.156
Europe	Bosnia and Herzegovina	91	0.177
Europe	Croatia	102	0.177
Europe	Fyr Macedonia	91	0.177
Europe	Montenegro	22	0.177
Europe	Slovenia	63	0.177
Europe	Romania	132	0.342

Appendix Table 4.4: Summary statistics by high and low female share

Variable	Full = 30559		High Female: 15317		Low Female: 15242		High - Low	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Difference	p-value
Account payable	43.87	36.54	45.97	37.01	41.77	35.93	4.19***	0.00
Firm size	1.88	0.78	2.03	0.77	1.73	0.75	0.30***	0.00
Firm age	20.08	13.79	19.56	13.60	20.60	13.96	-1.04***	0.00
CEO experience	18.17	10.44	18.25	10.21	18.10	10.66	0.15	0.21
Ownership concentration	76.50	27.02	76.17	26.76	76.83	27.26	-0.66**	0.03
State	0.65	6.29	0.97	7.91	0.32	4.03	0.65***	0.00
Foreign	5.85	21.63	7.31	24.02	4.38	18.80	2.92***	0.00
Business group	1.82	0.38	1.82	0.39	1.83	0.38	-0.01	0.14
Export	8.16	19.65	10.86	22.53	5.46	15.80	5.40***	0.00
Industry sales growth	0.16	0.06	0.16	0.07	0.15	0.06	0.01***	0.00
Product competition	32.80	93.70	34.41	106.16	31.18	79.21	3.23***	0.00
Female CEO	0.12	0.32	0.17	0.37	0.07	0.25	0.10***	0.00
Sales growth	0.38	0.96	0.40	0.96	0.35	0.96	0.05***	0.00
Applied for a loan	0.27	0.44	0.32	0.47	0.22	0.41	0.10***	0.00
No need for a loan	0.52	0.50	0.52	0.50	0.51	0.50	0.01	0.29
Working capital financed by banks	15.63	23.99	15.79	23.69	15.46	24.29	0.33	0.24
Investment financed by banks	20.57	34.27	20.33	34.09	20.89	34.51	-0.56	0.37
Collateral share	15.87	2.76	15.69	2.95	16.06	2.53	-0.37***	0.00
Credit line	0.38	0.49	0.44	0.50	0.32	0.47	0.11***	0.00
Interaction frequency	0.51	0.50	0.50	0.50	0.52	0.50	-0.02***	0.00
Unit labor cost	4440.30	5601.54	4524.95	5465.23	4355.99	5733.03	168.96***	0.01
Capacity utilization	75.24	21.33	76.22	21.09	74.25	21.52	1.97***	0.00

Profit margin	0.36	0.30	0.37	0.30	0.35	0.30	0.02***	0.00

Appendix Table 4.5: Matching commodity price index to 3-digit ISIC code

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Predicted plough), using OLS regression in column (1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Predicted plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

		International Commodity Price Index											
ISIC2	Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
311	Food manufacturing	13.96	17.56	-15.89	13.49	18.58	-3.279	-0.32	-1.573	-16.91	1.484	3.796	-1.24
312	Food manufacturing	13.96	17.56	-15.89	13.49	18.58	-3.279	-0.32	-1.573	-16.91	1.484	3.796	-1.24
313	Beverage industries	15.07	21.13	-4.966	16.38	24.14	-18.11	-13.67	20.074	-7.194	-3.11	-4.71	-8.19
314	Tobacco manufactures	13.96	17.56	-15.89	13.49	18.58	-3.279	-0.32	-1.573	-16.91	1.484	3.796	-1.24
321	Manufacture of textiles	9.011	12.83	-12.11	65	49.68	-42.42	1.2995	-8.079	-15.26	5.3916	12.65	9.3067
322	Manufacture of wearing apparel, except footwear	9.011	12.83	-12.11	65	49.68	-42.42	1.2995	-8.079	-15.26	5.3916	12.65	9.3067
323	Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel	4.997	-9.96	-32.49	60.25	-8.3	1.5823	16.712	13.012	-21.6	-14.33	-8.35	-13.96
324	Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear	4.997	-9.96	-32.49	60.25	-8.3	1.5823	16.712	13.012	-21.6	-14.33	-8.35	-13.96

331	Manufacture of wood and wood and cork products, except furniture	-0.16	3	-4.94	1.14	8.73	-2.24	-0.48	1.42	-6.13	-1.71	-2.17	6.11
332	Manufacture of furniture and fixtures, except primarily of metal	-0.16	3	-4.94	1.14	8.73	-2.24	-0.48	1.42	-6.13	-1.71	-2.17	6.11
341	Manufacture of paper and paper products	-0.16	3	-4.94	1.14	8.73	-2.24	-0.48	1.42	-6.13	-1.71	-2.17	6.11
342	Printing, publishing and allied industries	-0.16	3	-4.94	1.14	8.73	-2.24	-0.48	1.42	-6.13	-1.71	-2.17	6.11
351	Manufacture of industrial chemicals	44.68	93.714	-36.44	-10.02	32.41	4.9179	-23.28	-2.771	-10.39	-24.78	-3.33	15.98
352	Manufacture of other chemical products	44.68	93.714	-36.44	-10.02	32.41	4.9179	-23.28	-2.771	-10.39	-24.78	-3.33	15.98
353	Petroleum refineries	6.148	31.397	-34.47	29.778	27.25	4.04	-0.11	-7.741	-42.54	-15.1	23.574	26.77
354	Manufacture of miscellaneous products of petroleum and coal	9.777	38.584	-38.53	24.547	29.8	-1.52	-0.984	-5.88	-44.1	-16.47	23.923	27.25
355	Manufacture of rubber products	8.832	14.44	-25.77	90.14	31.86	-29.89	-17.25	-29.98	-20.3	5.305	21.89	-22.45
356	Manufacture of plastic products not elsewhere classified	8.832	14.44	-25.77	90.14	31.86	-29.89	-17.25	-29.98	-20.3	5.305	21.89	-22.45
361	Manufacture of pottery, china and earthenware	-	-	-	-	-	-	-	-	-	-	-	-
362	Manufacture of glass and glass products	-	-	-	-	-	-	-	-	-	-	-	-
369	Manufacture of other non-metallic mineral products	-	-	-	-	-	-	-	-	-	-	-	-
371	Iron and steel basic industries	9.51	68.07	29.93	83.41	14.36	-23.40	5.32	-28.05	-42.36	4.32	21.46	-1.40

372	Non-ferrous metal basic industries	23.5	-10.2	-15.84	53.033	12.66	-17.8	-3.88	-12.18	-27.31	-5.307	22.19	6.628
381	Manufacture of fabricated metal products, except machinery and equipment	23.5	-10.2	-15.84	53.033	12.66	-17.8	-3.88	-12.18	-27.31	-5.307	22.19	6.628
382	Manufacture of machinery except electrical	23.5	-10.2	-15.84	53.033	12.66	-17.8	-3.88	-12.18	-27.31	-5.307	22.19	6.628
383	Manufacture of electrical machinery apparatus, appliances and supplies	-	-	-	-	-	-	-	-	-	-	-	-
384	Manufacture of transport equipment	23.5	-10.2	-15.84	53.033	12.66	-17.8	-3.88	-12.18	-27.31	-5.307	22.19	6.628
385	Manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods	-	-	-	-	-	-	-	-	-	-	-	-
390	Other Manufacturing Industries	23.5	-10.2	-15.84	53.033	12.66	-17.8	-3.88	-12.18	-27.31	-5.307	22.19	6.628

Appendix Table 4.6: Female employee, predicted plough and trade credit

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Predicted plough), using OLS regression in column(1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Predicted plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Model specification =	Dependent variable = Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Predicted plough	-7.56**	-7.44**	-7.10*	-6.82*	-6.82*
	[-2.03]	[-1.99]	[-1.85]	[-1.76]	[-1.77]
Female	0.34	0.36	-0.21	-0.33	-0.33
	[0.13]	[0.14]	[-0.08]	[-0.13]	[-0.13]
Firm Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.255	0.257	0.261	0.263	0.032
N	30559	30559	30559	30559	30559

Appendix Table 4.7: Female employee, aboriginal plough and trade credit

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Aboriginal plough), using OLS regression in column (1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Aboriginal plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Model specification =	Dependent variable = Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Aboriginal plough	-8.63**	-8.47**	-8.13**	-7.81**	-7.81**
	[-2.34]	[-2.27]	[-2.25]	[-2.12]	[-2.14]
Female	1.10	1.10	0.51	0.36	0.36
	[0.58]	[0.57]	[0.26]	[0.18]	[0.19]
Firm Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.255	0.257	0.261	0.263	0.032
N	30559	30559	30559	30559	30559

Appendix Table 4.8: Female employee, plough and trade credit: Heterogeneous analysis by EFD

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and the measure of gender bias (Plough), by firms' dependence on external finance. EFD is an indicator that equals to one if dependence on external finance is higher than the mean value and zero otherwise. Dependence on external finance is calculated as the fraction of capital expenditures not financed with internally generated cash flows in the United States during 1980s calculated at the three-digit ISIC level. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	EFD = 1				EFD = 0			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-14.56**	-14.31**	-14.36**	-13.73**	-6.27*	-6.10	-4.05	-3.73
	[-2.34]	[-2.27]	[-2.45]	[-2.35]	[-1.71]	[-1.63]	[-1.10]	[-1.00]
Female	3.69	3.59	2.49	2.05	0.02	0.01	-1.38	-1.51
	[0.86]	[0.84]	[0.60]	[0.50]	[0.01]	[0.00]	[-0.55]	[-0.59]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.248	0.249	0.255	0.257	0.257	0.259	0.261	0.264
N	11367	11367	11367	11367	19192	19192	19192	19192

Appendix Table 4.9: Non-production female employee, plough and trade credit

This table reports results of regressing Account payable on the interaction term of Female_non and the measure of gender bias (Plough).The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female_non and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female_non*Plough	-13.67*	-13.58*	-10.03	-9.87	-9.87
	[-1.75]	[-1.74]	[-1.30]	[-1.27]	[-1.28]
Female_non	6.80***	6.87***	3.60*	3.66*	3.66*
	[3.18]	[3.19]	[1.68]	[1.70]	[1.71]
Firm Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.254	0.257	0.260	0.263	0.032
N	30382	30382	30382	30382	30382

Appendix Table 4.10: Non-production female employee, inherited gender bias and trade credit

This table reports results of regressing Account payable on the interaction term of Female_non and the measure of gender bias (Inherited gender bias).The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female_non and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female_non*Inherited gender bias	-3.35	-3.35	-1.68	-1.68	-1.68
	[0.93]	[0.93]	[0.97]	[0.97]	[0.96]
Female_non	-3.94	-3.94	-5.45	-5.45	-5.45
	[0.74]	[0.74]	[0.65]	[0.65]	[0.64]
Firm Controls	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.098	0.098	0.108	0.108	0.013
N	9900	9900	9900	9900	9900

Appendix Table 4.11: Female employee, inherited gender bias and trade credit: PSM

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Inherited gender bias) in a propensity score matched sample. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Female_DV	Account Payable			
	PSM	OLS after PSM			
	(1)	(2)	(3)	(4)	(5)
Female_DV*Inherited gender bias	-	-18.18***	-18.18***	-18.05***	-18.05***
	-	[-4.17]	[-4.17]	[-5.33]	[-5.33]
Female_DV	-	-2.96***	-2.96***	-2.93**	-2.93**
	-	[-3.04]	[-3.04]	[-2.67]	[-2.67]
Firm size	0.53***	2.90***	2.90***	2.63***	2.63***
	[24.85]	[7.70]	[7.70]	[5.27]	[5.27]
Firm age	-0.01***	0.03	0.03	0.03	0.03
	[-4.61]	[0.72]	[0.72]	[0.70]	[0.70]
Export	0.01***	0.01	0.01	0.02	0.02
	[8.42]	[0.35]	[0.35]	[0.61]	[0.61]
State	0.01***	-0.11***	-0.11***	-0.11***	-0.11***
	[3.29]	[-3.80]	[-3.80]	[-4.72]	[-4.72]
Foreign	-0.00	0.07***	0.07***	0.07***	0.07***
	[-1.5]	[3.38]	[3.38]	[3.40]	[3.40]
Industry sales growth	-0.14	16.79	16.79	12.24	12.24
	[-0.50]	[0.95]	[0.95]	[0.53]	[0.53]
Product competition	-0.00***	0.02**	0.02**	0.07***	0.07***
	[-4.09]	[2.90]	[2.90]	[5.26]	[5.26]
Business group	0.04	-4.77***	-4.77***	-4.84***	-4.84***
	[0.94]	[-7.24]	[-7.24]	[-7.24]	[-7.24]
CEO experience	-0.00	-0.04	-0.04	-0.03	-0.03
	[-0.06]	[-0.35]	[-0.35]	[-0.34]	[-0.34]
Ownership concentration	0.00***	-0.03	-0.03	-0.04	-0.04
	[3.84]	[-1.12]	[-1.12]	[-1.36]	[-1.36]
Profit margin	-0.08*	1.23	1.23	1.54	1.54
	[-1.69]	[1.23]	[1.23]	[1.65]	[1.65]
Female CEO	0.62***	2.95**	2.95**	2.70**	2.70**

	[13.48]	[2.59]	[2.59]	[2.45]	[2.45]
Collateral share	0.00	-0.22	-0.22	-0.23	-0.23
	[0.25]	[-0.66]	[-0.66]	[-0.66]	[-0.66]
Credit line	0.19***	-3.60**	-3.60**	-3.66**	-3.66**
	[5.28]	[-2.60]	[-2.60]	[-2.85]	[-2.85]
Country FE	Yes	Yes	No	Yes	No
Industry FE	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	No
Country by Year FE	No	No	Yes	No	Yes
Industry by Year FE	No	No	No	Yes	Yes
R-squared	0.071	0.102	0.102	0.111	0.111
N	30559	9838	9838	9838	9838

Appendix Table 4.12: Female employee, inherited gender bias and trade credit: Interaction frequency

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Inherited gender bias, by firms' interaction frequency with suppliers. Interaction frequency is an indicator that equals 1 if firms purchase inputs from and interact with their suppliers every 20 days, the sample median value, or more frequent, and 0 if they do so at a longer time interval. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	All				Negative commodity price shock			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Inherited gender bias	-35.21**	-35.21**	-39.96***	-39.96***	-104.36***	-104.36***	-100.20***	-100.20***
	[0.02]	[0.02]	[0.00]	[0.00]	[-3.13]	[-3.13]	[-3.68]	[-3.68]
Female	-7.54**	-7.54**	-8.60**	-8.60**	3.48	3.48	2.53	2.53
	[0.02]	[0.02]	[0.01]	[0.01]	[0.74]	[0.74]	[0.73]	[0.73]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.101	0.101	0.111	0.111	0.063	0.063	0.063	0.063
N	9921	9921	9921	9921	4334	4334	4334	4334

Appendix Table 4.13: Female employee, inherited gender bias and bank credits

This table reports results of regressing firm access to bank credits on the interaction term of Female and Inherited gender bias. The dependent variable is either Working capital financed by banks or Investment financed by banks. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Working capital financed by banks				Investment financed by banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Inherited gender bias	7.38	7.38	9.27	9.27	-9.50	-9.50	-4.82	-4.82
	[0.99]	[0.99]	[1.05]	[1.05]	[-0.87]	[-0.87]	[-0.31]	[-0.31]
Female	-0.30	-0.30	-0.08	-0.08	-8.02*	-8.02*	-9.52*	-9.52*
	[-0.17]	[-0.17]	[-0.05]	[-0.05]	[-1.81]	[-1.81]	[-2.04]	[-2.04]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.279	0.279	0.280	0.280	0.205	0.205	0.203	0.203
N	9586	9586	9586	9586	3560	3560	3560	3560

Appendix Table 4.14: Gender bias and trade credit: The role of firms' location size

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Inherited gender bias, by firms' city size. We define large cities if they have a population higher than 250,000 (the median size of cities in our sample), and small cities if they have a smaller population. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	Firms located in large cities				Firms located in small cities			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Inherited gender bias	-56.15**	-56.15**	-66.21***	-66.21***	-4.25	-4.25	0.70	0.70
	[-3.67]	[-3.67]	[-5.74]	[-5.74]	[-0.34]	[-0.34]	[0.08]	[0.08]
Female	-8.99*	-8.99*	-9.44	-9.44	-6.69**	-6.69**	-8.06**	-8.06**
	[-1.97]	[-1.97]	[-1.87]	[-1.87]	[-2.49]	[-2.49]	[-2.95]	[-2.95]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.105	0.105	0.114	0.114	0.132	0.132	0.141	0.141
N	6599	6599	6599	6599	3322	3322	3322	3322

Appendix Table 4.15: Gender bias and trade credit: Heterogeneous analyses by unexpected credit shortages

This table reports heterogeneous results of regressing Account payable on the interaction term of Female and Inherited gender bias, by whether firms face unexpected credit shortages. Commodity price shock equals to 1 if an industry has experienced a price reduction relative to the previous year based on the matched price index and 0 otherwise. In column(1)-(4), we report our baseline results from the full sample, while in column (5)-(8), we report the results from firms in industries that face unexpected credit shortages. The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Inherited gender bias. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable							
Sample =	All				Negative commodity price shock			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Inherited gender bias	-35.21**	-35.21**	-39.96***	-39.96***	-104.36***	-104.36***	-100.20***	-100.20***
	[0.02]	[0.02]	[0.00]	[0.00]	[-3.13]	[-3.13]	[-3.68]	[-3.68]
Female	-7.54**	-7.54**	-8.60**	-8.60**	3.48	3.48	2.53	2.53
	[0.02]	[0.02]	[0.01]	[0.01]	[0.74]	[0.74]	[0.73]	[0.73]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes

Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.101	0.101	0.111	0.111	0.063	0.063	0.063	0.063
N	9921	9921	9921	9921	4334	4334	4334	4334

Appendix Table 4.16: Gender bias and trade credit: The role of firm demand for credits

This table reports results of regressing either Applied for a loan or No need for a loan on the interaction term of Female and Plough. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Applied for a loan				No need for a loan			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female*Plough	-0.05*	-0.05*	-0.04	-0.04	0.00	0.01	0.00	0.00
	[-1.71]	[-1.68]	[-1.53]	[-1.52]	[0.11]	[0.16]	[0.01]	[0.09]
Female	0.01	0.01	0.00	0.00	-0.06***	-0.06***	-0.06***	-0.06***
	[0.58]	[0.55]	[0.21]	[0.23]	[-3.29]	[-3.46]	[-3.07]	[-3.35]
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Country by Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Industry by Year FE	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.352	0.353	0.353	0.354	0.107	0.108	0.109	0.110
N	30112	30112	30112	30112	21999	21999	21999	21999

Appendix Table 4.17: Female employee, plough and trade credit: Dropping Indonesia

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Plough), using OLS regression in column (1)-(4) and Tobit regression in column (5). The dependent variable is Account payable} from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Plough	-10.32**	-9.67**	-8.46**	-7.67*	-7.67*
	[-2.41]	[-2.20]	[-2.16]	[-1.93]	[-1.94]
Female	2.82	2.28	0.99	0.33	0.33
	[1.21]	[0.95]	[0.41]	[0.13]	[0.13]
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.266	0.268	0.272	0.274	0.033
N	28682	28682	28682	28682	28682

Appendix Table 4.18: Female employee, plough and trade credit: Dropping India

This table reports results of regressing Account payable on the interaction term of Female and the measure of gender bias (Plough), using OLS regression in column (1)-(4) and Tobit regression in column (5). The dependent variable is Account payable from the World Bank Enterprise Survey, calculated as the share of material inputs or services paid after delivery. The key explanatory variable is an interaction term of Female and Plough. See Table A1 in the Online Appendix for more detailed variable definitions and data sources. We include country, industry, year, or country by year and industry by year fixed effects flexibly in model specifications. We report t-stats calculated using heteroskedasticity robust standard errors clustered at country level in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%.

Dependent variable =	Account Payable				
	OLS				Tobit
	(1)	(2)	(3)	(4)	(5)
Female*Plough	-8.41**	-7.76**	-7.29**	-6.52*	-6.52*
	[-2.30]	[-2.06]	[-2.00]	[-1.75]	[-1.77]
Female	1.87	1.31	1.22	0.58	0.58
	[0.82]	[0.56]	[0.52]	[0.24]	[0.25]
Country FE	Yes	No	Yes	No	No
Industry FE	Yes	Yes	No	No	No
Year FE	Yes	Yes	Yes	No	No
Country by Year FE	No	Yes	No	Yes	Yes
Industry by Year FE	No	No	Yes	Yes	Yes
R-squared	0.318	0.319	0.321	0.323	0.040
N	24319	24319	24319	24319	24319

Chapter 5: Discussion and Conclusion

Given the first order impact of finance on economic growth, it is important to study what factors promote financial development (e.g., Levine, 1997). This thesis, motivated by the literature on law and finance (e.g., La Porta, et al., 1997, 1998), endowment and finance (e.g., Beck, et al., 2003), and culture and finance (e.g., Stulz and Williamson 2003; Guiso, Sapienza and Zingales 2004), examines three determinants of the quality of modern financial markets. In this concluding chapter, I first briefly summarize the key findings of the three empirical studies, followed by a discussion of the policy implications of the findings. I will then elaborate the contributions of my studies. Lastly, I will discuss a key limitation, and therefore a possible future research area, of the thesis.

5.1 Summary of Key Findings

In the first study, I construct a new dataset of a key Chinese institution, Xinfang, for protecting private property rights and enforcing contracts. I document that Xinfang has encouraged commercial and financial intermediations in China via its key legal functions, including private property rights protection and contract enforcement. In particular, I discover that firms in provinces with higher quality Xinfang system have better access to finance, and this relationship is more pronounced in firms that are heavily reliant on external funding for technological reasons. This result is consistent with the key insight from the law and finance theory, which champions that better functioning legal system promotes financial development.

In the second study, I examine the impact of the historical TseTse fly and its associated disease, *nagana*, on financial development today. Prior research shows that the TseTse fly, through killing domesticated animals, forced many Africans to rely on hunting and gathering (*versus* intensive agriculture) as their main subsistence strategy (e.g., Alsan, 2015). I first argue and present evidence that this particular subsistence strategy perpetuated narrow ethnic identities in Africa, breaking down social cohesion, and thus sustained a low level of social trust. The reduction in trust in the TseTse-infested areas in turn had negative ramifications on financial transactions today. Indeed, my analyses further discover that firms and households in the fly-infested places have lower access to external finance today, and such negative impact is more pronounced for firms that are more dependent on finance for technological reasons.

Since the TseTse precluded many Africans to adopt intensive agriculture and its associated technologies (i.e., the plow, water power, etc.), people in historically-infested areas over time developed a negative sentiment towards new technologies. Using a newly digitized dataset, I show that people in high TseTse-infested areas are less likely to be prepared to learn new technologies. In addition, they are also less likely to agree with the statement that "the world is a better place with technology". Since financial technology helps closing the financial inclusion gap and therefore has real impact in economic growth, I test whether the TseTse fly has influenced household adoption of financial technology. I discover that household in places with high-TseTse prevalence today are less likely to use mobile money.

In the last study, I exploit two plausibly exogenous variations in gender bias to study whether there exists a gender gap in the informal financial markets. The first is based on a well-established insight in economics that countries with a heritage of plough agriculture exhibit gender biased views favoring males (Alesina, Giuliani and Nunn 2013; 2018; Boserup 1970). The economic logic is as follows: (a) the practice of plough agriculture generated a division of labor along gender lines where men specialized in work outside home in the fields and women specialized in housework; (b) this is because plough agriculture requires substantial upper body strength and the bursts of power to control the plough, which gives men an advantage relative to women; and (c) societies featuring traditional plough agriculture have thus developed beliefs that the natural place for women is at home and such beliefs have persisted even if societies moved out of agriculture. I therefore use whether a country has a heritage of plough agriculture as my first proxy for gender bias.

The second measure of gender bias is constructed from survey responses by descendants of U.S. immigrants on a question about the appropriate role of women in a society. As stressed by Putnam (2000) and Guiso, Sapienza and Zingales (2006) that social capital is transmitted by family from parents to children, gender beliefs of a U.S. descendent is therefore a good proxy for gender beliefs of their immigrant ancestors, and by extension a good proxy for the inherited component of gender beliefs in the country of origin today.

Using these measures, I uncover that in high-gender-biased countries, firms with more female production employees have less access to trade credits. I

also find that these empirical patterns cannot be explained solely by firms' endogenous hiring decisions. Lastly, I show that firms with a higher proportion of female employees, on average, have lower unit costs of labor. This suggests that firms in high gender-biased countries are facing trade-offs between access to trade credit and lower labor costs.

5.2 Implications

Before discussing the particular contributions, it is important to note that this thesis is not just about assessing the impact of the Xinfang system, the TseTse fly, and gender bias on modern financial development; it is about discovering and understanding the determinants of financial development more broadly and shedding lights on policies to improve the function of modern financial systems. For example, the first study shows that the law and finance theory does apply to China once taking the Xinfang system into consideration. This suggests that in order to improve the Chinese financial markets, policy makers can consider taking the legal approach, such as enacting private property protection law and tightening contract enforcement regulations. While prior literature on law and finance in China is influential and important, it tends to emphasize the informal approach such as reputation (e.g., Allen, et al., 2005). My finding suggests, on the other hand, a different perspective in approaching this policy issue. Similarly, the second study shows that the TseTse fly influences modern finance through trust and the tendency to adopt new technologies. This is highly relevant to policy makers since trust and, to a larger extent, the willingness to adopt technologies are malleable (e.g., Algan and Cahuc, 2010). Finally, the last study documents a

gender gap in firm access to trade credits. It suggests that affirmative actions that allow firms characterized by females to access to finance at ease can reduce the friction in financial markets, and therefore contribute to growth.

5.3 Contributions

The first study on the relationship between the Xinfang system and financial development in China makes two key contributions. First, existing literature on the Chinese legal system and financial market seems to challenge the traditional law and finance theory. Allen et al. (2005) discover that the fastest growing firms in China do not rely on the formal legal or financial systems. This raises a natural question about the applicability of the law and finance view to China. Exploiting a larger database, however, Ayyagari et al. (2010) document that Chinese firms with access to bank credits do experience faster growth than firms with informal financing. My study provides a reconciliation of these studies by showing that once the Xinfang system is taken into account, the law and finance theory fits Chinese data well. This finding suggests that regulators, in order to improve the financial and therefore economic development, can take the legal approach of reform into account when considering relevant policies.

The first study also underscores the importance of legal system's adaptability. Although the growth of the Chinese economy over the past several decades created demands for the development of legal institutions to support new commercial, corporate, and financial arrangements, the formal legislature and courts were unable to adapt efficiently by creating and implementing new

statues. Xinfang, on the other hand, evolved to satisfy these demands. The evidence presented here implies that the Xinfang system helped reduce the gap between the contracting needs of the economy and the capabilities of the legal system.

The second study, where I examine the impact of the historical TseTse fly and its associated disease, *nagana*, on financial development today, makes the following contribution to the literature. First, this paper contributes to the scant literature on disease environment and the function of modern financial markets. So far, Beck et al. (2003) is the only study that investigates the effect of disease environment on financial development. I add to this literature in three important ways. First, while Beck et al. (2003) study the general disease environment, I look at a specific epidemic disease transmitted by the TseTse fly. This allows me to trace the precise transmission environment and therefore to exploit a cleaner identification strategy. Moreover, I go beyond the cross-country correlations by assessing within country, but cross ethnic location variations in firm and household access to finance, as well as in financial technology penetration. This provides a better understanding of the disease-finance relationship. Finally, I focus on the disease environment prior to colonization. This allows us to examine channels that are independent to the institutions established by the colonial powers. Additionally, it is more relevant to policymakers because epidemic diseases, without colonization, can be controlled and mitigated through effective domestic policies.

The second study also contributes to the literature on history and finance. A common approach in this literature is to study various dimensions of modern financial development by exploiting historical shocks, such as the passage of the Public Law 280 in the United States (Brown et al., 2016), a change in the Catholic doctrine during the Italian Renaissance (Pascali, 2016), antisemitism violence in Germany (D'Acunto et al., 2018), the slave trades in Africa (Pierce and Snyder, 2017, Levine et al., 2020), the establishment of the mining mita in Peru (Natividad, 2019), the arrival of telegraph in China (Lin et al., 2020), and the historical adoption of the plough across the developing world (An, 2020). My study of a historical epidemic disease implies that the long-term impact of diseases on finance, and on the operating mechanisms (i.e., trust, etc.), should be considered when designing the policies to combat infectious diseases.

The last study on gender bias in informal financial markets contributes a growing body of empirical literature on gender gap in the field of finance. While influential, existing studies only look at formal financial markets. In particular, researchers show that female entrepreneurs are less likely to apply for bank loans (Cavalluzzo, Cavalluzzo and Wolken 2002; Buvinic and Berger 1990) and more likely to rely on informal finance (Richardson, Howarth and Finnegan 2004; Ongena and Popov 2016), even though banks do not appear to discriminate against female (Carter et al. 2007; Aterido, Beck and Iacovone 2011; Bruhn 2009). My study complements this literature by examining the gender gap in access to trade credits, which is the most important source of short-term finance for manufacturing firms (Petersen and Rajan 1997; Fisman and Love 2003; Klapper, Laeven and Rajan 2012).

The last study is also closely related to a recent work by Ongena and Popov (2016). Using similar identification strategy, the authors discover that firms led by female entrepreneurs are less likely to use bank loans and are more likely to resort to informal finance. My paper is different from Ongena and Popov (2016) in two aspects. First, while Ongena and Popov (2016) focus on female owners, I study the impact of female workers. Since gender norms are a part of culture that applies to the whole society (Stulz and Williamson 2003; Guiso, Sapienza and Zingales 2004), it is important to expand the investigation to a wider scope of occupations such as production workers in manufacturing firms. Second, my results shed light on the supply side impact of gender bias, while Ongena and Popov (2016) highlight the demand side effects. In particular, an important insight from Ongena and Popov (2016) is that female entrepreneurs choose to rely on informal finance. My results, in contrast, uncover that firms with more female workers are offered less trade credits, regardless of their demand for finance.

To the extent that I measure gender bias using country-level inherited gender beliefs and plough agriculture, the third study is also related to an important literature on the impact of institutional characteristics on the function of credit market (e.g., Ghoul and Zheng 2016; Zheng et al. 2012, 2013). In an insightful work, for example, Ghoul and Zheng (2016) show that firm access to trade credits is positively associated with several dimensions of national culture, such as collectivism, power distance, uncertainty avoidance, and masculinity. I add to this literature by documenting the independent impact of gender beliefs, another important dimension of national culture, on trade credit provision.

Lastly, the third study also adds to the literature that examines various frictions on the function of the financial market. For example, Djankov, McLiesh and Shleifer (2007) examine the role of information asymmetry in shaping the function and development of financial markets. La Porta et al. (1997, 1998) assess the relationship between the extent of the legal constraints on managerial moral hazards and firm financing patterns across the world. I, consistent with Ongena and Popov (2016), Stulz and Williamson (2003) and Guiso, Sapienza and Zingales (2004), show that gender bias exerts a significant impact on the function of credit markets, and offer relevant policy implications to alleviate this friction.

5.4 Limitation and Future Research

The key limitation of the thesis lies in the trade-off between internal and external validity. For example, in the first study, although my results suggest that the Xinfang promotes financial development in China, I am unable to make a clear prediction on the Xinfang-finance relationship going forward. This is because (a) China is enacting and enhancing private property laws and (b) the government is trying to incorporate the Xinfang system with the formal legal system. As a result, this may have reduced the relevance of my findings to policy makers. Similarly, although I show that the TseTse impeded financial development in Africa through trust and the tendency to adopt financial technologies, I am unable to make outside-sample predictions with regard to the relationship between disease and finance. This is due to the fact that the endowment in each country and continent is distinct and therefore how people respond to disease is different: a similar shock may generate a different response in terms of social capital and norms,

with varying consequences on the function of financial markets. Further research can thus extend my study and apply the methodology in other context, thus yielding a more complete understanding of the relationship between disease and finance.

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