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Essays on Financial Development and Corporate Resilience to Crises

by

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Acknowledgements

When the time comes to actually write the acknowledgements in my dissertation, it feels a little different from what I had imagined before. Now, at midnight, I sit in front of my screen, surrounded by a song that reminds me of the past years. I feel calm and happy, looking forward to the challenges of the future. I have become more confident and brave than before, after all that I have experienced, gained and, of course, lost. There is always a journey waiting to complete a real me.

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Abstract

This paper consists of three empirical studies on financial development and corporate crisis resilience.

The first study examines the legacy of property rights institutions and their subsequent influences on both household and corporate finance. I argue that the formation of property rights institutions can be traced back to the Neolithic transformation, when hunter-gatherers became the first farmers, and that agricultural endowments positively influence financial activities today. My results show that an early Neolithic transformation predicts better financial development and property rights institutions of global countries, less financial constraints for firms, and easier access to finance for households. Consistent with the financial constraint alleviation argument, my examination of the firm sample shows that early transformation reduces investment sensitivity to cash flows and reduces cash holdings. My results based on ethnicity level data provide evidence on how the Neolithic transition influenced the formation of property rights norms in the pre-industrial period, which helps to explain the persistence of development.

The second study examines the influences of historical social capital accumulation and firm resilience to crises. Weather-related social capital reduces financial barriers for firms and increases firm resilience to crises through more accessible finance. The results show that pre-industrial weather uncertainty provided firms with fewer financial obstacles, especially in areas with more incentives or advantages to cooperate historically to insure against weather risks. Long-term weather risks have positive effects on firm survival

and recovery from systemic banking crises and COVID-19 crises, because this higher level of social capital can alleviate firms' financial constraints by enabling more credit from banks and supply chains. I test the accumulation of social capital as an influence channel by showing the links between temperature volatility and cooperation in 1500 AD and social trust today.

The third study examines gender differences in the operation of firms during the COVID-19 pandemic and assesses the effectiveness of mitigation strategies. I document that firms with more than 50% female employees are 2.1% more likely to be permanently closed than others, and suffer greater reductions in the number of employees, hours of operation, and sales. Female-dominated firms rely mainly on government subsidies as a source of financing compared to other forms of financing, and are indeed 3.5% more likely to receive government support than other firms. Both firm-specific conditions and country-specific factors explain the difference. Drawing on the theory of corporate governance institutions (CGIs), I examine the role of a female-friendly policy environment in supporting at-risk firms and find that such a policy environment makes female-dominated firms more optimistic about recovering from the crisis.

Lay Summary

This paper examines three determinants of financial development and firm resilience to crises. In the first study, I examine the influences of Neolithic transformation on modern finance through the formation of property rights institutions. I show that early Neolithic transformation predicts better financial development and property rights institutions of global countries, less financial constraints for firms, and easier access to finance for households. This study explains why development can persist by documenting the long-term influences of property rights institutions.

In the second study, I examine the influences of historical social capital accumulation on firms' resilience to crises. Historical weather risk can stimulate cooperation and thus lead to higher levels of trust. I show that pre-industrial weather uncertainty provided firms with fewer financial obstacles, especially in areas with more incentives or advantages to cooperate historically to insure against weather risks. Long-run weather risks have positive effects on firm survival and recovery from systemic banking and COVID-19 crises through the financial channel. This study highlights the critical role of social capital in modern finance and suggests that the ability of firms to overcome hardship may be shaped by the climate risks faced by their ancestors.

In the third study, I test for gender differences in the operation of firms during the COVID-19 pandemic and the effectiveness of mitigation policies. I document that firms with more than 50% female employees are more likely to close permanently than others, and suffer greater reductions in the number of employees, hours of operation, and sales. Female-dominated firms are more

likely to receive government support than other firms. Both firm-specific conditions and country-specific factors explain the difference. I find that a female-friendly policy environment makes female-dominated firms more optimistic about recovering from the crisis. My findings highlight the importance of designing fiscal stimulus packages and social assistance programmes to address gender inequality in the Covid-19 pandemic.

Contents

Chapter 1. Introduction

Development of financial markets today can by shaped by long-lasting institutions and culture. This thesis is in line with the so-called History & Finance approach as defined by D'Acunto (2017). The approach exploits natural experiments of the past to directly explain current financial outcomes. For example, natural experiments in History & Finance studies include European colonization (Beck, Demirguc-Kunt, and Levine, 2003), antisemitism in Germany (D'Acunto, Prokopczuk, and Weber, 2018), telegraph in China (Lin et al., 2021), slave trade (Pierce and Snyder, 2017; Levine, Lin, and Xie, 2020) and Tsetse fly (An, Hou, and Lin, 2022) in Africa. In this thesis, I focus on persistence of institutions and norms related to property rights, social trust, and gender role. Three specific institutions or norms in my studies are legacy of events and traditions in history, and they can explain divergency in access to finance and corporate resilience to crises nowadays.

Property rights institution is critical in the process of financial development. The security of property rights involves facilitating private contracting and limiting government coercion and expropriation (Levine, 2005), adds incentives to participate in financial markets (Acemoglu and Johnson, 2005). Both law and finance theory (La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 1998) and endowment theory (Acemoglu, Johnson and Robinson, 2005) note the importance of property right institutions for financial development. It remains unclear about the origin of property right.

In the first study of this thesis, I try to explore the legacy of property right institutions, and its subsequent influences on both household finance and

corporate finance. I argue that the formation of property rights institution can be traced to Neolithic Transformation, when the hunter-gatherers became the first farmers, and the agricultural endowment positively influences financial activities today.

Farming and its associated sedentary living require significant long-term investment in field preparation, animal raising, dwelling construction, and storage. Unlike wild resources, the domesticated resources fundamental to the livelihood of farmers were sufficiently valuable and limited spatially to make private ownership technically feasible (Bowles and Choi, 2019). Further, Neolithic transition led to the accumulation of food surpluses, thus the rise of social classes and the emergence of states (Borcan, Olsson, and Putterman, 2021). The accumulation of statehood experience increased a country's ability to consolidate power, design effective rules of law, and enforce laws (Bockstette, Chanda, and Putterman, 2002), subsequently formed the basis for building property rights institutions.

To verify this hypothesis, I exploit several worldwide geo-referenced datasets. Results show that early Neolithic transformation predicts better financial development and property rights institutions of global 151 countries, less financial constraints among firms and households. My results based on ethnicity-level records provide evidence on how Neolithic transformation influenced formation of property rights norms in pre-industrial period, which help to explain the persistence of development.

My second study focuses on the role of social trust on finance. As a critical component of social capital, trust is conventionally deemed as critical for

commercial transaction (Arrow, 1972), financial contracts (Guiso, Sapienza, and Zingales, 2004), stock markets (Guiso, Sapienza, and Zingales, 2008), venture capital investment (Bottazzi, Da Rin, and Hellmann, 2016) and household finance (D'Acunto et al., 2018; Levine et al., 2020), for the reason that institutions, firms and individuals would hardly like to get involved in financial transactions if they don't believe in counterparts in markets.

During uncertain economic times, firms with better access to finance usually perform better than others (Levine, Lin, & Xie, 2018; Ding, Levine, Lin, & Xie, 2021), and the ease of obtaining finances to some extent depends on social capital of places where firms located. It is arguably important to understand how social capital relate to firms' access to finance, especially during crises. However, social capital is often endogenous to economic conditions. To avoid this identification threat, I focus on local social capital that driven by historical weather risks, that accumulated through long history of cooperation across communities.

Buggle and Durante (2021) document positive influences of climatic variability on cultural heritage of trust. Back in pre-industrial time, weather fluctuation, as one of the main sources of economic risk, lead to farmers' cooperation with members of the broader community to cultivate/obtain subsistence in need. Such cooperation involves interaction with people living in neighbouring areas who were likely to be affected by weather fluctuations in less correlated ways. Through cooperation, groups are likely to understand language of one another, exchange customs, and share similar norms. Consequently, trust was developed through inter-group exchanges.

Drawing on the view of Buggle and Durantem (2021), I hypothesize that weather-induced social capital reduces financial obstacles for firms and enhances corporate resilience to crises through more accessible finances. To examine the hypothesis, I construct measures of historical weather uncertainty, and combine large-scale data sets of firms and households with high-resolution weather data. Results show that pre-industrial weather uncertainty endowed firms with less financial obstacle, especially in areas with more incentives or advantages to cooperate historically to insure against weather risks. Long-run weather risks have positive impacts on firms' survival and recovery from crises of systemic banking crises and COVID-19 because that greater level of social capital can mitigate firms' financial constraints by enabling more lending from banks and supply chains. I verify the accumulation of social capital as an influencing channel by showing the links between temperature volatility and 1) cooperation in 1500 CE, 2) social trust nowadays.

Gender norms substantially influence firms' equal access to financial resources. My third study aims to identify gendered impacts of Covid-19 on firms' performance, survival, and financial support from governments. In particular, it explores the role of policy environment on government support to firms which have a major fraction of females among total workers. Results of this thesis are in line with Corporate Governance Institutions (CGIs) theory that governments' decision-making is undertaken in the light of prevailing beliefs, norms, and rules of the collectivity (Capron & Guillen, 2007; Chow, Petrou, & Procopiou, 2022). I discover that female employees-dominated firms suffer more under the crisis, however, a female-friendly policy environment can

predict more government supports to those vulnerable ones. Female-friendly policy environment is found to negatively associated with historical customs of bride price, which is a transfer of money and/or other valuable assets that is made at marriage from the groom and/or his parents to the bride's parents.

The rest of this thesis is organized as follows. Chapter 2 is on the agricultural origin of property rights, and its subsequent impacts on access to finance. Chapter 3 explore the role of weather-induced social trust on access to finance and corporate resilience to crises. Chapter 4 examines the gendered impacts of the Covid-19 on firms, and the role of gender norms on policy environment. Chapter 5 concludes.

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Chapter 2. Agricultural Origin of Property Rights and Access to Finance

2.1 Introduction

Finance plays a critical role in promoting physical capital accumulation (King and Levine, 1993) and reduces income inequality (Beck, Demirgüç-Kunt, and Levine, 2007). Historical events are documented to exert long-lasting influences on institutions and culture which are tight to financial development today, such as European colonization (Beck, Demirguc-Kunt, and Levine, 2003), antisemitism in Germany (D'Acunto, Prokopczuk, and Weber, 2018), and slave trade (Pierce and Snyder, 2017; Levine, Lin, and Xie, 2021) and Tsetse fly (An, Hou, and Lin, 2022) in Africa. Influences of those events are limited in specific regions. As D'Acunto (2017) highlights the importance of understanding current financial outcomes and institutions from facts and institutions in the past, I echo the so-called *History & Finance* approach by exploring the influences of Neolithic transformation, perhaps the most world-wide influential event before the era of European expansion, on institutions that matter for finance.

Roughly in 10,000 BC, human settlement pattern experienced a significant change: transiting from foraging to farming. Considerable number of people in an area are believed to have met most of their food needs from cultivated foods. This milestone-event in human history, the Neolithic transformation, is deemed as being of paramount importance in progressing the human societies to industrial modernity (Diamond, 1997). Areas that made early transition enjoyed high population density in pre-industrial societies (Ashraf and Galor, 2011), developed civilization, statehood (Borcan, Ola, and

Putterman, 2018), technology and science earlier. Putterman and Weil (2010) observe strong persistence that having ancestors who lived in places with early agricultural and political development predicts high current GDP. The deep-rooted influences of agriculture transition on economic activities are being continually explored. Does this early development driven by natural endowments shape financial institutions, and in what ways?

Agriculture transition plays an important role in formatting norms and institutions related to property rights. Farming and its associated sedentary living require significant long-term investment in field preparation, animal raising, dwelling construction, and storage. Unlike wild resources, the domesticated resources fundamental to the livelihood of farmers were sufficiently valuable and limited spatially to make private ownership technically feasible (Bowles and Choi, 2019). Neolithic transition led to the accumulation of food surpluses, thus the rise of social classes and the emergence of states (Borcan, Olsson, and Putterman, 2021). The accumulation of statehood experience increased a country's ability to consolidate power, design effective rules of law, and enforce laws (Bockstette, Chanda, and Putterman, 2002), subsequently formed the basis for building property rights institutions.

The security of property rights involves facilitating private contracting and limiting government coercion and expropriation (Levine, 2005), adds incentives to participate in financial markets (Acemoglu and Johnson, 2005). Both law and finance theory and endowment theory note the importance of property right institutions for financial development. The law view (La Porta,

Lopez-de-Silanes, Shleifer, and Vishny, 1998) holds that legal traditions differ in terms of the priority they attach to protecting the rights of private investors vis-a-vis the State and this has important implications for financial development. The endowment theory (Acemoglu, Johnson and Robinson, 2005) states that European colonization strategy (settler mortality and population density before colonization) associated property rights institutions influence financial development. Although law and finance theory and endowment theory have different focuses on the determination of property right institutions, they all speak to the importance of protection of property rights on finance. Neolithic transition matters to property rights institutions, meanwhile it provides an ideal setting to study how persistent institutions shape modern finance. It is a biogeography-driven event. Only areas endowed with certain favorable conditions could enjoy early development. Therefore, the event is unrelated to pre-existing institutions.

My analyses start from confirming a positive relationship between Neolithic transition and the level of financial development among 151 countries. I measure early development led by Neolithic transformation using the recorded number of thousand years elapsed, until the year 2000, since the population residing within a country's modern national borders got more than half of their calories from cultivated foods and domesticated animals for their subsistence. I use Neolithic transition data constructed by Putterman (2008), based on regional and country-specific archaeological studies. Because I contend that Neolithic transition potentially shaped institutions and norms that matter to modern finance, while the persistence of institutions and norms relies on

population, it is important to incorporate effects of migration into my key measure. To trace the fraction of the year 2000 CE population's ancestral origins to the given country in the year 1500 CE, I adjust Putterman's transition data by Putterman and Weil's migration matrix (2010). The adjusted transition timing reflects the historical features of a population's ancestors rather than the history of the place they live today. I firstly show that early Neolithic transition predicts better modern financial development as measured by private credit to gross domestic product (GDP) % and deposit to GDP %. The effects are economically and statistically significant. Results are robust to extensive control variables that include colonization and its associated legal systems, religions, historical population, current GDP growth, and other geographical features that deemed to be important for institutions. When I use Neolithic timing data without adjusting migration as explanatory variable, I still find positive effects, but slightly lower value of coefficient, which confirms that the long-lasting influence sustained through population.

Next, I show that Neolithic timing are associated with better property rights institutions, and the relationship could be dictated in pre-industrial periods at ethnicity-level. One strength of my analyses is that property rights institutions are measured using comprehensive data sources. At country-level, I measure property rights institutions by multiple dimensions including the ability of laws protect private property rights, the degree to what extent the government enforces those laws, and convenient and equal access to property rights. At ethnicity-level, I use dataset from Murdock's Ethnographic Atlas (1957) which records features of global ethnicities in pre-industrial periods. Importantly, the

dataset contains indicators of whether an ethnicity had heritage rules or customs on private properties (land and movables), and whether an ethnicity has transited into an agricultural society. At individual level, I use individual reported confidence in court system and norms related to property rights institutions to measure property rights institutions (from World Values Survey). At firm-level, I use firms' reported quality of court system as one of measures. The positive relation between early transition and property rights institutions is robust among all dimensions of analyses.

The benefit of using individual and firms' datasets is that I can control for a set of individual/firm-specific characteristics, which can partly mitigate bias in estimations. More importantly, my firm results are robust to alternative and more location-specific Neolithic transition measures. The firm datasets provide longitude and latitude of firm locations. In firm-level analysis, I construct European NUTS-3[1] regional transition measures using another data source from Pinhasi, Fort, and Ammerman (2005). While transition data from Putterman (2008) is based on archaeological records, data from Pinhasi et al. (2005) is calibrated C14-dates of transition at 765 Neolithic sites. I combine regional transition measures with firm data via location of firms. Location-specific early transition still predicts better property rights and less financial constraint. Financial constraint mitigation effects are mainly shown among firms with high value of tangibles, consistent with the rationale that under good property rights institutions, banks are more willing to lend to firms, especially to

[1] According to Eurostat's definition of European regions on the basis of administrative criteria, NUTS 3 level divides regions based on population ranging from 800,000 and below.

firms who are more able to provide collaterals. My results are robust to a set of regional controls and firm characteristics.

Finally, I test whether early transition is associated with households' access to finance. With better property rights institutions, household finance in a country should also be more developed. I use a global household finance sample that covering households from 137 countries. Consistently, I find that households have easier access to financial services (bank accounts, credit cards, emergency funds from banks, mobile/Internet banking, online pay) with experience of early transition.

Overall, my results exhibit that Neolithic transformation provided institutional foundation for developing modern finance. One may concern that my national transition timing measure from Putterman (2008) is based on archaeological recordings which might contain mistakes. To address the potential issue of measurement error, I complement Ordinary Least Square models with an instrumental approach. I predict Neolithic timing by the number of domesticable animals and plants available in 10,000 BCE, longitude, latitude, climate, and continent size. Those instruments are proved to be important determinants for the invention and diffusion of farming (Hibbs and Olsson, 2004; Borcan et al, 2021). I redo the baseline analysis and show estimates of predicted Neolithic timing are positive and exhibit similar economic effects on financial development and property rights institutions.

Olsson and Paik (2020) argue that region witnessing early transition to agriculture tended to be characterized by more extractive capacity and less

inclusive political institutions, and document that early farming led to lower incomes in the western core. My results cannot be interpreted as completely contradictory against Olsson and Paik (2020). While they focus on democratic differences caused by the timing of transition, the channels I explored are institutional advantages for developing financial systems. In addition, I examine the relation between transition and finance in a global setting, which differs from their scope of study. One may still doubt that financial development is an important channel that drives incomes, so how could early transition positively influence finance while have a negative relation with incomes? I replicated baseline specifications in Olsson and Paik (2020), and found that after including a set of controls which are proved to be important for incomes (in addition to original controls they have), the negative relation between early transition and incomes disappeared. I also note that Dickens and Lagerlöf (2021) find a positive effect of early agriculture on modern agglomeration in Northern Europe. To ensure that my findings are not driven by national incomes, my measures of financial development are scaled by GDP, and I control for historical population (a proxy for historical economic development) and current GDP growth in all specifications.

This study mainly contributes to two streams of literature. Firstly, I add to finance literature by identifying the timing of Neolithic transition as a long-lasting determinant of financial development, and especially emphasizing the importance of property rights institutions. Most relevantly, seminal work by La Porta et al. (1997, 1998) focus on important implications of legal traditions protecting the rights of private investors for financial development; and

Acemoglu and Johnson (2005) examine how European colonization strategy associated property rights institutions influences financial development. My study explores effects of agricultural lifeways on emergency of property rights institutions, and how persistent institutions shape modern finance. I speak to literature on the relation between property rights and finance[2]. Claessens and Laeven (2003) study the influences of property rights on allocation of investable resources, and show that better property rights lead to higher growth through improved access to financing, and lead to more efficient investment. Berkowitz, Lin, and Ma (2015) find that the improved property rights promote investment, access to finance, and led to a significant increase in firm value.

Secondly, my work relates to studies on agricultural origins of economic behavior, including differences in beliefs and values regarding gender role (Alesina, Giuliano, and Nunn, 2013), the prevalence of long-term orientation and its associated preference for technological adoption, education, saving and smoking (Galor and Özak, 2016), individual outcomes of education and wealth (Michalopoulos, Putterman, and Weil, 2019), civil conflicts (Iyigun, Nunn, and Qian, 2017), modern agglomeration (Dickens and Lagerlöf, 2021) etc. D'Arcy, Nistotskaya, and Olsson (2021) document transition to agricultural production and property rights to land have been a key institution for economic development. My study contributes to this stream of literature by firstly linking early farming practices to early property rights institutions which could explain divergency of financial development today.

[2] See Levine (2021) for a comprehensive review on law, endowments, and property rights.

By learning from history, this study implies that currently under-developed countries may find it helpful to improve their design of law to protect private property rights and effectiveness of administrations, in order to provide firms with a more ideal institutional environment. Other identified historical sources of financial development include colonization associated legal origins (La Porta, Florencio, Shleifer, and Robert, 1998), disease environment (Beck et al., 2003; An et al., 2021), distrust caused by historical antisemitism (D'Acunto et al., 2019) and slave trade (Levine et al., 2020).

2.2 Literature Review and Hypothesis

Three fundamental views about the determinants of financial development all note the importance of institutions for finance. The law and finance theory (La Porta et al., 1998) holds that legal traditions differ in terms of the priority they attach to protecting the rights of private investors vis-a-vis the state and this has important implications for financial development. The endowment theory (Acemoglu, Johnson and Robinson, 2001) argues that the disease and geographical environment influence the formation of long-lasting institutions that influence financial development. The culture-religion view (Stulz and Williamson, 2003) proposes that culture matters for financial development since it affects values, beliefs, institutions and how resources are allocated in an economy.

Institutions refer to established patterns of behaviour or rules that shape and govern social interactions. Institutions can include organisations, laws, customs, norms and traditions that influence individuals and groups in

their actions and decision-making processes (Hodgson, 2006). Institutions persist through the interplay of individual actions, the internalisation of institutional conventions, and the structured interactions between individuals that maintain and reproduce the institution over time. There is empirical evidence that institutions can persist over long periods of time. For example, Acemoglu, Johnson, and Robinson (2001) document that extractive political institutions bequeathed by European colonists between the seventeenth and nineteenth centuries have persisted to the present day. current differences in trust levels within Africa can be traced back to the transatlantic and Indian Ocean slave trades. Nunn & Wantchekon (2011) document that the slave trade between 1400 and 1900 had a long-term impact on a culture of mistrust within Africa. Voigtländer and Voth (2012) show that county-level differences in anti-Semitism in Germany have persisted for over 600 years.

I argue that Neolithic transformation, as a milestone-event in human history, might influence modern finance by shaping institutions which attach importance on private property rights. Neolithic transformation started roughly in 10,000 BC. Driven by superior access to plants and animals suitable for domestication (Diamond, 1997) and a large increase in climatic seasonality (Matranga, 2019), hunter-gatherers abandoned their traditional nomadism and started to rely on cultivated foods. Seven times independent invention of agriculture occurred in the Fertile Crescent, Subsaharan Africa, North and South China, the Andes, Mexico, and North America. Influences of early transition persist. Locations that made early transition enjoyed high population density in 1500 (Ashraf and Galor, 2011), developed civilization, statehood

(Borcan, Ola and Putterman, 2021), technology and science earlier (Comin, Easterly and Gong, 2010). The persistence still holds when Putterman and Weil (2010) adjust for migration. Having ancestors who lived in places with early agricultural and political development predicts high income today, as well as determines the present global distribution of crop productivities, ethnic groups, cultural traditions, and political institutions.

Property rights institutions relate to whether rules protect citizens' property from the from authorities. In the Middle Ages, feudalism emerged as a system whereby a lord granted land to his vassals in exchange for their loyalty and service. This system established a hierarchical structure and provided a basic form of property rights protection, as the lord recognised and defended the vassals' rights to the land they farmed. When there are no checks on the state, on politicians, and on elites, private citizens do not have the security of property rights necessary for investment. In this case, private citizens find it impossible to write credible contracts with the state to prevent future expropriation. Nowadays, a good protection of private property facilitates innovative commercial and financial arrangements. Beck, Demirguc-Kunt and Levine (2002) show that the effectiveness of property rights protection influences the ability of firms to raise capital and grow. Acemoglu and Johnson (2003) note that property rights institutions have a first-order effect on long-run economic growth, investment, and financial development. Berkowitz, Lin, and Ma (2015) find that the improved property rights promote investment, access to finance, and led to a significant increase in firm value. D'Arcy, Nistotskaya, & Olsson (2021) present a novel dataset on the emergence of state-administered

cadasters for 159 countries over the last millennium to show that clearly defined land rights provide economic agents with improved access to credit, secure returns on investment, free up resources to defend their land rights, and facilitate land market transactions.

Early transition refers to the emergency and development of property rights institutions. Theoretical work of Bowles and Choi (2019) argues that possession-based private property is a pre-condition of farming. Farming and its associated sedentary living require significant long-term investment in field preparation, animal raising, dwelling construction, and storage. Unlike wild resources, the domesticated resources fundamental to the livelihood of farmers were sufficiently valuable and limited spatially to make private ownership technically feasible. From the view of Bowles and Choi (2019), a would-be first farmer was motivated to undertake the long-term production process because private possession in their areas was more readily established and defended for cultivated crops and domesticated animals. Afterwards, Neolithic transition led to the accumulation of food surpluses, thus the rise of social classes and the emergence of states (Borcan, Olsson, and Putterman, 2020). The accumulation of statehood experience increased a country's ability to consolidate power, design effective rules of law, and enforce laws (Bockstette, Chanda, and Putterman, 2002), subsequently formed the basis for building property rights institutions. D'Arcy et al. (2021) show that clearly defined land rights provide economic agents with increased access to credit, secure returns on investment, free up resources used to defend one's land rights, and facilitate land market transactions. Formalized land records also strengthen

governments' capacity to tax land-owners. While institutions and social norms are often transmitted over generations (Putterman and Weil, 2010), I expect that institutions and norms influenced by the Neolithic transition could persist and even shape economic decisions and outcomes today.

Putterman (2008) firstly discovers that the relation between national institutions of property rights and transition years is positive. Later, work of Ang (2013) finds that states with a longer history have stronger fiscal and legal capabilities. Early states designed effective rules that contribute to institutional environment and deepening financial systems. To take together, studies suggest that Neolithic transition and its associated early development contribute to design and enforcement of rules that protect private property. On the other hand, more secure property right adds incentives to invest, thus contributes to long-run economic growth and financial development (Acemoglu and Johnson, 2005). It still lacks solid empirical evidence on the link between Neolithic transition and property rights institutions, and to what extent early transition influences the level of financial development.

On a contradictory view, early transition is associated with extractive institutions that might impede financial development. Olsson and Paik (2020) note that region witnessing early transition to agriculture developed more extractive capacity and less inclusive political institutions, which are detrimental for innovation and productivity in the long run. For example, in ancient Egypt, the large-scale irrigation systems are in the control of rulers, which turns these societies into absolutist states, and peasants were reduced to a slave-like

status (Galor and Özak, 2016). Powerful elites are better able to oppose democratization, even affect political regimes in the present. In the Middle East, the earliest agricultural societies witnessed the rise of civilizations in the form of autocratic states, where rulers keep both land and political power highly centralized (Blaydes, 2017). Such historical extractive institutions harmed economic development. Acemoglu, Johnson and Robinson (2002) document that European adopt extractive institutions among densely populated areas in 1500 for the exploiting labor force and taxation purpose, which lowers incentives for investment and innovation. Spolaore and Wacziarg (2013) point out that extractive institutions can erode initial development brought by environmental endowments. For example, societies that were endowed with climate and soil conditions well-suited for growing sugar, coffee, rice, tobacco ended up with unequal slave economies in the hands of a small elite, implementing policies and institutions that perpetuated such inequality.

Work of Olsson and Paik (2020) shows a reversal of fortune happened within the Western agricultural core. Regions which made early transition to Neolithic agriculture are now poorer than regions that made the transition later. This reversal started before the era of European colonization. Their explanation of this reversal is that agricultural adoption timing and indicators of inclusive, democratic institutions have a strong association. Countries with an early transition tended to be more autocratic both in 1500 and the 20th century. In addition, early transition has been found to be associated with social norm that valuing obedience more (Olsson and Paik, 2016), which is also related to autocracy. Overall, if early transition shape institutions in an autocratic way, I

should observe a negative relation between financial development and the timing of transition.

2.3 Data

I describe data sources and sample construction in this section. For variables not covered here, please see Appendix for all details.

Time of transition to agriculture is defined as number of thousand years elapsed, until the year 2000, since the population residing within a country's modern national borders got more than half of their calories from cultivated foods and domesticated animals for their subsistence. Country level transition data is compiled by Putterman (2008) based on regional and country-specific archaeological studies. They treat a country as having made the agricultural transition if any appreciable region within the country had done so. For example, India is considered as having made the transition once Indus Valley agriculture is well evident, although large portions of modern India outside the sphere of agriculture hadn't. Transition timing data is ancestry adjusted using Putterman and Weil's migration matrix (2010), which considers the fraction of the year 2000 CE population that can trace its ancestral origins to the given country in the year 1500 CE. Putterman & Weil (2010) construct the migration matrix using a combination of historical and contemporary data. The authors use a variety of sources, including historical records, genealogies, and linguistic and genetic evidence, to estimate the proportion of the ancestors of each country's current population who lived in each source country in 1500. They then use this information to construct a matrix with 165 rows, each for a

present-day country, and 172 columns containing the same 165 countries plus seven other source countries with current populations of less than half a million. The entries in the matrix are the proportions of long-term residents' ancestors estimated to have lived in each source country in 1500, and each row adds up to one. The authors take a 'fractional' view of ancestry and descent, meaning that the entries in the matrix measure the fraction of a country's ancestry attributable to different source countries. The adjusted transition timing reflects the historical features of a population's ancestors rather than the history of the place they live today. Among 151 countries, the mean transition timing is 5440 years prior to year 2000.

My regional level measures of Neolithic transition timing are much more spatially specific than national level one. Subnational transition data is constructed using calibrated C14-dates of the earliest Neolithic occupation. Pinhasi et al. (2005) provide calibrated C14-dates of transition at 765 Neolithic sites throughout Europe and Southwest Asia. I aggregate the C14-dates of transition at European NUTS 3 levels. According to Eurostat's definition of European regions on the basis of administrative criteria, NUTS 3 level divides regions based on population ranging from 800,000 and below. The regional level transition timing is the length between mean calibrated C14-dates of all archaeological sites covered by each region and the year of 2000. There are 694 small regions included in my NUTS 3 level analysis. In Appendix Table 5, I report the distribution of NUTS 3 regions across 29 European countries.

My country-level financial development measures are from the World Bank's Global Financial Development Database[3], which provides annual measures of depth, access, efficiency, and stability of financial systems. I use (1) private credit to GDP % and (2) deposit to GDP % to measure national level of financial development (average values between 2000 and 2017). The two measures of financial development are commonly used in existing financial studies such as An, Hou & Lin (2022). I measure property rights institutions using four different indexes. The first and most important one is from Heritage's Index of Economic Freedom database[4]. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. The measure is well-used in many seminal studies, such as Acemoglu and Johnson (2003) and Levine (2005). The other three supplemental measures are from Property Rights Alliance's and World Bank's WGI database[5]. They cover different dimensions of property rights institutions.

Data of ethnicity-level pre-industrial existence of private property rights is obtained from Murdock's Ethnographic Atlas (1957), a comprehensive collection of data on different societies and cultures around the world. This dataset has been widely used in the political economy, economic history and cultural economics literatures as it contains ethnographic information on the pre-industrial characteristics of 1,265 ethnic groups, where an ethnicity refers to a social group that shares common cultural, linguistic, religious or ancestral

[3] https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
[4] https://www.heritage.org/index/property-rights
[5] https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators

characteristics. Murdock's Ethnographic Atlas survey was conducted among pre-industrial ethnic groups (from 1600), thus it enables us to identify early existence of property rights institutions. Murdock's Ethnographic Atlas provides information on subsistence types. If an ethnic group reports to obtain over a half subsistence from agriculture, I identify the group as having finished Neolithic transition. By types of property, I use two property rights measures. One measure indicates whether an ethnicity has individual property rights in land or of any rule of inheritance governing the transmission of such rights, and the other indicates existence of inheritance rule for movable property. The dataset also provides ethnicity-level characteristics such as community size, history of slavery, types of marriage organization, and specific location of the ethnicity. Some characteristics are control variables in my empirical specification.

I have two sets of firm samples, which are obtained from the Worldscope and World Bank Enterprise Survey (WES)[6], respectively. Worldscope provides panel data of firms globally. I use this data set from Worldscope to analysis firms' financial decisions. Enterprise Surveys offers an expansive array of economic data on firms, but the data is based on survey questions which are conducted once a few years. WES sample could reflect firm-reported quality of property rights. Most importantly, I have information of firms' locations from both data sets. I identify which NUTS-3 region a firm locates via GIS software, and then combine firms' information with regional features.

[6] https://www.enterprisesurveys.org/en/data

The household finance data source is from World Bank's Financial Inclusion Database 2017[7], a comprehensive data set on how adults save, borrow, make payments, and manage risk, covering 150,000 adults aged 15 and above in over 140 economies. I use this data set to study households' access to and use of financial services, and control for individual characteristics such as education, income, gender, and age.

I obtain individuals' opinions on quality of legal institutions and on their thoughts about behaviors that harm private property rights from World Value Survey database. It covers worldwide respondents, and give information including individual age, gender, education, incomes, and their opinions on a large set of issues. For all variables used in my analyses, I report summary statistics in Table 1.

Table 1. Summary statistics

This table reports summary statistics of our country-level, ethnicity-level, NUTS 3-level, firm-level, and individual level variables in this study.

Panel A. Country-level data

	N	Mean	St.Dev	p25	Median	p75
Neolithic timing	151	5.44	2.11	3.59	5.5	7.08
Private credit to GDP	151	45.91	45.72	16.07	31.24	61.54
Deposit to GDP	151	55.55	50.02	22.4	39.69	75.13
Property rights	151	56.79	18.68	43.1	56.4	70.5
IPRI	123	5.69	1.43	4.7	5.4	6.5
Property register	151	14.92	7.51	8	14.5	22.4
Rule of law	151	-.13	0.98	-.84	-.41	.53
French legal origin	151	.45	0.50	0	0	1
Roman Catholics	151	30.68	35.80	.7	12.6	59.5
Muslims	151	24.86	36.17	0	2.4	40
Protestant	151	10.89	19.22	.2	1.9	13.2
GDP growth	151	4.08	1.91	2.8	3.97	4.97
Ln Population 1500	151	13.12	1.88	12.09	13.35	14.22
Absolute latitude	151	27.41	16.96	13	25.75	41
Longitude	151	18.14	56.00	-4	21	45
Elevation	151	.54	0.47	.24	.39	.72

[7] https://microdata.worldbank.org/index.php/catalog/3324

Temperature	151	18	8.33	10.19	21.13	25.09
Precipitation	151	86.4	59.49	43.43	70.14	125.77

Panel B. Ethnicity-level data

	N	Mean	St.Dev	p25	Median	p75
Property - land	738	.74	.44	0	1	1
Property - movables	780	.85	.36	1	1	1
Lending tradition	1063	.14	0.07	.09	.14	.18
Transition	780	.65	.48	0	1	1
Absolute latitude	780	20.65	16.93	7	14	35
Longitude	780	1.15	80.4	-70.5	13	36.5
Slavery	780	2.05	1.33	1	2	3
Community size	780	1.86	2.46	0	0	3
Clan	780	.22	.41	0	0	0

Panel C. NUTS 3-level data

	N	Mean	St.Dev	p25	Median	p75
Neolithic timing-mean	694	7.11	0.68	6.77	7.15	7.34
Neolithic timing-nearest	694	6.19	0.81	5.88	6.23	6.51
Distance to water	694	2.64	2.12	0	3.34	4.49
Railway coverage	694	.23	0.20	.09	.17	.32
Log GDP pc	694	9.6	0.88	8.84	9.98	10.22
Log area	694	7.56	1.34	6.7	7.83	8.62

Panel D. WES firm data

	N	Mean	St.Dev	p25	Median	p75
Firm size	8796	.06	0.20	.01	.02	.05
Firm age	8796	19.07	12.85	11	18	24
Manager experience	8796	21.53	10.74	14	20	28
Female manager	8796	.17	0.38	0	0	0
Foreign ownership	8796	5.89	22.19	0	0	0
State ownership	8796	.16	2.87	0	0	0
Export	8796	11.36	25.75	0	0	3
Court system	8796	2.41	0.98	2	2	3

Panel E. Worldscope data

	N	Mean	St.Dev	p25	Median	p75
Capital expenditure/Assets	31747	.25	19.02	.01	.03	.06
Ln(cash ratio)	32684	1.93	1.46	1.25	2.15	2.88
Cash flow	32684	.11	5.24	.02	.09	.18
Ln(sales+1)	32684	19.06	2.73	17.45	19.08	20.82
Current assets	32684	.39	0.22	.22	.38	.53
EBIT	32684	-.03	3.60	0	0	0
Leverage	32684	.79	25.86	.08	.41	.97
ROA	32684	.24	42.34	-.45	3.54	7.17

Panel F. WVS individual-level data

	N	Mean	St.Dev	p25	Median	p75
Female	293823	.51	.5	0	1	1
Ln Age	293823	3.64	.4	3.33	3.66	3.97
Ln Age squared	293823	13.44	2.91	11.1	13.42	15.76
Incomes	293823	4.7	2.3	3	5	6
Urban	293823	.81	.39	1	1	1
Confidence in courts	293823	2.55	.93	2	3	3

Justifiable: stealing	143179	1.8	1.8	1	1	2
Justifiable: bribe	353977	1.83	1.84	1	1	2

2.4 Empirical Analyses

2.4.1 Financial development across countries

I firstly perform country-level analysis to examine the relation between the timing of Neolithic transition and developing levels of financial systems. I use specification shown as below:

$$FDevelopment_c = \alpha + \beta Neolithic\ Timing_C + X_C'M + \varepsilon_c \qquad (1)$$

where the dependent variable is financial development in country *c*. The World Bank's Global Financial Development Database provides annual indicators. I use averaged values of (1) private credit to GDP % and (2) deposit to GDP % to measure national level of financial development between year 2000 and 2017. The two variables measure the depth of financial development of a given country. Mean values of the two indicators are 45.91% and 55.55%. ***Xc*** is a vector of economic, geographic, culture and institutions of country *c*, which contains indicator of legal origins, religions of population (Roman Catholics, Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth.

Results are presented in Table 2. I find early transition is positively related to financial development, and the economic significance isn't trivial. In Column (2) and (5), OLS estimation of Neolithic timing is 5.369 and 6.958, which means that each 1,000-year-experience since transition is associated with 5.369% higher private credit by deposit money banks to GDP ratio, and

6.958% higher deposits to GDP ratio. The coefficients of control variables are consistent with previous studies, for instance, French legal origin is negatively associated with financial development, while Protestant religion has positive association.

In Column (3) and (6), I report IV estimation of Neolithic timing. Neolithic transition is an exogenous event, as Diamond (1997) suggested, it was largely driven by biogeographic and geographic features. One may concern that the transition timing data from Putterman (2008) is based on archaeological recordings which might contain mistakes, and this could affect the accuracy of my estimation. To address the potential issue of measurement error, I complement Ordinary Least Square models with an instrumental approach. At first stage, I predict Neolithic timing by climate suitability, latitude and East-West continental axis, continent size, the number of domesticable plants and animals available in 10,000 BC. Those factors are proved to be important determinants for the invention and diffusion of farming (Hibbs and Olsson, 2004; Ashraf and Michalopoulos, 2015). Borcan et al. (2021) use these biogeography variables

Table 2. Financial development across countries

This table reports OLS and 2SLS regression results of financial development of countries on the timing of Neolithic transformation. The dependent variables are Private credit to GDP, and Deposit to GDP, which measure the depth of financial development (average value over 2000 - 2017). The explanatory variable, *Neolithic timing* is the country-level ancestry adjusted average years from Neolithic transition to year 2000. Country controls include French legal origins, religions of population (Roman Catholics, Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth. See the Appendix for more detailed variable definitions and data sources. Heteroskedasticity-robust t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Private credit to GDP			Deposit to GDP		
Neolithic timing	5.427***	5.369***		7.04***	6.958***	
	(3.212)	(3.224)		(3.756)	(3.519)	
Neolithic timing-IV			6.068***			7.686***
			(2.586)			(2.83)
French legal origin		-5.896	-3.578		-4.474	-3.71
		(-.737)	(-.68)		(-.504)	(-.669)
Protestant		.368*	.273		.395*	.316
		(1.727)	(1.259)		(1.701)	(1.254)
GDP growth		-5.195**	-3.175*		-6.077**	-3.824*
		(-1.999)	(-1.925)		(-2.031)	(-1.799)
Ln Population 1500		.402	-2.747**		.58	-2.888*
		(.278)	(-1.99)		(.348)	(-1.672)
Constant	17.188	30.737	62.506	18.18	23.216	62.729
	(1.631)	(.544)	(1.392)	(1.577)	(.361)	(1.141)
Observations	151	151	127	151	151	127
R-squared	.062	.289	.476	.086	.295	.463
Country controls	Yes	Yes	Yes	Yes	Yes	Yes

as their instrument tool for timing as well. As shown in Appendix Table 2, R square of my first stage specification is 0.675, suggesting these features together are effective instruments. In Table 2 Column (3) and (6), estimates of predicted Neolithic timing are 6.068 and 7.686, slightly larger than value of OLS estimation. It means that the biogeographically driven Neolithic transformation has more pronounced influences after I addressed the measurement error concern. I also test whether my instruments suffer from weak or over-identification issues. Because Cragg-Donald F statistics are larger than Stock-

Yogo Critical Values (5% maximal IV relative bias), I can reject the null hypothesis that the estimator is weakly identified. My estimator also passes over-identification test, given that p-values of Hansen J test are small enough.

2.4.2 Property rights institutions

As a next step, I examine the relation between Neolithic transition and property rights institutions. The security of property rights involves 1) facilitating private contracting and 2) limiting government coercion and expropriation (Levine, 2005). I consider both two aspects of property rights institutions. Results show that earlier transition is positively associated with property rights institutions both historically and contemporarily.

To measure modern institutions, I use four different indexes. The first and most important one is from Heritage's Index of Economic Freedom database. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts. With a range from 0 to 100, the more certain the legal protection of property, the higher a country's score. The other three supplemental measures are from Property Rights Alliance's and World Bank's WGI database. They cover different dimensions of property rights institutions. The International Property Rights Index (IPRI) is specific to the core legal and political environment that are directly associated to the strength and defense of physical and intellectual property rights. Property register index measures the

reliability of infrastructure, transparency of information, geographic coverage, land dispute resolution and equal access to property rights. Rule of law index captures perceptions of the extent to which agents have confidence in and abide by the rules of society, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

I regress the set of institutional indicators on Neolithic transition timing separately, and control for an array of country-specific factors. Table 3 reports OLS and 2SLS estimation of Neolithic transformation timing. Results show that early transition is positively associated with quality of property rights institutions. OLS estimates show that a 1,000-year-earlier transition is related to 2.04 higher property rights indicator, 0.19 higher IPRI score, 0.761 higher property register index, and 0.095 higher rule of law index (mean values of the four indicators are 56.79, 5.69, 14.92 and -0.137). Again, I find that IV estimates are larger than OLS estimates, resemble to what I find in section 4.1.

To capture the enduring influences of Neolithic transformation, I then examine the relation between historical existence of property rights rules and Neolithic timing. I retrieve pre-industrial institution measures from Giuliano and

Table 3. Property rights across countries

This table reports OLS and 2SLS regression results of property rights institutions on the timing of Neolithic transformation. Dependent variables measure the quality of modern institutions protecting private property rights. *IPRI* is specific to the core factors that are directly associated to the strength and defense of physical and intellectual property rights; *Property register* measures the reliability of infrastructure, transparency of information, geographic coverage, land dispute resolution and equal access to property rights. The explanatory variable, *Neolithic timing* is the country-level ancestry adjusted average years from Neolithic transition to year 2000. Country controls include French legal origins, religions of population (Roman Catholics,

Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth. See the Appendix for more detailed variable definitions and data sources. Heteroskedasticity-robust t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Property rights		IPRI		Property register		Rule of law	
Neolithic timing	2.042***		0.190***		0.761***		0.095**	
	(2.893)		(2.828)		(2.960)		(2.415)	
Neolithic timing-IV		3.333***		0.213**		1.238***		0.136**
		(3.297)		(2.334)		(3.552)		(2.270)
French legal origin	-2.974	-5.519**	-0.155	-0.287	-0.985	-0.903	-0.151	-0.257**
	(-1.038)	(-2.039)	(-0.570)	(-1.114)	(-0.808)	(-0.711)	(-1.035)	(-2.043)
Protestant	0.207***	0.158**	0.032***	0.021***	0.016	0.028	0.014***	0.011**
	(3.327)	(2.071)	(4.901)	(2.677)	(0.606)	(0.849)	(3.485)	(2.304)
GDP growth	-0.420	0.267	-0.002	0.021	0.014	0.149	-0.064	-0.031
	(-0.482)	(0.332)	(-0.028)	(0.288)	(0.043)	(0.426)	(-1.566)	(-0.811)
Ln Population 1500	-1.023	-1.992***	-0.065	-0.199***	-0.576**	-0.806***	-0.059*	-0.136***
	(-1.595)	(-3.017)	(-1.123)	(-3.336)	(-2.226)	(-2.737)	(-1.766)	(-3.974)
Constant	70.844***	95.155***	6.557***	9.335***	27.826***	33.201***	0.473	2.476**
	(3.215)	(4.339)	(3.131)	(4.485)	(3.239)	(3.952)	(0.412)	(2.201)
Obs.	151	126	123	105	151	127	154	127
R-squared	0.515	0.544	0.494	0.564	0.576	0.545	0.540	0.606
Country controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4. Pre-industrial inheritance rule for real property and lending tradition

This table reports OLS regression results of pre-industrial property rights institutions on the timing of Neolithic transformation. Dependent variables Property - land and Property – movables measure the existence of pre-industrial inheritance rule for real property; Lending tradition measures the share of motif related to lending in an ethnical group's oral tradition. The explanatory variable Transition indicates whether an ethnicity had transited or not by the time when the survey was conducted. Ethnicity controls include slavery, community size, clan communities, absolute latitude, and longitude. See the Appendix for details of variable definition. Heteroskedasticity-robust t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Property - land		Property - movables		Lending tradition	
Transition	.444***	.357***	.218***	.163***	.042***	.022***
	(11.016)	(9.356)	(6.961)	(4.788)	(7.574)	(4.334)
Slavery	.051***	.024**	.058***	.03***	.012***	.001
	(5.001)	(2.22)	(8.054)	(3.108)	(7.758)	(.868)
Community size	.002	-.003	.005	.007	.001	.001
	(.478)	(-.539)	(1.377)	(1.319)	(1.366)	(1.179)
Clan	.011	-.01	.053**	.019	.006	-.009*
	(.345)	(-.312)	(2.351)	(.657)	(1.085)	(-1.83)
Absolute latitude	-.002	-.006**	0	.003	0***	.001
	(-1.547)	(-2.407)	(-.19)	(1.111)	(3.043)	(1.383)
Longitude	.001***	.003***	.001***	0	0***	0*
	(4.26)	(2.681)	(7.298)	(.421)	(4.286)	(-1.729)
Constant	.359***	.549***	.57***	.604***	.074***	.108***
	(6.91)	(8.582)	(12.94)	(10.213)	(11.255)	(11.41)
Observations	738	693	780	735	1063	1012
R-squared	.426	.599	.327	.467	.17	.451
Country FE	No	Yes	No	Yes	No	Yes

Nunn (2018). The dataset contains ancestral characteristics of global modern populations at ethnicity-level. My historical measures of property rights are 1) existence of land property rights, 2) removable property rights of an ethnicity in pre-industrial era. In this analysis, I also consider tradition related to financial activities. Michalopoulos & Xue (2021) introduce a catalog of oral traditions spanning approximately 1,000 societies. Their data is based on folklore[8]. I use a motif that reflects groups' intensity of lending tradition as an outcome variable. The higher value of a motif, the higher fraction of words related to the motif in the total number of motifs within a group's oral tradition. The independent variable in my pre-industrial analysis is a dummy indicating whether an ethnic group obtain over 50 percentage of subsistence from agriculture (definition of having finished Neolithic transition). Meanwhile, I control for ethnic characteristics including history of slavery, community size, and an indicator of clan community. Results in Table 4 suggest that early transition is positively associated with the existence and enforcement of pre-industrial property rights rules, as well as the existence of early financial activities. Neolithic transition dummy predicts 0.357 more likelihood of having land property rights, 0.163 more likelihood of having removable property rights rules in the pre-industrial time, and 0.022 higher intensity of lending tradition.

I next perform individual-level analysis on the relation of Neolithic transition and property rights. I obtain individual-level data from World Value

[8] It is the collection of traditional beliefs, customs, and stories of a community passed through the generations by word of mouth.

Survey. Using survey data on individuals, I could observe how people judge the effectiveness of legal systems that could protect their private property, and how

Table 5. Property right institutions reported by citizens

This table reports OLS regression results of citizens' confidence in courts and norms related to property rights institutions on the timing of Neolithic transformation. Sample is from World Value Survey 2000 - 2017 dataset. Dependent variable Confidence in courts is the level of a respondent's self-reported confidence in courts; Justifiable: stealing/bribe is the level of a respondent's self-reported justification of corresponding behaviors (ranges from 0 to 10). The explanatory variable, Neolithic timing, is the country-level ancestry adjusted average years from Neolithic transition to year 2000. Country controls include French legal origins, religions of population (Roman Catholics, Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth. The individual controls include a gender indicator, ln Age, ln Age squared, indicator of income levels, and indicator of whether a respondent lives in urban or not. See the Appendix for more detailed variable definitions and data sources. Standard errors are clustered at country-level, and t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Confidence in court		Not justifiable: stealing		Not justifiable: bribe	
Neolithic timing	.037*		.076*		.069**	
	(1.964)		(1.815)		(2.409)	
Neolithic timing-IV		.055*		.123**		.097
		(1.831)		(2.039)		(1.621)
French legal origin	.025	.026	-.045	-.033	-.109	-.144
	(.289)	(.312)	(-.218)	(-.137)	(-.632)	(-.685)
Protestant	.008***	.007***	0	0	.002	0
	(4.252)	(2.754)	(.08)	(-.089)	(.725)	(-.146)
GDP growth	.02	.009	-.045	-.068	-.052**	-.043
	(.82)	(.376)	(-1.187)	(-1.457)	(-2.054)	(-1.133)
Ln Population 1500	.017	-.013	.024	.006	.034*	-.016
	(1.139)	(-.755)	(.761)	(.182)	(1.81)	(-.733)
Constant	3.901***	2.964***	10.837***	10.536***	8.849***	9.561***
	(6.592)	(5.528)	(8.031)	(7.322)	(13.256)	(8.767)
Obs.	293823	251239	143179	120042	355276	303042
R-squared	.086	.089	.066	.089	.032	.036
# countries	93	93	69	69	97	97
Country controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes

people view behaviors that might impede private property rights. Measures of property rights institutions are 1) citizens' confidence in courts and 2) norms related to property rights. Table 5 reports OLS estimates of Neolithic transition on individual views. Results show that a 1,000-year-earlier transition is related to 0.037 more degree of confidence in courts, 0.076 less degree of thinking stealing as justifiable, and 0.069 less degree of thinking bribe as justifiable. Sample mean of three measures are 2.55, 1.8, and 1.83. To reduce estimation bias, I include a set of individual characteristics such as age, gender, and level of incomes as controls.

2.4.3 European NUTS 3-level analysis

In this section, I combine location-specific Neolithic transition measures with firm-level survey data to test influences of early transition on modern institutions and finance. I construct European NUTS-3 regional transition measures using calibrated C14-dates of transition at 765 Neolithic sites from Pinhasi, Fort, and Ammerman (2005). I link regional transition measure with firm data via longitude and latitude of a firm's location. Location-specific early transition predicts better property rights as reported by firms, lower investment sensitivity to cash flows, and less cash holdings. The firms' level specification is:

$$Firm_{i,r} = \alpha + \beta Neolithic\ Timing_r + X_i'M + + X_r'N + \varepsilon_{i,r} \qquad (2)$$

where $Firm_{i,r}$ is a set of survey answers from firm *i* in European region *r*. ***X****r* is a vector economic and geographic features of NUTS region *r*, including distance to water, distance to railway, GDP per capita, and size of area. ***X****i* is a vector of firm characteristics including firm *i*'s size, age, manager experience,

manager gender, foreign/state ownership in percentage, business group, exports, industry fixed effects, country fixed effects and year fixed effects.

I measure property rights institutions using the firms' reported fairness of local court system. Table 6 shows the positive influences of Neolithic transition on the quality of court system by WES firms. Independent variable is the level of firms' satisfaction on court system. It varies from 1 to 4. The higher value of court system, the stronger agreement of firms with the statement that "The court system is fair, impartial and uncorrupted". Neolithic timing measure in Column 1, 3 and 5 is the NUTS 3 regional mean transition years, and the measure in Column 2, 4 and 6 is the transition years of the nearest Neolithic sites in Pinhasi, Fort, and Ammerman (2005) to firms' locations. Results show that in regions with longer experience of agricultural lifeways, firms' reported fairness of local court system is better. My specification generates comparable coefficients between two kinds of Neolithic transition measures (0.128 in Column 5 and 0.109 in Column 6). This finding is consistent with my results in section 4.2.

According to the financial constraint mitigation argument (Chen et al., 2014), better protection of property rights help relieve financial constraints facing firms and enable them to hold less cash for precautionary purposes. The rationale is that good property right institutions can boost banks' confidence in lending as the chance of loan repayment and repossessing collateral increases. A better access to finance means firms should keep less precautionary cash. Drawing on the financial constraint mitigation argument, I test the relation

Table 6. Property right institutions reported by firms

This table reports OLS regression results of firm self-reported quality of court system on the European NUTS 3-level timing of Neolithic transformation, respectively. Firm sample is from *World Enterprise Survey 2013 - 2019* database. Dependent variable, *Court system: fair, impartial, uncorrupted* ranges from 1 to 4, where the higher value, the stronger agreement of firms with the statement that "The court system is fair, impartial and uncorrupted". In columns 1, 3 and 5, *Neolithic timing* is European NUTS 3-level average years from Neolithic transition to year 2000; in columns 2, 4 and 6, *Neolithic timing* is transition years of the nearest ancestral site from Neolithic transition to year 2000. NUTS3 controls include distance to water, distance to railway, GDP per capita, and size of area. Firm controls include firm size, firm age, manager experience, manager gender, foreign/state ownership in percentage, business group, and exports. All specifications contain country fixed effects, year fixed effects, and industry fixed effects. See the Appendix for details of variable definition. Standard errors are clustered at NUTS3-level, and t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Court system: fair, impartial, uncorrupted					
Neolithic timing-mean	.138**		.142**		.128*	
	(2.079)		(2.046)		(1.89)	
Neolithic timing-nearest		.116***		.115***		.109***
		(2.931)		(2.774)		(2.974)
Firm size			.167***	.168***	.165***	.166***
			(3.389)	(3.36)	(3.349)	(3.307)
Firm age			.001	.001*	.001	.002*
			(1.503)	(1.725)	(1.582)	(1.805)
Manager experience			-.004***	-.004***	-.004***	-.003***
			(-2.937)	(-3.01)	(-2.86)	(-2.849)
Female manager			-.06**	-.06**	-.061**	-.061**
			(-2.284)	(-2.277)	(-2.28)	(-2.268)
Foreign ownership			.001***	.001***	.001***	.001***
			(3.056)	(2.905)	(3.148)	(3.038)
State ownership			.007**	.007**	.007**	.007**
			(2.197)	(2.244)	(2.215)	(2.254)
Business group			.1***	.104***	.104***	.107***
			(2.896)	(3.088)	(3.03)	(3.221)
Export sales			-.0004	-.0004	-.0004	-.0004
			(-.876)	(-.903)	(-.841)	(-.865)
Distance to water					-.014	-.014
					(-.911)	(-.892)
Railway coverage					-.18	-.204*
					(-1.634)	(-1.822)
Log GDP pc					-.034	-.043
					(-.446)	(-.653)
Log area					.023	.021
					(.672)	(.634)
Constant	1.388***	1.654***	1.397***	1.695***	1.69	2.02**
	(2.782)	(6.326)	(2.625)	(5.996)	(1.456)	(2.443)
Observations	10529	10629	9943	10041	9943	10041
R-squared	.077	.078	.087	.088	.089	.09
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

between early transition with firms' financial constraints, and corporate cash holdings. As I identify that early transition predicts better property rights institutions, there should be a negative relation between early transition and financial constraints.

My results in Table 7 are based on firm sample from Worldscope. I examine effects of early transition on firms' financial constraints, as proxied by investment sensitivity to cash flow (same approach in Chen et al., 2014). The dependent variable is *Capital expenditure/Assets*. Typically, firms rely more on internal financing when they face serious financial constraints, because that external financing is more costly than internal financing. Therefore, the coefficient of cash flow on investment is expected to be significantly positive, and its value can be regarded as a measure of the degree of financial constraint. The key explanatory variable is *Neolithic timing * Cash flow*. As I contend that agricultural origin of property rights could reduce firms' financial constraints, I expect the coefficient of the interaction term between Neolithic timing and cash flow should be negative. In addition, my specification contains country fixed effects, year fixed effects, and industry fixed effects. Firm controls are size of sales, current assets ratio, cash flows ratio, EBIT, Leverage, ROA. NUTS3-level covariates include distance to water, distance to railway, GDP per capita, and size of area. Standard errors are clustered at NUTS3-level.

In Table 7 Column 1, the coefficient of the interaction is -0.437, while the coefficient of the cash flow itself is 3.399, which are consistent with my

prediction. In NUTS-3 regions with earlier transition, firms are less financially constrained, because that firms' investment relies less on corporate cash holdings. A 7000- thousand-year difference in Neolithic timing translates to

Table 7. Financial constraints: investment sensitivity to cash flow

This table shows the effects of Neolithic transformation on firms' investment sensitivity to cash flows. The firm sample is from Worldscope 2010 to 2019. *Capital expenditure/Assets* is the dependent variable. A firm belongs to the group of *High tangibles* when its ratio of property, plant, and equipment over total assets exceeds the sample median. In columns 1, 3 and 5, *Neolithic timing* is European NUTS 3-level average years from Neolithic transition to year 2000; in columns 2, 4 and 6, *Neolithic timing* is transition years of the nearest ancestral site from Neolithic transition to year 2000. NUTS3 controls include distance to water, distance to railway, GDP per capita, and size of area. Firm controls include size of sales, current assets ratio, cash flows ratio, EBIT, Leverage, ROA. All specifications contain country fixed effects, year fixed effects, and industry fixed effects. See the Appendix for details of variable definition. Standard errors are clustered at NUTS3-level, and t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Capital expenditure/Assets					
	All		High tangibles		Low tangibles	
Neolithic timing-mean	-.437***		-.393***		-.064	
# Cash flow	(-7.862)		(-3.126)		(-1.409)	
Neolithic timing-mean	-.014		-.251		-.072	
	(-.077)		(-.727)		(-.329)	
Neolithic timing-nearest		-.488***		-.475***		-.068
# Cash flow		(-9.285)		(-3.768)		(-1.324)
Neolithic timing-nearest		.115		-.008		.098
		(1.097)		(-.103)		(.444)
Cash flow	3.399***	3.375***	3.129***	3.31***	.491	.462
	(9.857)	(11.651)	(4.006)	(4.754)	(1.425)	(1.357)
Ln(sales+1)	-.091*	-.085*	-.241	-.234	-.056	-.052
	(-1.781)	(-1.764)	(-1.385)	(-1.383)	(-1.217)	(-1.223)
Current assets	-.45	-.449	.545	.512	-.785	-.762
	(-.898)	(-.896)	(.636)	(.623)	(-1.013)	(-1.013)
EBIT	.181	.174	.249	.207	.03	.03
	(1.113)	(1.118)	(.856)	(.676)	(.863)	(.943)
Leverage	.0002	.0003	.0004	.0004	-.0004	-.0004
	(1.468)	(1.607)	(1.468)	(1.445)	(-.816)	(-.838)
ROA	.001	.001	.007	.007	.0003	.0002
	(.85)	(.826)	(1.168)	(1.154)	(.439)	(.376)
Distance to water	.001	-.001	-.014	-.017	.029	.028
	(.039)	(-.043)	(-.288)	(-.374)	(.457)	(.461)
Railway coverage	.16	.201	1.093*	1.144*	-.636	-.531

	(.404)	(.536)	(1.685)	(1.75)	(-.724)	(-.702)
Log GDP pc	.064	.04	.12	.135	-.006	-.035
	(.526)	(.341)	(.55)	(.644)	(-.024)	(-.143)
Log area	-.067	-.084	-.385	-.388	.177	.146
	(-.548)	(-.697)	(-1.505)	(-1.484)	(.872)	(.85)
Constant	2.024	1.461	7.997	6.015	.993	.305
	(.69)	(.692)	(1.111)	(1.175)	(.323)	(.104)
Constant	31778	33172	15935	16476	15749	16599
R-squared	.037	.037	.077	.077	.018	.017
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

3.059 different sensitivity. The effects have economic significance considering the average relation between investment and cash holdings is 3.399. From Column 4 to 6, I separate firms into a group with high value of tangibles, and another group with low value of tangibles. Firms' tangibles properties can be used as collaterals to apply loans. Under good property rights institutions, banks are more willing to lend to firms, especially to firms who are more able to provide collaterals. Thus, I expect that the financial constraint mitigation effects are mainly shown among firms with high value of tangibles. I calculate firms' value of tangibles using a ratio of property, plant, and equipment over total assets. If one's value of tangibles exceeds the sample median, it belongs to the group of *High tangibles*, and *Low tangibles* otherwise. Column 3 and 4 show results of the *High tangibles* group, where I do observe similar effects to Column 1 and 2. Consistently, I find that the effects are not significant among firms with low value of tangibles, although the coefficients are still negative.

Better access to finance means firms should keep less precautionary cash. I next examine whether early transition predicts less cash holdings in firms. In Table 8, dependent variable is *Ln(cash ratio)*, which equals to logged

cash holdings scaled by total assets (same approach in Harford et al., 2008; Chen et al., 2014). My variable of interest is *Neolithic timing*. In Column 1, the coefficient of *Neolithic timing* is -0.118, quite comparable to -0.094 in Column 2. The results mean that firms keep less cash in regions that experienced early transition. Again, I divide firm sample into groups of *High tangibles* and *Low*

Table 8. Firms' cash holdings

This table shows the effects of Neolithic transformation on firms' cash holdings. The firm sample is from Worldscope 2010 to 2019. *Ln(cash ratio)* is logged cash holdings scaled by total assets. A firm belongs to the group of *High tangibles* when its ratio of property, plant, and equipment over total assets exceeds the sample median. In columns 1, 3 and 5, *Neolithic timing* is European NUTS 3-level average years from Neolithic transition to year 2000; in columns 2, 4 and 6, *Neolithic timing* is transition years of the nearest ancestral site from Neolithic transition to year 2000. NUTS3 controls include distance to water, distance to railway, GDP per capita, and size of area. Firm controls include size of sales, current assets ratio, cash flows ratio, EBIT, Leverage, ROA. All specifications contain country fixed effects, year fixed effects, and industry fixed effects. See the Appendix for details of variable definition. Standard errors are clustered at NUTS3-level, and t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			Ln(cash ratio)			
	All		High tangibles		Low tangibles	
Neolithic timing-mean	-.118**		-.195***		-.049	
	(-2.194)		(-2.922)		(-.736)	
Neolithic timing-nearest		-.094***		-.141***		-.065*
		(-2.585)		(-3.055)		(-1.652)
Ln(sales+1)	.035*	.032*	.074***	.072***	.01	.001
	(1.872)	(1.748)	(4.015)	(3.956)	(.505)	(.039)
Current assets	.467***	.45***	.597***	.596***	.171	.172
	(3.976)	(3.939)	(3.353)	(3.4)	(1.371)	(1.384)
Cash flow	.0004	.0004	.002***	.002***	.021	.021
	(.233)	(.226)	(3.431)	(3.377)	(1.195)	(.725)
EBIT	-.001	-.001	.316***	.318***	.028	.057**
	(-1.193)	(-1.072)	(2.619)	(2.626)	(1.428)	(1.98)
Leverage	-.001*	-.001**	-.0004	-.0004	-.001**	-.001**
	(-1.959)	(-2.001)	(-1.534)	(-1.526)	(-2.295)	(-2.386)
ROA	.0002	.0002	.007***	.007***	-.0003	-.0003
	(.766)	(.798)	(3.557)	(3.607)	(-.926)	(-1.315)
Distance to water	.009	.005	.016	.012	-.0002	-.003
	(.937)	(.551)	(1.15)	(.91)	(-.015)	(-.224)
Railway coverage	.265**	.241**	.269	.305*	.193**	.161*
	(2.128)	(2.156)	(1.39)	(1.759)	(2.067)	(1.893)
Log GDP pc	.066	.09	.104	.142	-.092	-.049
	(.981)	(1.397)	(1.141)	(1.604)	(-1.226)	(-.724)
Log area	-.034	-.033	-.013	-.015	-.077**	-.069**
	(-1.31)	(-1.334)	(-.337)	(-.416)	(-2.526)	(-2.53)
Constant	1.403	1.002	.268	-.562	3.834***	3.602***
	(1.539)	(1.205)	(.233)	(-.527)	(3.961)	(4.082)
Observations	32684	34113	16239	16782	16242	16585
R-squared	.216	.214	.228	.227	.19	.186
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

tangibles. Results in Column 3 to Column 6 show that the effects are mainly shown among firms will high value of tangibles. In regions with good property rights institutions, firms don't have to keep much cash because that they have better access to finance. In particular, tangibles can be used as collaterals of loans, thus firms with more tangibles have less necessity to hold cash for precautionary purposes.

Firms' less cash holdings and lower sensitivity of investment to cash flow mean that the firms' use of capitals are more efficient, and more investment or growth opportunities won't be given up, which will promote firms' long-run development.

2.4.4 Household finance

My final step is to explore Neolithic transformation's influences on contemporary household finance. The household-level data is from the World Bank. I examine the relation between early transition and household access to bank credits and fintech adoption. For access to bank credits, my measures include 1) whether an interviewee has an account at financial institutions, 2) whether an interviewee has a credit card, 3) whether an interviewee be able to get emergency funds from financial institutions. Fintech adoption is measured by indicators of 1) access to mobile or Internet bank, and 2) household use of Internet pay. I use the following regression specification:

$$Household_{k,c} = \alpha + \beta Neolithic\ Timing_C + X_C'M + +X_k'N + \varepsilon_{k,c} \qquad (3)$$

where the dependent variable measures access to finance of household k in country c. I control for household specific characteristics such as education,

Table 9. Households' access to finance

This table reports OLS regression results of household access to bank credit and household Fin-tech adoption on the timing of Neolithic transformation. The household finance sample is from *World Bank Global Financial Inclusion 2017* database. In Panel A, *Bank account* is an indicator that equals 1 if the respondent is reported to have an account at a financial institution; *Credit card* is an indicator that equals 1 if the respondent is reported to own a credit card; *Emergency funds* is an indicator that equals 1 if the respondent could come up with emergency funds from financial institutions. In Panel B, dependent variable, *Mobile or Internet Bank* indicates whether the respondent uses mobile phone or Internet to access financial accounts; *Internet Pay*, equals 1 if the respondent made payment using the Internet. Country controls include French legal origins, religions of population (Roman Catholics, Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth. Individual controls include a gender indicator, ln Age, ln Age squared, education and five household income level indicators [omitted group: Income (poorest 20%)]. See the Appendix for more detailed variable definitions and data sources. Standard errors are clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Panel A. Access to bank credits

	(1)	(2)	(3)	(4)	(5)	(6)
	Bank account		Credit card		Emergency fund	
Neolithic timing	0.038***	0.038***	0.023***	0.023***	0.018***	0.018**
	(3.901)	(3.805)	(2.718)	(2.747)	(2.755)	(2.590)
Education	0.213***	0.205***	0.096***	0.080***	0.079***	0.074***
	(11.751)	(12.618)	(7.023)	(7.007)	(7.775)	(8.628)
Income (richest 20%)	0.160***	0.161***	0.113***	0.115***	0.158***	0.158***
	(14.178)	(14.622)	(10.429)	(10.713)	(18.443)	(18.683)
Income (fourth 20%)	0.092***	0.092***	0.065***	0.065***	0.104***	0.104***
	(10.827)	(11.073)	(7.887)	(8.023)	(12.862)	(12.937)
Income (third 20%)	0.058***	0.058***	0.044***	0.044***	0.069***	0.069***
	(8.837)	(9.112)	(6.786)	(6.853)	(10.114)	(10.231)
Income (second 20%)	0.030***	0.030***	0.026***	0.026***	0.038***	0.038***
	(5.684)	(5.785)	(5.442)	(5.433)	(7.369)	(7.501)
Female	-0.054***	-0.054***	-0.033***	-0.034***	-0.021***	-0.021***
	(-6.204)	(-6.221)	(-7.091)	(-7.632)	(-6.088)	(-6.295)
Ln Age	1.717***	1.740***	1.316***	1.364***	0.286***	0.303***
	(11.325)	(11.837)	(8.111)	(8.319)	(2.845)	(3.048)
Ln Age squared	-0.221***	-0.225***	-0.176***	-0.184***	-0.027*	-0.030**
	(-10.189)	(-10.736)	(-7.684)	(-7.985)	(-1.866)	(-2.095)
Constant	-2.918***	-2.853***	-2.359***	-2.155***	-0.757***	-0.713***
	(-8.840)	(-7.679)	(-6.176)	(-5.495)	(-3.112)	(-2.745)
Country controls	Yes	Yes	Yes	Yes	Yes	Yes
GDP growth	No	Yes	No	Yes	No	Yes
# countries	137	137	137	137	137	137
Obs.	146782	146782	144715	144715	146782	146782
R-squared	0.280	0.284	0.209	0.218	0.158	0.161

Panel B. Fintech adoption

	(1)	(2)	(3)	(4)
	Mobile or Internet Bank		Internet Pay	
Neolithic timing	0.018**	0.018**	0.027***	0.027***
	(2.063)	(2.023)	(3.111)	(3.011)
Education	0.146***	0.136***	0.110***	0.100***
	(10.888)	(11.405)	(8.793)	(8.901)
Income (richest 20%)	0.144***	0.146***	0.131***	0.132***
	(14.395)	(15.159)	(12.249)	(12.871)
Income (fourth 20%)	0.076***	0.077***	0.077***	0.077***
	(8.606)	(8.872)	(8.448)	(8.678)
Income (third 20%)	0.047***	0.047***	0.046***	0.046***
	(7.153)	(7.338)	(6.543)	(6.746)
Income (second 20%)	0.018***	0.019***	0.017***	0.017***
	(3.719)	(3.818)	(3.696)	(3.766)
Female	-0.044***	-0.045***	-0.037***	-0.037***
	(-9.725)	(-10.089)	(-7.797)	(-8.264)
Ln Age	2.522***	2.554***	1.916***	1.946***
	(13.793)	(13.829)	(10.724)	(10.847)
Ln Age squared	-0.362***	-0.367***	-0.283***	-0.288***
	(-13.561)	(-13.655)	(-10.801)	(-10.997)
Constant	-4.062***	-3.927***	-3.113***	-3.009***
	(-11.163)	(-10.190)	(-8.257)	(-7.432)
Country controls	Yes	Yes	Yes	Yes
GDP growth	No	Yes	No	Yes
# of countries	137	137	137	137
Obs.	138,128	138,128	144,924	144,924
R-squared	0.314	0.317	0.316	0.320

income level, gender, age, and country-level features related to economy, geography, religion, and legal origins.

There are 146,782 households from 137 countries in my household sample. Results in Table 9 show that earlier transition in a country is associated with easier access to financial services today. I find that 1,000 years longer experience since Neolithic transformation predicts 3.8% more households having an account at a financial institution, 2.3% more households owning a credit card, and 1.8% more households who can get emergency funds from

financial institutions. Table 8 Panel B shows influences on households' adoption of fintech. 1,000 years earlier transition predicts 1.8% more population reported to use mobile or Internet banking services, and 2.7% more population using Internet pay. Reasonably, I also show positive relation between education, incomes, age with access to bank credits and Fintech, and females suffer from restricted access to finance.

2.5 Concluding Remarks

Financial development plays an important role in economic activities today. For firms, better financial environment means the ease with which any entrepreneur or company with a sound project can obtain finance at low cost (Rajan and Zingales, 2003). For households, easier access to finance can increase and secure savings, reduce transactions costs, improve households' resilience to shocks, and enhance consumption smoothing (Campbell, 2006; Tufano, 2009). Historical events, to some extent, drive the divergency of financial development through shaping institution and social norms, such as slave trade and European colonization.

I identify a long-lasting determinant of financial development: the timing of Neolithic transition, when wide-scale human cultures transited from a lifestyle of hunting and gathering to one of agriculture and settlement. This event made an increasingly larger population possible, and still influences contemporary wealth, institutional quality, and culture. Firstly, I show that countries experienced earlier Neolithic transition enjoy better financial development today. I then explore its relationship with access to finance among

firms and households. For firms, I find that location-specific transition predicts less financial constraint and less corporate cash holdings. The effects are larger on firms with high value of tangibles. For households, I also find positive relation between early transition and access to financial services, prevalence of fintech adoption.

I show that an important institution "protection of private property rights" makes the influences of transition years persistent. Combining ethnicity-level records in pre-industrial period, I capture the enduring influencing channel. Property rights institution is arguably critical for long-run growth. From a policy perspective, I suggest that currently under-developed countries may find it helpful to improve their design and enforcement of law to provide better protection on private property. Overall, this study enriches our understanding about long-term development (see Spolaore and Wacziarg, 2013 for a comprehensive review) by showing that the timing of Neolithic transformation has positive influences on modern finance via shaping formal institutions and norms that related to property rights.

This study still comes with limitations. It cannot explain the fact that countries having long history like Iraq, Turkey and China are less developed today than younger countries like Britain and Denmark. The reason behind this circumstance needs further investigation. I suggest that the Neolithic transition is only one of many conditions for long-term development, given that many other things have happened over such a long period. The influences of historical diffusion of farming might be conditional on other factors. One might

be interested in exploring events possibly disturb or enhance the influences, such as extreme weather, Columbian Exchange, conflicts, or migration.

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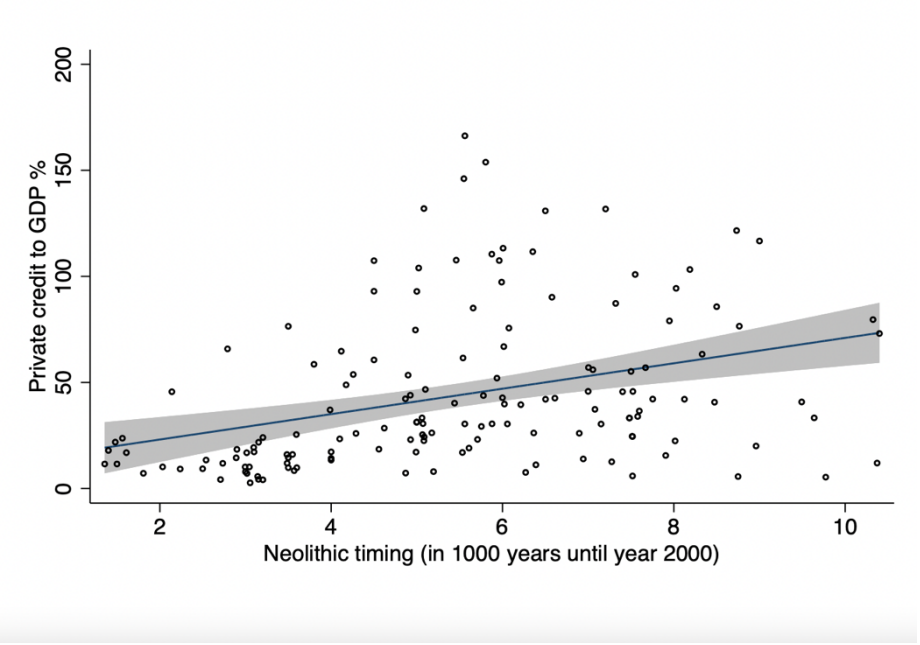
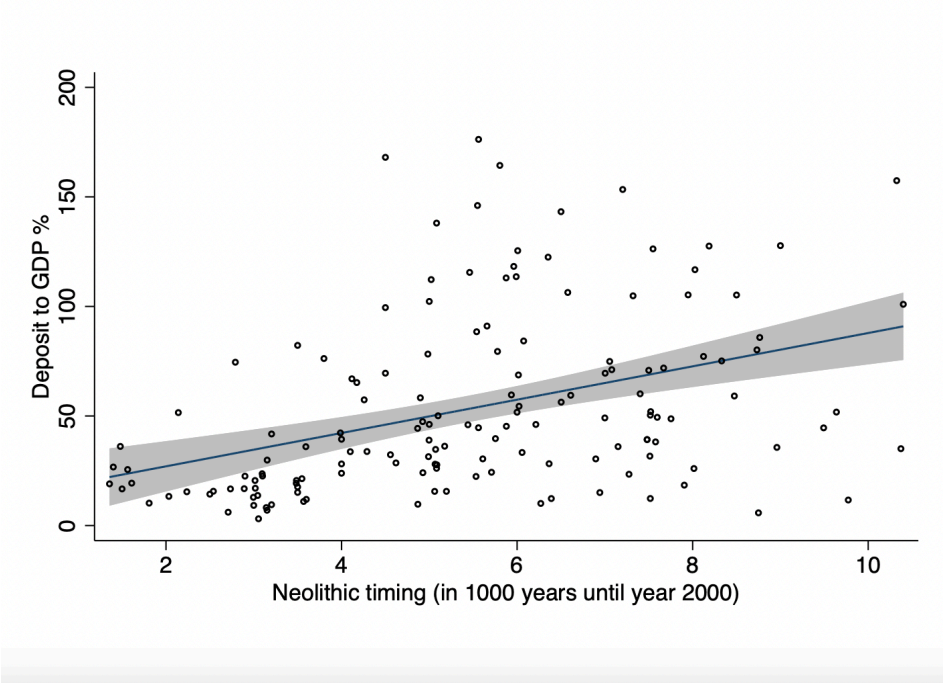
Appendix Figure 1. Neolithic transition and private credit to GDP



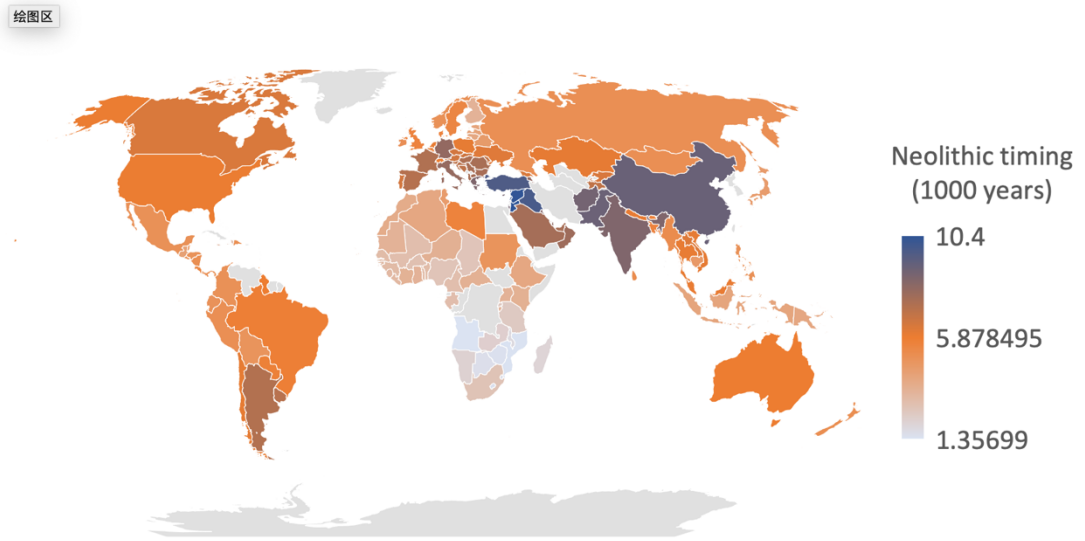
Notes: This figure shows the scatter plot between Neolithic timing and the average ratio of private credit to GDP over 2000-2017.

Appendix Figure 2. Neolithic transition and deposit to GDP

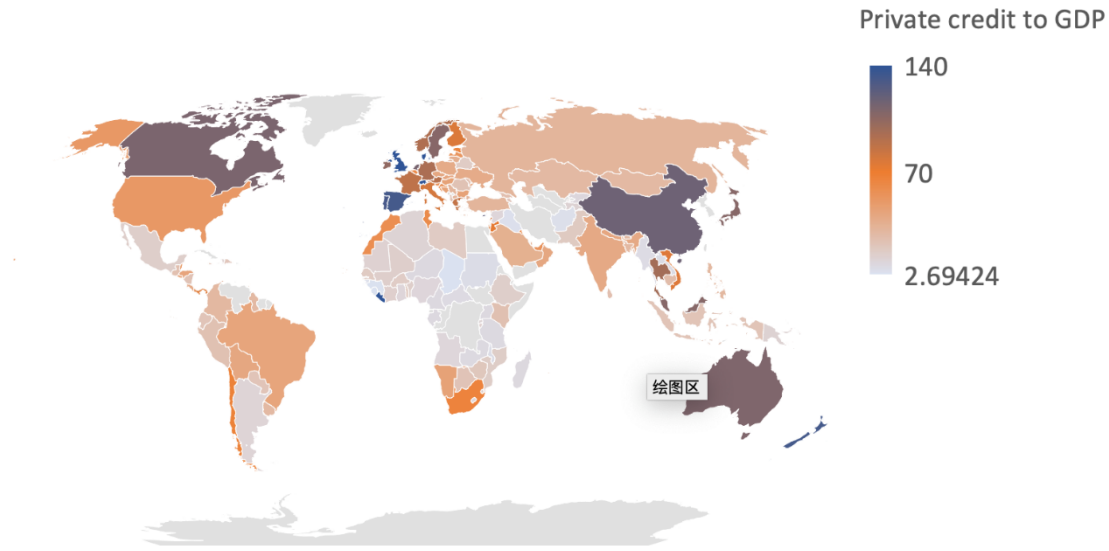


Notes: This figure shows the scatter plot between Neolithic timing and the average ratio of deposit to GDP over 2000-2017.

Appendix Figure 3. Neolithic transition and financial development in map

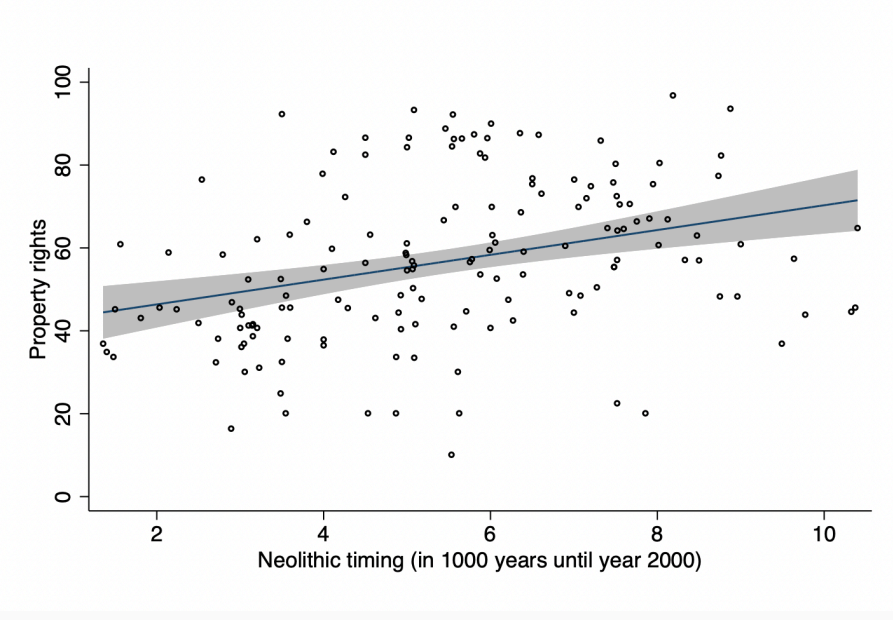


Notes: This figure shows the distribution of Neolithic transition timing across countries.



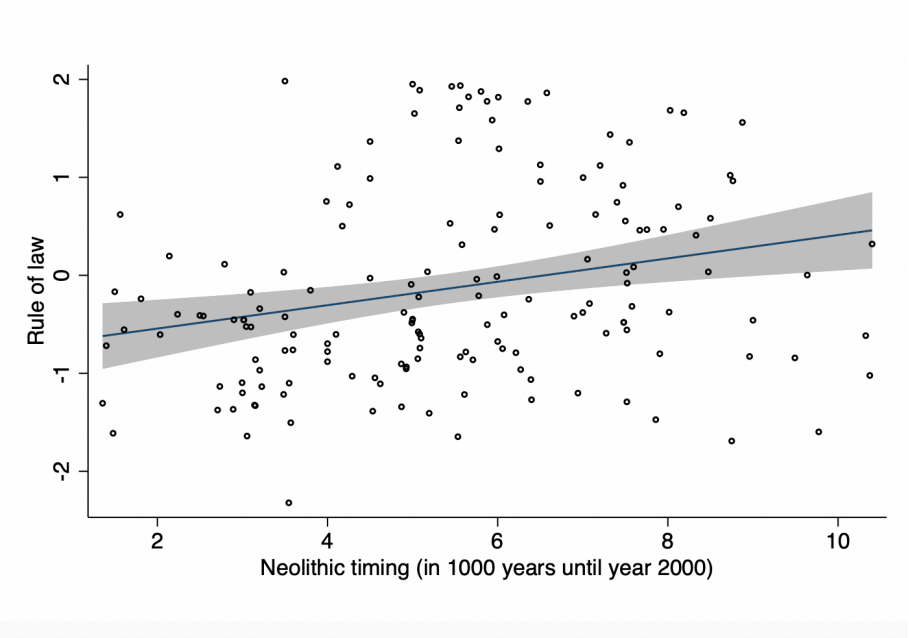
Notes: This figure shows levels of financial development measured by private credit to GDP across countries.

Appendix Figure 4. Neolithic transition and property rights



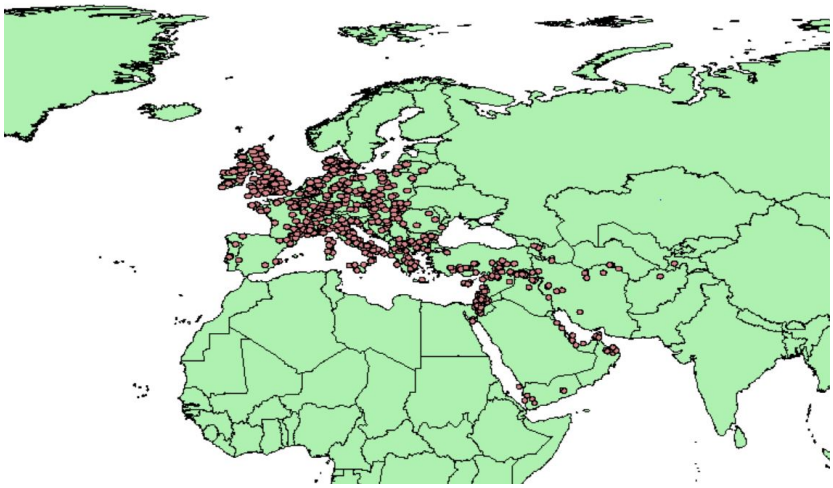
Notes: This figure shows the scatter plot between Neolithic timing and property rights index from *Heritage's Index of Economic Freedom* database.

Appendix Figure 5. Neolithic transition and rule of law

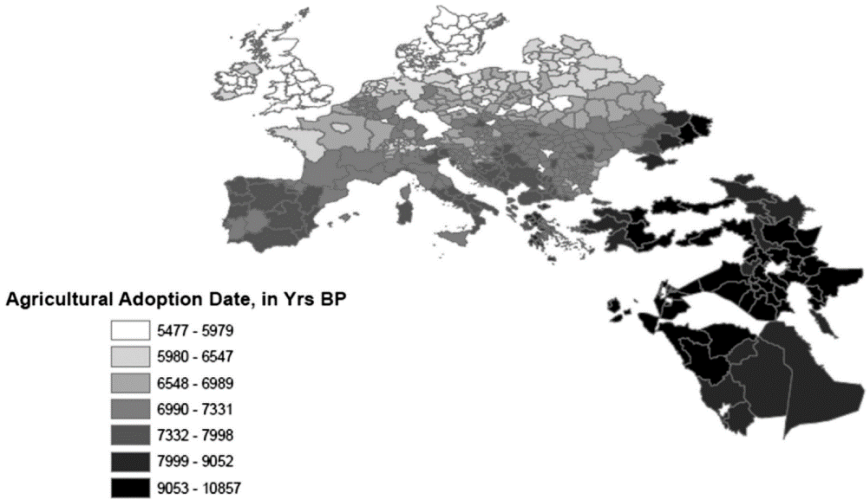


Notes: This figure shows the scatter plot between Neolithic timing and rule of law index from *The World Bank's Worldwide Governance Indicators.*

Appendix Figure 6. Location of 765 Neolithic sites and Neolithic timing of Western NUTS 3 regions



Notes: This map displays the location of 765 Neolithic sites in the Western area. Calibrated C14-dates from these 765 Neolithic sites are available from Pinhasi, Fort, and Ammerman (2005). The NUTS 3 regional transition timing is constructed based on calibrated C14-dates of these sites.



Notes: The figure shows the geographical distribution of dates for average time since agriculture transition among Western NUTS 3 regions. Source: Olsson and Paik (2020).

Appendix Table 1. Variable definition and data source

Variable	Definition	Data source
Country-level variable		
Neolithic timing	The ancestry adjusted average of Neolithic transition timing, the number of thousand years elapsed (as of the year 2000) the population residing within a country's modern national borders began practicing sedentary agriculture as the primary mode of subsistence.	Putterman and Weil (2010)
Private credit to GDP	The financial resources provided to the private sector by domestic money banks as a share of GDP, averaged over 2000-2017. Domestic money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	The World Bank's Global Financial Development Database
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.	
Property rights	The degree to which a country's laws protect private property rights and the degree to which its government enforces those laws.	Heritage's Index of Economic Freedom database
IPRI	The International Property Rights Index (IPRI), developed by the Alliance for Property Rights, is specific to the core factors that are directly associated to the strength and defense of physical and intellectual property rights. Three core components of the IPRI are legal and political environment, physical property rights, intellectual property rights.	Property Rights Alliance
Property register	The index is the sum of the reliability of infrastructure, transparency of information, geographic coverage, land dispute resolution and equal access to property rights.	
Rule of law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	The World Bank's Worldwide Governance Indicators (WGI)
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-de-Silanes, Shleifer, and Vishny (1998)
Roman Catholics	The shares of the population that are Catholic in 1980	
Muslims	The shares of the population that are Muslim in 1980	Beck, DemirgüçKunt, and Levine (2003)

Protestants	The shares of the population that are Protestant in 1980	
Absolute latitude	The absolute value of the latitude of a country's approximate geodesic centroid	the CIA's World Factbook, Galor and Özak (2016)
Longitude	The longitude of a country's approximate geodesic centroid	
Elevation	The mean elevation of a country in km above sea level, calculated using geospatial elevation data at a 1-degree resolution	the G-ECON project, (Nordhaus et al., 2006)
Temperature	The intertemporal average monthly temperature of a country in degrees Celsius per month over the 1961–1990 time period	
Precipitation	The intertemporal average monthly precipitation of a country in mm per month over the 1961–1990 time period	
GDP growth	Average value of GDP growth rates between 2000 and 2017	World Bank's World Development Indicators
Ln Population 1500	Natural logarithm of the population in 1500	Ashraf, and Galor (2013)
Plants	The number of annual and perennial wild grass species, with a mean kernel weight exceeding 10mg, that were prehistorically native to the region to which a country belongs	Hibbs and Olsson (2005)
Animals	The number of domesticable large mammalian species, weighing in excess of 45 kg, that were prehistorically native to the region to which a country belongs	
Continent size	The total land area of a continent (or landmass)	
Climate	An index of climatic suitability for agriculture based on the Köppen-Geiger climate classification system	
Ethnicity-level variable	**Source: Ethnographic Atlas, Murdock (1957)**	
Property-land	It indicates the existence of individual property rights of land or of any rule of inheritance governing the transmission of such rights. It is constructed based on item EA074 in Ethnographic Atlas.	
Property-movables	It indicates the existence of individual property rights of movables or of any rule of inheritance governing the transmission of such rights. It is constructed based on item EA076 in Ethnographic Atlas.	
Transition	It indicates whether an ethnicity had transited or not by the time when the survey was conducted. It is constructed based on item EA005 in Ethnographic Atlas. If an ethnicity is reported to depend on agriculture for more than 50% subsistence, the indicator is assigned with a value of 1.	

Absolute latitude	The absolute value of the latitude of an ethnicity's approximate geodesic centroid.
Longitude	The longitude of an ethnicity's approximate geodesic centroid.
Slavery	It indicates the presence of slavery
Community size	It is the mean size of local communities.
Clan	Indicator that equals one when Murdock's community marriage organization variable indicates that "clan communities or clan barrios" are present and zero otherwise. Source: Murdock (1967); variable code in the Ethnographic Atlas v15.
NUTS 3-level variable	**Source: Olsson and Paik (2020)**
Neolithic timing	Average time since adoption of agriculture of a region, in years before present (year 2000)
Ln Distance to water	Natural logarithm of distance to an ice-free coastline or a sea-navigable river in kilometers
Ln Area	Natural logarithm area of region in square kilometers
Railway coverage	Railroad coverage in 1000 km^2
Ln GDP pc	Natural logarithm of GDP per capita on NUTS3 in euros
Firm-level variable	**Source: World Bank Enterprise Survey (2013-2019)**
Firm size	The number of employees, 1000 per unit
Firm age	Years of operation
Manager experience	Years of the top manager's experience working in the firm's sector
Female manager	Value is 1 if top manager is female
Foreign ownership	Proportion of foreign ownership in a firm (%)
State ownership	Proportion of government/state ownership in a firm (%)
Export	Percentage of sales made as direct export
Court system	It is ranges from 1 to 4, where the higher value, the stronger agreement of firms with the statement that "The court system is fair, impartial and uncorrupted".
Firm-level variable	**Source: Worldscope (2010-2019)**
Capital expenditure/Assets	It measures the investment sensitivity to cash flow.
Ln(cash ratio)	The logarithm of firms' cash ratio, where the ratio of cash and cash equivalents to net assets, where net assets = total assets – cash and cash equivalents

Cash flow	Earnings before extraordinary items and depreciation minus cash dividends, scaled by total assets
Current assets	It includes cash, cash equivalents, accounts receivable, stock inventory, marketable securities, pre-paid liabilities, and other liquid assets.
EBIT	Earnings before interest and taxes (EBIT) is an indicator of a company's profitability. It is calculated as revenue minus expenses excluding tax and interest.
Leverage	Total debt divided by total assets
ROA	Return on assets (ROA) is a metric that indicates a company's profitability in relation to its total assets.
Individual-level variable	**Source: World Value Survey (2000-2017)**
Incomes	10 scales of incomes, where 10 is highest income group
Female	An indicator that equals one if the respondent is female, and zero otherwise.
Ln Age	Natural logarithm of the respondent age.
Ln Age squared	Squared natural logarithm of the respondent age.
Urban	An indicator that equals to one if a respondent lives in urban.
Confidence in courts	It is the level of a respondent's self-reported confidence in courts (ranges from 1 to 4).
Justifiable: stealing	It is the level of a respondent's self-reported justification of the behavior of stealing property (ranges from 0 to 10).
Justifiable: bribe	It is the level of a respondent's self-reported justification of the behavior of someone accepting a bribe (ranges from 0 to 10).
Household-level variable	**Source: World Bank Global Financial Inclusion Database (2017)**
Education	An indicator that equals one if an individual's educational attainment is secondary or more, and zero otherwise.
Income	Household income quintile indicators within each country, 5 levels in total.
Female	An indicator that equals one if the respondent is female, and zero otherwise.
Ln Age	Natural logarithm of the respondent age.
Ln Age squared	Squared natural logarithm of the respondent age.
Bank account	An indicator that equals 1 if the respondent is reported to have an account at a financial institution.
Credit card	An indicator that equals one if the respondent reports having a credit card that allows one to borrow money in order to make payments or buy things, and one can pay the balance off later.

Emergency funds	An indicator that equals one if the respondent reports being able to come up with emergency funds from financial institutions.
Mobile or Internet bank	An indicator equal to one if the respondent uses mobile phone or Internet to access financial accounts.
Internet pay	An indicator equal to one if a respondent has made payments on bills or bought things online using the internet.

Appendix Table 2. IV first stage

This table reports the first stage of 2SLS regressions in this study. The dependent variable is country-level timing of Neolithic transformation, from Putterman (2008). Six biogeography variables are used together to predict the Neolithic timing. They are the number of domesticable animals and plants available in 10,000 BCE, longitude, latitude, climate, and continent size. Heteroskedasticity-robust t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	Neolithic timing
Plants	0.018
	(0.805)
Animals	0.357***
	(5.151)
Size	0.000
	(1.290)
Axis	0.001
	(1.647)
Latitude	-0.008
	(-0.981)
Climate	0.007
	(0.051)
Constant	1.824***
	(4.448)
F-test	27.29
Obs.	130
R-squared	0.675

Appendix Table 3. Neolithic transition without adjusting historical migration

This table reports OLS results of financial development of countries on the timing of Neolithic transformation. The dependent variables are Private credit to GDP, and Deposit to GDP, which measure the depth of financial development (average value over 2000 - 2017). Explanatory variable the country-level average years from Neolithic transition to year 2000 without adjusting historical migration. Country controls include French legal origins, religions of population (Roman Catholics, Muslims, Protestants), absolute latitude, longitude, elevation, temperature, precipitation, Ln Population 1500, and GDP growth. See the Appendix for more detailed variable definitions and data sources. Heteroskedasticity-robust t-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Private credit to GDP		Deposit to GDP	
Neolithic timing	2.437*	3.458**	3.562**	4.91**
	(1.879)	(2.096)	(2.437)	(2.481)
French legal origin		-7.616		-6.648
		(-.948)		(-.747)
Protestant		.269		.284
		(1.287)		(1.238)
GDP growth		-5.525**		-6.536**
		(-2.259)		(-2.298)
Ln Population 1500		-.572		-.83
		(-.388)		(-.46)
Constant	35.06***	55.489	39.399***	58.721
	(4.433)	(1.052)	(4.536)	(.946)
Observations	158	154	158	154
R-squared	.017	.27	.03	.272
Country controls	Yes	Yes	Yes	Yes

Appendix Table 4. Correlation between country-level transition measures

This table reports the correlation between country-level transition measures. *Neolithic timing-Pinhasi et al. (2005)* is country-level transition data computed based on calibrated C14-dates of transition from Pinhasi et al. (2005). Pinhasi et al. (2005) provide calibrated C14-dates of transition at 765 Neolithic sites throughout Europe and Southwest Asia. We average the C14-dates of transition at country level. *Neolithic timing-Putterman (2008)* is country-level transition data, constructed by Putterman (2008), based on regional and country-specific archaeological studies. The measure treats a country as having made the agricultural transition if any appreciable region within the country had done so.

Variables	(1)	(2)
(1) Neolithic timing-Pinhasi et al. (2005)	1.000	
(2) Neolithic timing-Putterman (2008)	0.694	1.000

Appendix Table 5. European countries and NUTS 3 regions

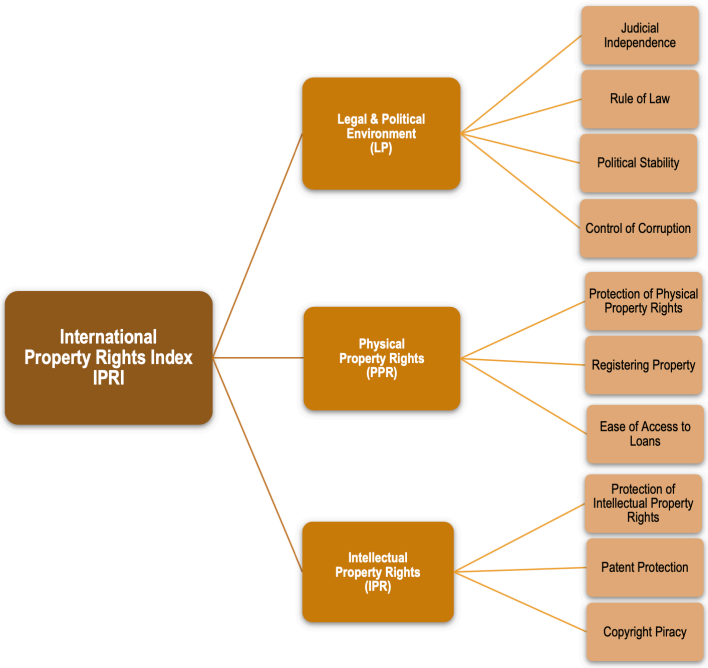
This table reports the number of NUTS 3 regions of each European country included in this study.

Country	# of NUTS 3 regions
Austria	17
Belgium	22
Bulgaria	28
Croatia	19
Cyprus	1
Czech Republic	3
Czechia	5
Estonia	2
France	73
Germany	195
Greece	20
Hungary	9
Ireland	8
Italy	58
Latvia	4
Lithuania	9
Luxembourg	1
Macedonia	5
Netherlands	28
North Macedonia	5
Poland	59
Portugal	7
Romania	31
Slovakia	5
Slovenia	9
Spain	25
Sweden	14
Switzerland	1
Turkey	31
Total	694

Additional notes

Data of IPPR index (one of property rights measures in Table 2)

FIGURE 1. INTERNATIONAL PROPERTY RIGHTS INDEX STRUCTURE



Web link of data source:

https://knoema.com/atlas/topics/World-Rankings/World-Rankings/International-property-rights-index?action=export&gadget=tranking-container

Chapter 3. Climate Legacy of Corporate Resilience to Crises

3.1 Introduction

Given the huge economic losses caused by recent Covid-19, it becomes increasingly important to understand how firms build resilience to disasters such as banking crises, catastrophe, and epidemic diseases. Discovered factors that could rescue firms from crises including access to credits (Levine, Lin, & Xie, 2018), ESG (Ding, Levine, Lin, & Xie, 2021), and corporate culture (Li, Liu, Mai, & Zhang, 2021), although differ from each other, all point to the critical role of social capital and networks in firms' survival and recovery. I argue that the process of social capital accumulation over generations explains why firms' ability to overcome hardship varies across different culture. By exploring the role of historical weather uncertainty, a key driver of cooperation between communities, I show that local social capital that shaped by ancestors' cooperation to combat uncertainty could persist to affect the resilience of firms in recent bad times. To the best of my knowledge, this is the first study documents social capital as an essential link between resilience of ancestorial communities and resilience of modern firms.

During uncertain economic times, firms with better access to finance usually perform better than others (Levine, Lin, & Xie, 2018; Ding, Levine, Lin, & Xie, 2021), and the ease of obtaining finances to some extent depends on social capital of places where firms located. For instance, it has been found that firms in regions endowed with higher level of trust are more resilient to banking crises because they obtain more trade credits that somehow compensate

temporary shortage of bank credits (Levine, Lin, & Xie, 2018). It is arguably important to understand how social capital relate to firms' access to finance, especially during crises. However, social capital is often endogenous to economic conditions. To avoid this identification threat, I focus on local social capital that driven by historical weather risks, that accumulated through long history of cooperation across communities.

Magnitude of social capital can be shaped by the history of how humans respond to weather risks. Buggle and Durante (2021) document positive influences of climatic variability on cultural heritage of trust. Back in pre-industrial time, weather fluctuation, as one of the main sources of economic risk, lead to farmers' cooperation with members of the broader community to cultivate/obtain subsistence in need. Such cooperation involves interaction with people living in neighbouring areas who were likely to be affected by weather fluctuations in less correlated ways. For example, trade activities could improve an area's resilience to negative effects of climate change (Waldinger, 2015). Through cooperation, groups are likely to understand language of one another, exchange customs, and share similar norms. Consequently, trust was developed through inter-group exchanges. Buggle and Durante (2021) show that European regions with higher pre-industrial climatic variability display higher levels of trust today, and climate variability is associated with a higher propensity to trade with individuals in other communities. Consistently, Dang and Dang (2021) document that individuals heavily threatened by weather fluctuation and with higher share of agricultural incomes exhibit more trust in others.

I contend that higher level of social capital resulting from historical cooperation could build modern firms' resilience by enabling more accessible finance. As a critical component of social capital, trust is conventionally deemed as critical for commercial transaction (Arrow, 1972), financial contracts (Guiso, Sapienza, and Zingales, 2004), stock markets (Guiso, Sapienza, and Zingales, 2008), venture capital investment (Bottazzi, Da Rin, and Hellmann, 2016) and household finance (D'Acunto et al., 2018; Levine et al., 2020), for the reason that institutions, firms and individuals would hardly like to get involved in financial transactions if they don't believe in counterparts in markets. Therefore, if climate risks in the past lead to a higher level of trust, I expect to observe more accessible finance, thus more resilience of firms in bad times.

Beside trust, civic engagement and political participation are important parts of social capital (Alesina & Giuliano, 2011), which are also likely be influenced by long-run experience of climate risks and then create fertile ground for corporate resilience via financing channel. Climate risks are associated with more open, participative political institutions (Buggle and Durante, 2021), and higher democracy (Brückner and Ciccone, 2011), where the first study shows that climate change-induced cooperation favoured the early adoption of inclusive political institutions that associated with higher quality of local governments today, while the latter one observes that variation in rainfall is followed by significant improvement in democratic institutions. Trade activities, one way that ancestors adopt to overcome weather shocks, also predict high levels of local democracy (Fenske, 2014). Under participative political institutions, citizens are less likely to concern property being expropriated by

the government and powerful elites, which to some extent fosters better financial environment for modern firms (Acemoglu and Johnson, 2005).

Above links between weather-driven social capital and financial development suggest positive relation between weather risks and firms' access to finance during crises. Thus, this study intends to evaluate influences of such social capital on firms' resilience. I argue that there are two advantages of using historical weather risks to capture social capital. Firstly, the exogenous nature of weather risks helps to mitigate reverse causality issue, as it is unlikely that historical weather can be affected by modern economic activities. But I also note it is possible that historical weather might cause additional unknown economic consequences (in addition to cooperation) that further affect financial development. To tackle this concern, I capture the cooperation channel precisely by testing whether more incentives/gains from cooperation make effects of weather risks on access to finance stronger. Another strength of using historical weather risks is that it varies with specific location of firms, thus the captured local social capital could better explain within-country spatial divergency in access to finance. I also consider if firms with certain features deliberately locate at regions with higher or lower historical weather uncertainty, which might bias my estimation if the features are associated with firms' ability to obtain financing. To address this issue, I include comprehensive set of firm characteristics and industry indicators in my specifications.

I begin by constructing measures of historical weather uncertainty. Following Buggle and Durante (2021), climatic variation is the standard

deviation of inter-yearly temperature. I construct inter-annual variability in temperature at country-level and ethnicity-level using highly spatially disaggregated monthly time-series data based on actual weather station records for the period 1900-2000[9]. I obtain standard deviation across years for each month-grid cell observation, and then average monthly data to get grid cell-level measure. Then, I compute country-level and ethnicity-level data by averaging grid cell data that correspond to a given country/ethnicity. My finest ethnicity-level fluctuation varies from 0.28 to 0.98, with a median value of 0.75 and deviation value of 0.17, which are comparable with that of in Buggle and Durante (2021). I show a map of spatial distribution of temperature uncertainty in Appendix Figure 1.

For the country-level measure, I adjust migration between 1500 to present time using matrix of population flows from Putterman and Weil (2010), thus it proxies the temperature fluctuation experienced by historical population lived in a given country before 1500 AD. By using the adjusted measure, I aim to capture the culturally embodied, inter-generationally transmitted effect, rather than the direct effect of geography. The same data source and construction method are also used by Ashraf and Michalopoulos (2015) in examination of the relationship between weather fluctuation and the invention of agriculture happened approximately 12,000 years ago. They justify the appropriate use of this data to proxy ancient weather by stating that the cross-

[9] The weather data is obtained from the TS 4.05 data set constructed by the Climatic Research Unit (CRU) of the University of East Anglia (Mitchell, Carter, Jones, Hulme, and New, 2004). This dataset employs reports from climate stations across the globe, providing monthly temperature observations for each grid cell at a half-degree resolution.

country distribution of temperature volatility during the twentieth century was not significantly different from that which existed prior to the Neolithic Revolution. I believe that my measure of historical weather variation is appropriate for the same reason.

Nevertheless, to further eliminate the concern that the 1990 – 2000 weather data couldn't represent historical weather risks, I supplement it by constructing historical temperature variation measure using simulating weather data from the TraCE dataset (He, 2011). This data contains climatic conditions of the entire planet, and it covers a period over the last 22,000 years. The reason for why I don't use it as my baseline weather measure is that its resolution is relatively low (3.75*3.75 degree-cells) compared with the CRU TS 4.05 data, and the data is simulated based on CCSM5 model instead of being real weather records. The low resolution of TraCE data decides it isn't adequate for constructing ethnicity-level measure, thus I only use it to calculate an alternative measure of historical weather fluctuation at country-level. This historical measure covers the period between 500 AD and 1500 AD, and it is also adjusted for migration.

Firstly, I provide evidence that climate risks lead to large-scale cooperation in 1500 CE. My proxies of historical cooperation are obtained from Comin, Easterly, and Gong (2010), which capture the existence of sophisticated technology in historical periods. Litina (2016) argues that sophisticated means of communication and transportation are catalysts in the advancement of large-scale cooperation, conversely, under-development of these technologies

reflects relative scarce of large-scale cooperation. Thus, I use index of technology sophistication in 1500 CE to proxy the extent of deep-rooted cooperation. I specifically focus on technology of transportation and communication, which are most related to cooperation across communities. High volatility of temperature indeed predicts higher level of historical cooperation. The relationship is robust to adding a set of economic and geographical conditions which might are deemed to be important to development in 1500 CE.

I then examine the relationship between climate risks and levels of trust across countries and within-country, respectively. In inter-country analysis, my measure of trust at individual-level is obtained from World Value Survey, which covers individuals' information from 94 countries. In intra-country analysis, my sample of individuals is from Afrobarometer Survey. Afrobarometer sample enables us to identify which ethnicity group do individuals belong to, thus I could combine individual level trust with historical weather conditions of ethnicity groups. I believe that it is more appropriate to detect previous accumulation of social capital at ethnicity-level, given that national boarders have changed dramatically in the long history, and that norms usually transit along cultural groups. By using ethnicity as unit of analysis, I can more precisely capture cultural traits, and identify within-country variation. Because that Afrobarometer only conducted surveys in Africa, and also that historical records (including territories, customs) of ethnic groups are available in Africa other than other continents, all my ethnicity-level analyses are performed in context of Africa.

My results indicate that individuals with ancestors experienced higher fluctuation in temperature have higher levels of interpersonal trust today. Types of trust I examined include general trust, intra-group trust, inter-group trust, and trust for neighbours, relatives. The result is robust to controlling for various geographic conditions, colonization, legal origins, slave trade, historical population, current GDP per capita, and individual characteristics (education, age, gender, living conditions, and an indicator of living in urban/rural area). This finding is in line with evidence from European regions in Buggle and Durante (2021) that climate risks exerted positive influences on formation of trust attitudes.

I next investigate how social capitals captured by climate risks further benefit financial markets associated with households' and firms' ease of access to finance. Outcomes of household finance is based on country-level variation of temperature, while outcomes of firms' access to finance capture the relationship at ethnicity-level. An, Hou, and Lin (2022) note that culture of trust is important for households' wiliness of using financial services. Accordingly, if weather uncertainty endowed local culture with a high level of trust, I expect to find more prevalent use of household finance. Using a sample covering households from 136 countries, I document that households are more likely to open bank accounts, save money at or borrow from banks, use innovative financial services such as mobile money bank and Intermate pay in countries with experience of higher volatility of temperature. The positive relation is robust to controlling countries' economy, institutions, and individuals' characteristics.

Firms' data is from World Enterprise Survey. This data set provides specific location of each firm, thus I could align firms' data with climate risks of ethnicities that they located at. Results show that high inter-annual temperature fluctuation is associated with low level of financial obstacles reported by firms, and higher incentives of ancestors to cooperate under weather risks make the effects stronger. I capture the incentives of cooperation using a geographic feature: spatial variation of temperature uncertainty. According to Buggle and Durante (2021), cooperation is more feasible to insure against weather risks when environmental conditions are less correlated with that of neighbour areas.

To address the concern of omitting national factors which are correlated with both weather and financial development, I include country fixed effects into specifications, thus all time-invariant country-level features are captured. I also include a comprehensive set of controls including firm characteristics, indicators of industries, survey years, and ethnicity features that might be important for financial development such as distance to coast, malaria index, slave trade, political centralization, population density, and other geographic traits. Standard errors are clustered by ethnicities. Due to the rich records of ethnicities in Africa, analysis in this section is conducted among African firms. I still use a sample of European firms to check the robustness of this finding, and a consistent pattern is shown.

I further examine how climate risks are associated with firms' access to two types of financial resources: bank credits and trade credits. My results show that higher weather fluctuation predicts better access to bank loans and

trade credits for firms, and the relation is stronger when incentives of ancestors to cooperate under weather risks are higher. My observed positive relation is consistent with the view that trust eases firms' access to bank loans (An, Hou, and Lin, 2022) and trade credits (Pierce and Snyder, 2018).

As a next step, I explore how firms' resilience to crises is determined by climate-induced social capitals. My tests contain two types of crises: COVID-19 and systemic banking crises. They both incurred paramount shocks on financial circumstance of global firms. After outbreak of COVID-19, World Bank conducted follow-up interviews among firms which they have surveyed before, providing a comprehensive view on influences of COVID-19 on doing business. I link firms' post-COVID situation with temperature volatility of their located countries to test the influences of weather-induced social capital on firms' outcomes. My results show that at locations with higher temperature volatility, firms are less likely to be permanently closed due to COVID-19. The influences on firms' closure are stronger among firms at locations with higher incentive of historical cooperation, and in countries that with higher infection rate of COVID-19.

In examination of firms' resilience to banking crises, I construct a sample that covers firms in 17 countries from 1990 through 2011[10]. During the examined period, multiple systemic banking cries happened independently. Using difference-in-difference method, I find that greater weather uncertainty is associated with more increases in trade credits when firms confronted shortage

[10] Sample construction follows the approach of Levine, Lin, & Xie (2018).

of bank credits due to banking crises, and that the effects are mainly driven by firms in industries with high dependence in external finance and industries that technologically have tight supply chain-relationship [11] . I don't observe differences in firms' equity issuance and debt issuance, suggesting that during banking crises, social capitals build firms' resilience through facilitating lending from supply chains. To ensure my findings aren't driven by other correlated macroeconomic conditions, I include a set of interaction terms between weather uncertainty and time-variant conditions of economy and institutions in my difference-in-difference setting. My results are robust to the inclusion. Overall, I show that historical weather-related social capital could explains firms' resilience to both banking crises and COVID-19.

My research contributes to four strands of literature. First, this study speaks to literature on resilience of firms against crises, i.e. banking crises (Levine, Lin, & Xie, 2018), climate risk (Huang, Kerstein, & Wang, 2018), epidemics, and other natural disasters (Salvato, Sargiacomo, Amore, & Minichilli, 2020). Firms' characteristics that deemed to be essential to corporate resilience include corporate culture (Li, Liu, Mai, & Zhang, 2021), access to finance, CSR practices (Lins, Servaes, & Tamayo, 2017), ownership (Ding, Levine, Lin, & Xie, 2021). I establish that social capitals resulting from cooperation against weather risks build corporate resilience to crises today. In face of banking crises, firms endowed with high social capital get support

[11] In Nunn (2007), relationship-specificity is measured by proportion of goods' intermediate inputs that require relationship-specific investments. The measure classifies inputs that are neither bought and sold on an exchange nor reference priced as relationship-specific. If an input is sold on an exchange or is reference priced in trade publications, then the market for the input is thick, with many alternative buyers and sellers.

through informal finance, while under COVID-19, such firms take advantage of both more bank loans and trade credits. Most relevantly, Levine, Lin, & Xie (2018) note that greater trust makes firms more resilient to banking crises because they obtain more trade credits; Lins, Servaes, & Tamayo (2017) observe that the trust between a firm and both its stakeholders and investors pays off when the overall level of trust in corporations and markets suffers negative shock from financial crisis.

Secondly, it builds on literature that highlight the importance of social capitals for financial markets (Guiso, Sapienza, and Zingales, 2004; Guiso, Sapienza, and Zingales, 2008; D'Acunto et al., 2018; Levine, Lin, and Xie, 2018; Levine et al., 2020). While slave trade is documented to affect access to finance and firms' ownership structure through social capital channel, this study is the first to explore the role of pre-industrial climate as environmental endowment of social capital accumulation, which thereafter facilitate firms with better access to finance, especially important for firms suffering from negative shocks.

Thirdly, this study contributes to weather-economy literature. Climatic conditions have been related to various socio-economic outcomes ranging from agricultural productivity (Adams, Rosenzweig, Peart, Ritchie, McCarl, Glyer, Curry, Jones, Boote, and Allen, 1990; Deschênes and Greenstone, 2007), to health outcomes (Deschênes, Greenstone, and Guryan, 2009; Maccini and Yang, 2009; Deschênes and Greenstone, 2011), economic growth (Dell et al., 2012), sedentary lifestyle (Matranga, 2019) and social conflict (Miguel, Satyanath, and Sergenti, 2004; Miguel, 2005; Hsiang, Burke, and Miguel, 2013;

McGuirk and Nunn, 2020). I establish a positive relation between social capitals and weather fluctuation in Africa, supplementing to Buggle and Durante (2021) which document the relation using European setting. The fact that Africa suffers from prevalent mistrust makes this investigation in the context of Africa necessary[12]. My results imply that climate uncertainty might foster long-run growth if social capitals accumulated through human's mitigation behaviors.

I also enrich the rapidly growing history & finance literature[13] by linking historical climate condition to contemporary finance. Identified historical sources of financial development include legal origins (La Porta, Florencio, Shleifer and Robert, 1998), initial endowments (Acemoglu, Johnson and Robinson, 2001), state history (Ang, 2013), distrust caused by historical antisemitism (D'Acunto, Prokopczuk and Weber, 2019) and slave trade (Levine, Lin and Xie, 2020). D'Acunto (2017) highlights the importance of explaining current financial outcomes through the long-run persistence of economic and social phenomena. Environmental condition is documented to be an important source shaping modern finance. Beck, Demirgüç-Kunt and Levine (2003) uncover those geographical endowments affecting colonizers' mortality influence the formation of long-lasting legal traditions; Stulz and Williamson (2003) discover that geographic characteristics facilitating international trade

[12] Slave trade (Nunn and Wantchekon, 2011), family ties (Moscona, Nunn, and Robinson, 2017), and forced labor (Blouin, 2021) largely reduced trust on the continent (see Figure 5). Lack of social capital in Africa leads to financial constraints (Pierce and Snyder, 2018) and concentrated ownership structure (Pierce and Snyder, 2020) of firms, adds barrier on households' access to finance (Levine, Lin and Xie, 2020).

[13] Financial activities are documented to be impacted by culture and formal institutions resulting from historical events. Historical events are documented to exert long-lasting influences on institutions and culture which are tight to financial development today, such as European colonization (Beck, Demirguc-Kunt, and Levine, 2003), antisemitism in Germany (D'Acunto, Prokopczuk, and Weber, 2018), and slave trade (Pierce and Snyder, 2017; Levine, Lin, and Xie, 2020) and Tsetse fly (An, Hou, and Lin, 2022) in Africa.

activities temper the influences of culture on creditor rights; while An, Hou, and Lin (2022) recently show disease environment affects cultural norms that attached to financial development. This study relates to the literature by showing uncertainty of historical weather as an unexpectedly source of environmental endowment to modern finance.

3.2 Climate Risk and Culture of Cooperation

This study especially focuses on the long-run effects of climate uncertainty in pre-colonial times. Climate volatility is a universal and primitive source of environmental risk, and affects various economic outcomes (see Dell, Jones, and Olken 2014 for a comprehensive review). Fruitful evidence in climate-economy literature prove that climate change played a critical role in the past. For instance, historical weather-led outcomes include civil conflicts (Miguel, Satyanath, and Sergenti 2004; McGuirk and Nunn 2021), political stability (Brückner and Ciccone 2011), variation of cultural persistence (Giuliano and Nunn, 2021), among others. Climatic uncertainty has been found to drive the emergency of cooperation to insure against environmental risk, thus lead to accumulation of social capital in the long run (Buggle and Durante, 2021; Dang and Dang, 2021).

The emergence and prevalence of norms that facilitate mutual trust can be traced to the need for large-scale cooperation (Henrich et al., 2001). Natural weather fluctuations are considered as the main risks for agricultural activities. Especially in early societies, collective action and broad participation was required to undertake and construct the necessary agricultural infrastructure,

which could mitigate the adverse effect of unfavourable environment (Litina, 2016). All major forms of agricultural infrastructure such as irrigation systems, storage facilities and drainage systems require large-scale cooperation at the community or at the state level. Among natural conditions, weather is the one of the most unpredictable and influential factors affecting subsistence as well as other economic activities in the past when effective technology (e.g. air conditioning, convenient transport, advances in infrastructure technology and weather forecasting technology) that could mitigate effects of adverse weather is unavailable.

In addition to large-scale construction of infrastructure, there are additional ways which are documented to be applied by pre-industrial societies to against weather shocks, such as exchange through long-distance trade activities and establishment of communal risk-sharing institutions. Through the development of trade relationships with neighbouring localities, spatially dispersed exchange networks, communities effectively overcome food shortages caused by aggregate weather shocks. Those reactions all require cooperation among communities, thus lead to early accumulation of social capital. Fenske (2014) notes that regions with more varied ecosystems have greater incentives to trade. In more diverse ecological environments, localities specialize in different subsistence activities, and were therefore in a better position to buffer climatic shocks via economic exchange. Buggle and Durante (2021) document that climatic risk has a persistent effect on culture favoring the emergence of a set of rules and institutions that made it easier to trust and cooperate with strangers. They summarize four major insurance mechanisms

which are adopted to cope with climate risks (see table below). In another example, people in ancient civilisations such as Mesopotamia, Egypt and the Indus Valley faced the challenge of uncertain rainfall patterns. To ensure consistent agricultural production, they developed sophisticated irrigation systems that required collective effort. Communities worked together to build canals, reservoirs and dams to store and distribute water, minimising the impact of drought or excessive rainfall. Dang and Dang (2021) also discover positive influences of weather variation on development of trust in the setting of Vietnam, where the effects are found to be stronger among regions that more rely on agriculture incomes.

Storage	Grain storage institutions, constructed and organized by the village community, administered by trustworthy villagers, allowed farmers to borrow grain in times of bad harvests and to repay it with small interests (McCloskey, 1991).
Scattering	Farmers divided their plots into long thin strips scattered across the area. The open fields-system was characterized by a high degree of solidarity and collective action for the rotation and cropping regulations that were decided communally.
Communal risk-sharing institutions	In form of corporation, self-governed associations characterized by voluntary cooperation between

	unrelated individuals shared power and accountable leaders.
Trade	The establishment of trade links that allow to import food in times of adverse shocks from regions that were not hit by the same shock (Fenske, 2014).

The effects of historical climatic uncertainty are long-lasting because norms and cultural traits survived and transmitted across generations (Boyd and Richerson, 1995). It has been found that high levels of social capital and trust formed over generations still play an essential role in enhancing economic activities such as commercial transactions, entrepreneurship, innovation, accumulation of human capital, credit markets and enforcement of contracts (Arrow, 1972; Guiso, Sapienza, and Zingales, 2004; Guiso, Sapienza, and Zingales, 2008).

3.3 Data

I describe the construction of the key variables including temperature volatility, social capital, firms' and households' data in this section. More details of all data source and variable definitions are given in Appendix.

3.3.1 Temperature volatility

My measures of temperature volatility are constructed following Buggle and Durante (2021). I construct inter-annual variability of temperature at country-level and ethnicity-level using highly spatially disaggregated monthly time-series data based on actual weather station records over the period of 1900-

2000. The weather data is obtained from the TS 4.05 dataset constructed by the Climatic Research Unit (CRU) of the University of East Anglia (Mitchell et al., 2004). This dataset employs reports from climate stations across the globe, providing monthly temperature observations for each grid cell at a half-degree resolution (0:5°* 0:5°).

I firstly compute standard deviation of monthly temperature across the whole period, therefore obtain volatility of temperature for every month on the basis of each grid cell (259,200 cells in total). I next average the 12 monthly volatility values to get inter-annual volatility for each cell. The calculation is processed using MatLab. Then I use ArcGis to aggregate the cell-level volatility at the scales that I want: country-level and ethnicity-level. The classification of ethnicities is based on Murdock's Ethnographic Atlas (Gis map from Nunn and Wantchekon, 2011). I ultimately have two sets of inter-annual temperature volatility measures, at country-level and ethnicity-level respectively. For the country-level measure, I adjust migration between year 1500 to year 2000 using matrix of population flows from Putterman and Weil (2010), thus it proxies the temperature fluctuation experienced by historical population lived in a given country before 1500 CE. By using the adjusted measure, I aim to capture the culturally embodied, inter-generationally transmitted effect, rather than the direct effect of geography.

Someone may concern that the climate volatility over 1900 to 2000 couldn't well represent pre-colonial weather conditions. I justify the reliability of this data source in two ways. Firstly, CRU TS data is widely used in the

economic literature to study effects of historical weather conditions on various economic outcomes (Ashraf and Michalopoulos, 2015; Matranga, 2019; Buggle and Durante, 2021; Giuliano and Nunn, 2021). Following the assumption made in those studies, I assume the temperature volatility during the twentieth century was not significantly different from that which existed prior to the Western colonization. My finest ethnicity-level fluctuation varies from 0.28 to 0.98, with a median value of 0.75 and deviation value of 0.17, which are comparable with that of in Buggle and Durante (2021).

To further eliminate the concern, I construct an alternative measure of historical temperature variation using simulating weather data from the TraCE dataset (He, 2011). This data contains climatic conditions for the entire planet, and covers a period over the last 22,000 years. As reported in Appendix table 3, climatic volatility over the past 100-year period (1900 CE – 2000 CE) are highly correlated with the corresponding values in the period from 500 CE to 1500 CE. The reason for why I don't use it as my baseline weather measure is that its resolution isn't high (3.75*3.75 degree cells) compared with the CRU TS 4.05 data, and the data is simulated based on CCSM5 model instead of originating from real weather records. The low resolution of TraCE data decides it isn't suitable for constructing ethnicity-level measure. I only use it to calculate historical weather fluctuation at country-level. My alterative historical measure covers period between 500 CE and 1500 CE, and it is also adjusted for migration. As reported in Appendix Table 3, climatic volatility over the past 100-year period (baseline measure) is highly correlated with the corresponding value in the period from 500 CE to 1500 CE (alternative measure).

My baseline country-level temperature volatility varies from 0.32 to 2.34, with median value of 0.89. The alternative temperature volatility is comparable to the baseline measure. It ranges from 0.08 to 0.88, and its median value is 0.34. Two measures have correlation at 0.75. See Table 1 for summary statistics.

3.3.2 Social capital

My first social capital measure is general trust from World Value Survey (WVS). Combining WVS data with temperature volatility measure, I construct a sample containing 254,783 individuals from 92 countries. I use interviewees' attitude towards the view of "Most people can be trusted" as my measure of general trust. I assign value of 1 to variable of general trust if the answer from respondents is "Most people can be trusted", and 0 to general trust if the answer

Table 1. Summary statistics

	N	Mean	St.Dev	p25	Median	p75
Country-level						
Uncertainty (adjusted) 1900-2000	96	1.02	.44	.66	.89	1.25
Uncertainty 1900-2000	96	.98	.48	.62	.84	1.22
Uncertainty (adjusted) 500-1500	96	.35	.16	.24	.34	.41
Uncertainty 500-1500	96	.34	.17	.2	.33	.41
Ln GDP pc	96	8.31	1.15	7.31	8.34	9.24
Transportation tech	96	.27	0.28	0	.17	.5
Communication tech	96	.45	0.38	0	.5	.75
Ethnicity-level						
Temperature uncertainty	154	.71	0.16	.29	.72	.98
WVS sample						
General rust	254783	.26	.44	0	0	1
Ln age	254783	3.63	.4	3.3	3.64	3.95
Ln age ^ 2	254783	13.37	2.92	10.86	13.23	15.61
Female	254783	.52	.5	0	1	1
Incomes	254783	4.65	2.31	3	5	6
Education	254783	4.71	2.23	3	5	6
Afrobarometer sample						
Trust neighbors	16261	1.72	0.99	1	2	3
Trust relatives	16261	2.17	0.95	2	2	3
Intra-group trust	16261	1.66	0.99	1	2	2
Inter-group trust	16261	1.34	0.97	1	1	2
Age	16261	36.22	14.62	25	32	45
Age ^ 2	16261	1525.49	1304.38	625	1024	2025
Female	16261	.5	0.50	0	0	1
Urban	16261	.37	0.48	0	0	1
Education	16261	3.12	2.01	2	3	4
Living conditions	16261	2.61	1.20	2	2	4
WES sample						
Financial obstacle	13895	1.64	1.32	0	2	3
Bank loan	13895	.19	0.40	0	0	0
Trade credit	13895	22.55	30.29	0	0	40
Reason: procedures	11214	.08	0.27	0	0	0

Reason: collaterals	11214	.08	0.26	0	0	0
Reason: interest rates	11214	.13	0.33	0	0	0
Firm size	13895	.09	0.37	.01	.02	.05
Firm age	13895	19.56	15.62	9	15	26
Manager experience	13895	18.24	11.28	10	15	25
Female manager	13895	.11	0.31	0	0	0
Foreign ownership	13895	7.76	24.16	0	0	0
State ownership	13895	.72	6.20	0	0	0
Business group	13895	.21	0.41	0	0	0
Export sales	13895	5.56	18.35	0	0	0
Closed permanently	3300	.23	0.42	0	0	0
WB households						
Account	145981	.6	0.49	0	1	1
Saving	144438	.25	0.43	0	0	0
Borrowing	145981	.22	0.42	0	0	0
Fintech account	137277	.29	0.46	0	0	1
Fintech pay	144118	.27	0.45	0	0	1
Education	145981	.66	0.47	0	1	1
Income (richest 20%)	145981	.25	0.43	0	0	0
Income (fourth 20%)	145981	.21	0.41	0	0	0
Income (third 20%)	145981	.19	0.39	0	0	0
Income (second 20%)	145981	.18	0.38	0	0	0
Female	145981	.54	0.50	0	1	1
Ln Age	145981	3.64	0.45	3.3	3.66	4.01
Ln Age squared	145981	13.44	3.23	10.86	13.42	16.06
Worldscope sample						
Crisis	8620	.61	0.49	0	1	1
Trade credit financing/ cost of goods	8620	.02	0.14	-.01	.01	.04
Trade credit financing/ total assets	8620	.02	0.10	-.01	.01	.03
Equity issuance	7334	.14	0.88	0	0	.04
Debt issuance	8638	.08	0.27	-.02	.01	.09
Firm size	8620	20.92	3.04	18.96	20.76	22.71
Long-term debt	8620	.15	0.15	.02	.12	.24
Tobins' Q	8620	.01	0.78	-.41	-.08	.36

is “Must be very careful”. This dataset also provides individual characteristics such as age, gender, incomes, education, etc., which I used as controls.

In my ethnicity-level analysis, I measure social capital using multiple types of social trust from Afrobarometer survey[14]. Afrobarometer survey reports interviewees’ ethnicity, thus I could combine Afrobarometer sample with ethnicity-level temperature volatility, which largely improves the accuracy of my identification. Afrobarometer provides individual-level survey data about public attitude on democracy, governance, the economy and society in over 30 African countries. Types of trust I examined include intra-group trust, inter-group trust, trust between neighbours, and relatives. My Afrobarometer sample covers 154 African ethnicities, with 16261 individual records.

I measure historical cooperation using national index of technology sophistication (technology in sectors of communication, transportation etc.) in 1500 CE, obtained from Comin, Easterly, and Gong (2010). As Litina (2016) argues that sophisticated means of communication and transportation are catalysts in the advancement of large-scale cooperation, I believe it is appropriate to proxy cooperation in the past. This data is constructed based on various anthropological and historical sources. For the communication index, a value of 0 indicates the absence of both true writing and mnemonic or non-written records, a value of 1 indicates the presence of only mnemonic or non-written records, and a value of 2 represents the presence of both. For the

[14] https://afrobarometer.org/

transportation index, a value of 0 indicates the absence of both vehicles and pack or draft animals, a value of 1 indicates the presence of only pack or draft animals, and a value of 2 indicates the presence of both.

3.3.3 Firm sample

My first firm sample is obtained from the World Bank Enterprise Survey (WES). Enterprise Surveys offers an expansive array of firms' information about firms' productivity, business practices, and business obstacles. For each firm, I get very specific location, thus I could combine firm data with any scale of spatial measures that I want (see Appendix Figure 3 for the spatial distribution of interviewed firms in Africa). I use this dataset to study how temperature volatility of ethnicities influences local firms' access to different finances. After outbreak of COVID-19, World Bank conducted surveys among firms that they have interviewed before, providing a comprehensive view on influences of COVID-19 on doing business. I use this dataset to examine corporate resilience to COVID-19.

In examination of firms' resilience to banking crises, I construct a sample using Worldscope dataset. I use publicly listed firms in manufacturing industries. The sample covers firms' records in 17 countries from 1990 through 2011. During the examined period, multiple systemic banking cries happened independently. By definition, systemic banking cries happened when the entire banking sector exhibits significant symptoms of financial distress (significant bank runs, huge losses, bank liquidations), and when the government intervenes in the banking sector in response to significant in the banking system

(Laeven and Valencia, 2013). I follow the approach in Levine, Lin, & Xie (2018), only focus on a 7-year event window. If a country experienced a crisis in year t, period of [t -3, t -1] is defined as the precrisis period, and [t, t+3] is defined as the crisis period.

3.3.4 Household finance

The household finance data source is from World Bank's Financial Inclusion Database 2017[15], a comprehensive data set on how adults save, borrow, make payments, and manage risk, covering 150,000 adults aged 15 and above. I use this data set to study households' access to and use of financial services, and control for individual characteristics such as education, income, gender, and age.

3.4 Accumulation of Social Capital

I start my analysis by verifying the link between weather risks and historical large-scale cooperation. My proxies of historical cooperation are constructed by Comin, Easterly, and Gong (2010), indicating the existence of sophisticated technology in 1500 CE. Litina (2016) argues that sophisticated means of technology are catalysts in the advancement of large-scale cooperation, so I also assume that greater technology sophistication implies existence of cooperation across broader areas. It is important to stress that technology measures in 1500 are estimated before European colonization, thus they do

[15] https://microdata.worldbank.org/index.php/catalog/3324

not incorporate the technology transferred by Europeans to the rest of the world after European exploration began around 1500.

In Table 2, I show that temperature volatility has a strong positive association with historical cooperation measures. Independent variable in the

Table 2. Cooperation in 1500 BC

This table reports influences of temperature uncertainty on cooperation in the agricultural stage (proxies of ancient cooperation). Dependent variables, Transportation tech and Communication tech measure the development of communication technology, and transportation technology in 1500 CE, respectively. The explanatory variable *Uncertainty* 500-1500 is the country-level inter-annual variability of temperature that covers period from 500 CE to 1500 CE; *Uncertainty* 1900-2000 is the country-level inter-annual variability of temperature that covers period from 1900 CE to 2000 CE, without adjustment for migration. Country controls include land suitability, average ruggedness, average elevation, access to navigable waterways, years since the Neolithic transition, distance from the nearest technological frontier in the year 1500, and an indicator of landlocked country. See the Appendix for more detailed variable definitions and data sources. Standard errors are robust to heteroskedasticity. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(3)	(4)	(5)	(6)
	Transportation tech		Communication tech	
Uncertainty 500-1500	0.400***		0.869***	
	(3.187)		(5.539)	
Uncertainty 1900-2000		0.128***		0.367***
		(2.731)		(6.715)
Land suitability	-0.195*	-0.234**	-0.039	-0.113
	(-1.833)	(-2.191)	(-0.297)	(-0.914)
Ruggedness	11.535	6.658	33.760	37.539
	(0.354)	(0.203)	(0.830)	(0.982)
Elevation	-0.104	-0.093	-0.159*	-0.162*
	(-1.448)	(-1.284)	(-1.774)	(-1.929)
Waterway	0.072	0.084	0.173	0.162
	(0.761)	(0.887)	(1.470)	(1.470)
Neolithic transition	0.058***	0.057***	0.034**	0.019
	(4.638)	(4.255)	(2.127)	(1.213)
Distance to frontier	-0.000	-0.000	-0.000	-0.000
	(-0.387)	(-0.167)	(-1.439)	(-0.911)
Landlocked island	0.027	0.002	0.165	0.105
	(0.267)	(0.018)	(1.284)	(0.865)
Population density 1500	0.043**	0.045**	0.080***	0.088***
	(2.530)	(2.577)	(3.723)	(4.345)
Constant	-0.072	-0.054	-0.017	-0.016
	(-0.749)	(-0.557)	(-0.141)	(-0.143)
Obs.	96	96	96	96
R-squared	0.652	0.641	0.709	0.741

first two columns is an index of technology adoption over transportation sector. Independent variable is the development of communication technology in columns 3 and 4. For each proxy of cooperation, I regress them on both temperature uncertainty from 500 to 1500, and temperature uncertainty from 1900 to 2000. In column 1 and 3, the weather uncertainty measure is based on weather data covers a period from 500 to 1500, simulated from CCSM5 model. Because technology sophistication index captures cooperation in 1500 CE, I use this weather uncertainty measure as baseline explanatory variable. In column 2 and 4, the alternative measure is based on real weather records from 1900 to 2000. The coefficient of weather uncertainty on transportation technology is 0.4. A standard deviation increase in temperature volatility (0.17) is associated with 0.068 higher value of transportation technology index. Because mean value of technology index is 0.27, I believe the magnitude of influence is high. Like findings from first two columns, for communication technology, the coefficient is 0.869.

I next examine the relationship between climate risk and levels of trust in a country or an ethnicity, respectively. To formally examine the relation, I regress measures of social trust on my self-constructed temperature volatility, while control for a set of individual characteristics and regional conditions that associated with development.

In country-level examination, I use both temperature volatility simulated based on CCSM5 model and temperature volatility based on real weather

records as explanatory variable. Baseline explanatory variables are adjusted for migration after 1500 CE. I also check the influencing power of unadjusted

Table 3. Temperature uncertainty and trust

Panel A. Country-level variation

This table reports OLS regression results of general trust on temperature uncertainty. Dependent variable *General trust* is from *World Value Survey*. The explanatory variable *Uncertainty* 500-1500 is the country-level ancestry adjusted inter-annual variability of temperature that covers period from 500 CE to 1500 CE; *Uncertainty* 1900-2000 is the country-level ancestry adjusted inter-annual variability of temperature that covers period from 1900 CE to 2000 CE; *Uncertainty (unadjusted)* is inter-annual variability of temperature without adjustment for migration. The individual controls include a gender indicator, ln Age, ln Age squared, income levels, and education levels. See the Appendix for more detailed variable definitions and data sources. Standard errors are robust clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			General trust			
Uncertainty 500-1500	.448***	.347***				
	(4.653)	(3.921)				
Uncertainty 500-1500			.276***			
(unadjusted)			(3.57)			
Uncertainty 1900-2000				.107***	.079**	
				(2.641)	(2.06)	
Uncertainty 1900-2000						.081***
(unadjusted)						(2.893)
Ln age		-.109	-.13		-.078	-.05
		(-.955)	(-1.131)		(-.749)	(-.49)
Ln age square		.02	.023		.014	.009
		(1.22)	(1.395)		(.884)	(.61)
Female		-.011***	-.011***		-.015***	-.016***
		(-3.908)	(-3.626)		(-4.253)	(-4.43)
Incomes		.012***	.013***		.01***	.01***
		(5.946)	(5.913)		(4.402)	(4.387)
Education		.01***	.01***		.007**	.007**
		(3.293)	(3.467)		(2.255)	(2.069)
Ln GDP pc		.033***	.04***		.028*	.029*
		(2.732)	(3.18)		(1.73)	(1.77)
Constant	.078*	-.146	-.135	.099**	-.086	-.131
	(1.864)	(-.707)	(-.648)	(2.084)	(-.396)	(-.617)
Observations	254783	254783	254783	213379	213379	213379
R-squared	.028	.043	.04	.012	.023	.026

Panel B. Ethnicity-level variation

Dependent variables are various types of trust, from *Afrobarometer* survey dataset. The explanatory variable *Temperature uncertainty* is ethnicity-level inter-annual variability of temperature. Ethnicity controls are slave trade, malaria risk, missions' area, railway, colonization, tsetse fly index, and existence of cities in 1400. The individual controls include a gender indicator, ln Age, ln Age squared, education levels, an urban indicator, and the level of living condition. See the Appendix for more detailed variable definitions and data sources. Standard errors are robust clustered by ethnicities. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Dependent variable	Independent variable: temperature uncertainty			
	(1)	(2)	(3)	(4)
Trust neighbors	0.620**	0.377*	0.377*	0.367*
	(2.32)	(1.93)	(1.92)	(1.94)
Trust relatives	0.486**	0.296**	0.296*	0.168
	(2.46)	(1.98)	(1.96)	(1.01)
Intra-group trust	0.777***	0.551**	0.551**	0.571***
	(2.82)	(2.58)	(2.57)	(2.67)
Inter-group trust	0.530**	0.367**	0.367**	0.523***
	(2.33)	(2.05)	(2.03)	(2.82)
# ethnicity	154	154	154	145
Individual controls	Yes	Yes	Yes	Yes
Slave trade control	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Education FE	No	Yes	Yes	Yes
Occupation FE	No	Yes	Yes	Yes
Religion FE	No	Yes	Yes	Yes
Living condition FE	No	Yes	Yes	Yes
Standard error clustered	Ethnicity	Ethnicity	Ethnicity-district	Ethnicity-district
Settlement pattern FE	No	No	No	Yes
Colonizer controls	No	No	No	Yes

temperature volatility based on both data sources. In Table 3 Panel A, first three columns exhibit estimates when I use temperature uncertainty from 500 to 1500 as independent variable, and last three columns show results when I use temperature uncertainty from 1900 to 2000. All coefficients of temperature volatility are positively associated with general trust. In Column 2, the coefficient of temperature volatility is 0.347, which means a standard deviation increase in temperature volatility (0.16) is associated with 0.056 higher value of trust measure. The magnitude of the observed effect is substantial considering mean value of general trust of my *World Value Survey* sample is 0.26. In Column 3, the coefficient of unadjusted temperature volatility is 0.276, slightly lower than the coefficient of adjusted measure, which is reasonable as I expect that culture of trust mainly transited through generations. In Column 5, the coefficient of temperature volatility is 0.079, which means a standard deviation increase in temperature volatility (0.44) is associated with 0.035 higher value of trust measure. Although measures of temperature volatility are based on different weather data, the magnitude of estimates in columns 2 and 5 are quite comparable. I note that estimates in column 5 should be more accurate due to it is backed by finer scale of weather records.

Because *Afrobarometer* reports interviewees' ethnicity, I could combine *Afrobarometer* individuals' data with my ethnicity-level temperature volatility. In Table 3 Panel B, I report ethnicity-level results. Types of social trust are *Trust neighbours, Trust relatives, Intra-group trust,* and *Inter-group trust*. In Column 4, I include a set of individual characteristics, ethnicity-level conditions as controls, and sub-national region fixed effects. I show that temperature volatility

is positively associated with all types of trust. My most important independent variable is *Inter-group trust,* because I hypothesize that climate risks triggered large-scale cooperation which could foster trust across communities especially between people whose living locations are distant from each other. I observe that a standard deviation increase in temperature volatility (0.16) is associated with 0.084 higher value of *Inter-group trust*. For *intra-group trust*, the increase is 0.0914. In line with literature, the effects of temperature volatility are slightly weaker for trust to either neighbours or relatives. I note that it has been found that family tie and general trust are negatively associated with each other. In context of this study, if weather risk could be insured against within family members, large-scale cooperation is not necessarily to be adopt, thus unlikely to increase social capital. However, this contradicts what I observe.

In line with Buggle and Durante (2021), my results indicate that individuals with ancestors experienced higher fluctuation in temperature have higher levels of interpersonal trust today. The result is robust to controlling for various geographic conditions, colonization, legal origins, slave trade, historical population, current GDP per capita, and individual characteristics such as education, age, gender, living conditions, and an indicator of living in urban or rural area.

3.5 Access to Finance

Greater social capital should be endowment of access to finance. I examine the relation between temperature volatility and household access to bank services and fintech adoption. Because I could only identify the nationality of a

household, the explanatory variable I use is national level temperature volatility. The household-level data is from the World Bank. For access to bank services, my measures include 1) whether an interviewee has an account at financial institutions, 2) whether an interviewee save at banks, 3) whether an interviewee borrow from banks. Fintech adoption is measured by indicators of 1) whether an interviewee has an account of mobile or Internet bank, and 2) household use of mobile or Internet pay. I control for household specific characteristics such as education, income level, gender, age, and country-level features related to economy and institutions. There are 145,981 households in my household sample. Results in Table 4 Panel A show that greater temperature volatility of a country is associated with easier access to financial services today. A standard deviation increase in temperature volatility (0.16) predicts 5% more households having an account at a financial institution, 4.8% more households save and 5.1% more households who can get emergency funds from banks. For FinTech adoption, 9.7% more population reported to have mobile or Internet banking accounts, and 10% more population using FinTech pay. Regarding coefficients of control variables, I find positive relation between GDP per capita, legal origin of common law, index of malaria risk with access to bank credits and Fintech, and female individuals suffer from more restricted access to finance.

Next, I investigate the effects of climate risks on firms' access to finance using firm sample from World Enterprise Survey. I align firms' data with climate risks of their associated ethnicities. In Table 4 Panel B, dependent variable is *financial obstacle* as reported by a firm. The variable ranges from 0

to 4, where the higher value, the severer issue of financial constraint. Independent variable is ethnicity-level temperature volatility. I add country fixed effects into specifications, thus all time-invariant country-level features are

Table 4. Temperature uncertainty and access to finance

Panel A. Country-level variation

This table reports influences of temperature uncertainty on households' access to finance and Fin-tech adoption. The household finance sample is from *World Bank Global Financial Inclusion 2017* database. *Financial account* is an indicator that equals 1 if the respondent is reported to have an account at a financial institution; *Household saving* and *Household borrowing* indicate whether a respondent is reported to save or borrow at a financial institution; *Fintech account* indicates whether a respondent used mobile phone or Internet to access financial accounts; *Fintech pay*, equals 1 if the respondent made payment using mobile or the Internet. The explanatory variable *Uncertainty* 500-1500 is the country-level ancestry adjusted inter-annual variability of temperature that covers period from 500 CE to 1500 CE; *Uncertainty* 1900-2000 is the country-level ancestry adjusted inter-annual variability of temperature that covers period from 1900 CE to 2000 CE; *Uncertainty (unadjusted)* is inter-annual variability of temperature without adjustment for migration. Country controls include Ln (GDP per capita), an indicator of common law, and malaria risk. Individual controls include a gender indicator, Ln Age, Ln Age squared, education and five household income level indicators [omitted group: Income (poorest 20%)]. See the Appendix for more detailed variable definitions and data sources. Standard errors are clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Dependent variable	Independent variable: temperature uncertainty				Obs.
	Uncertainty 500-1500	Uncertainty 500-1500 (unadjusted)	Uncertainty 1900-2000	Uncertainty 1900-2000 (unadjusted)	
	(1)	(2)	(3)	(4)	
Financial account	0.310***	0.291***	0.146***	0.117***	145,981
	(3.48)	(4.17)	(3.50)	(3.51)	
Household saving	0.303***	0.245***	0.118***	0.090***	144,438
	(3.73)	(3.39)	(3.80)	(3.89)	
Household borrowing	0.319***	0.260***	0.153***	0.105***	145,981
	(3.72)	(3.44)	(5.20)	(4.57)	
Fintech account	0.606***	0.525***	0.278***	0.221***	137,277
	(7.50)	(7.63)	(7.44)	(6.94)	
Fintech pay	0.631***	0.557***	0.313***	0.249***	144,118
	(7.91)	(8.15)	(9.31)	(9.01)	
Individual controls	Yes	Yes	Yes	Yes	
Country controls	Yes	Yes	Yes	Yes	

Panel B. Ethnicity-level variation

This table reports OLS regression results of firm access to finance on temperature uncertainty. Dependent variable *Financial obstacle* ranges from 0 to 4, which is the level of financial obstacle a firm reported to WES, where the higher value, the severer issue of financial constraint. *Temperature uncertainty* is ethnicity-level inter-annual variability of temperature. Ethnicity controls are malaria risk, an indicator of coast, slave trade, political centralization, Ln (pre-colonial population density), tsetse fly index, and other geographical features. Firm controls include firm size, firm age, manager experience, manager gender, foreign/state ownership in percentage, business group, exports, and indicators of industries at three-digit ISIC level. See the Appendix for more detailed variable definitions and data sources. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			Financial obstacle			
Temperature uncertainty	-1.114*	-1.222**	-1.655***	-1.551***	-1.551***	-1.551***
	(-1.854)	(-2.278)	(-3.051)	(-3.006)	(-3.029)	(-3.673)
Malaria index			-.015	-.014	-.014	-.014*
			(-1.447)	(-1.437)	(-1.412)	(-1.764)
Coast			-.264*	-.279**	-.279**	-.279***
			(-1.879)	(-2.01)	(-1.986)	(-3.361)
Slavery			.338*	.332*	.332*	.332**
			(1.776)	(1.75)	(1.758)	(2.446)
Political centralization			-.169*	-.174*	-.174*	-.174**
			(-1.762)	(-1.873)	(-1.883)	(-2.298)
Ln population density			.097**	.08**	.08**	.08***
			(2.623)	(2.236)	(2.319)	(3.448)
Tsetse fly			-.255	-.151	-.151	-.151
			(-.707)	(-.425)	(-.43)	(-.498)
Constant	2.618***	2.845***	.877	.393	.393	.393
	(4.958)	(6.057)	(.493)	(.222)	(.223)	(.234)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	Yes
Firm controls	No	Yes	Yes	Yes	Yes	Yes
Ethnicity controls	No	No	Yes	Yes	Yes	Yes
Clusters	Ethnicity	Ethnicity	Ethnicity	Ethnicity	Ethnicity-Year	Industry-Year
Observations	13895	13895	13895	13895	13895	13895
R-squared	.057	.084	.095	.111	.111	.111

omitted. In addition to firm characteristics, I control for ethnicity-level conditions that are important for financial development: malaria risk, an indicator of coast, slave trade, political centralization, Ln (pre-colonial population density), tsetse fly index, and other geographical features. Standard errors are clustered by ethnicities. Results in column 4 show that inter-annual temperature fluctuation is negatively associated with financial obstacles faced by firms. The coefficient of temperature volatility is -1.551. A standard deviation increase in temperature volatility relates to 0.248 lower level of financial obstacle. The effects are substantial, given that mean value of financial obstacle of this firm sample is 1.64. Our results are robust to Conley standard errors (1999) to account for spatial correlation, with cut-off values of 10° latitude and 10° longitude. Estimates of temperature volatility is -1.55, and the standard error corrected for spatial dependence is 0.456.

Because I hypothesized that the weather-induced social capital is mainly formed through collective agriculture and interactive trade activities, I next examine whether effects of weather risks on access to finance increase with incentives or probability of ancestors to cooperate in such sectors. I consider that weather risks in areas with neighbours having distinct weather conditions are easier to be diluted than that in areas whose weather is highly correlated with neighbours. If weather conditions are too synchronized across certain areas, I could image that collective cooperation has very limited impacts on coping with climate risks, as residents in such areas all experience uncertainty in similar direction. For example, when region A experiences crop failure, if its neighbour B's weather conditions are highly corelated with that of

A, it is very likely that B also experiences crop failure, thus they possibly end up with having nothing to exchange. Based on this view, weather risks mainly drive cooperative activities among ethnicities whose weather conditions are more spatially diverse. Therefore, I expect that effects of climate risks vary with the size of spatial correlation of temperature shocks. To examine this hypothesis, I construct a measure named *spatial variation.* It is standard deviation of temperature volatility across cells within ethnicities. I assume the higher value of the spatial variation, the more advantages of cooperation to insure against climate risks. Thus, I interact the measure of spatial variation with my temperature volatility measure to check whether the effects of temperature volatility on finance could be amplified.

In Table 5 column 1, my variable of interest is the interaction term *Spatial variation * Temperature uncertainty*. Results show that the effects of climate risks on firms' access to finance increase with the size of spatial variation. Coefficient of the interaction term is negative and significant. While the coefficient of Temperature volatility is still significant, its economic magnitude gets smaller. I also note that coefficient of spatial variation itself is positive, which means it is associated with server financial obstacle. In line with Pierce and Snyder (2018), my results show that slave trade predicts severer financial obstacle. Financial obstacle is negatively associated with coastal location. In sum, my results support that the way of weather risk influences modern finance is through increasing incentives to cooperate which then turns into accumulation of social capitals.

In addition to firms' financial obstacle, I investigate through which financing channel(s) do weather-induced social capitals influence firms, such

Table 5. Firms' external financing and mechanism of the influences

This table reports influences of temperature uncertainty on firms' external financing, and identifies the mechanism of historical cooperation. *Temperature uncertainty* is ethnicity-level inter-annual variability of temperature. *Spatial variation* is standard deviation of Temperature uncertainty within a given ethnicity. Ethnicity controls are malaria risk, an indicator of coast, slave trade, political centralization, Ln (pre-colonial population density), tsetse fly index, and other geographical features. Firm controls include firm size, firm age, manager experience, manager gender, foreign/state ownership in percentage, business group, exports, and indicators of industries at three-digit ISIC level. See the Appendix for more detailed variable definitions and data sources. Standard errors are clustered by ethnicities. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Financial obstacle	Bank loan	Trade credit	Reasons of not applying bank loan		
				Procedures	Collaterals	Interest rates
Temperature uncertainty	-19.429***	11.55***	6.287***	-2.656***	.188	-3.066*
# Spatial variation	(-2.706)	(4.63)	(4.158)	(-2.748)	(.16)	(-1.925)
Temperature uncertainty	-1.442***	.011	.1	-.231***	-.254***	-.284
	(-2.756)	(.059)	(.813)	(-2.677)	(-3.247)	(-1.571)
Spatial variation	13.77***	-8.5***	-5.251***	2.311***	-1.112	2.808***
	(3.109)	(-5.382)	(-5.747)	(3.622)	(-1.458)	(2.773)
Malaria index	-.012	-.005	-.007***	-.002	.003	-.002
	(-1.266)	(-1.227)	(-3.066)	(-1.331)	(1.584)	(-.613)
Coast	-.286**	-.009	-.071***	.034*	.051**	-.043*
	(-2.128)	(-.279)	(-3.301)	(1.705)	(2.464)	(-1.796)
Slavery	.311*	-.054	.055	.09***	.038	.015
	(1.679)	(-.977)	(1.591)	(3.075)	(1.483)	(.333)
Political centralization	-.108	.008	-.037*	-.005	.007	.003
	(-1.038)	(.221)	(-1.975)	(-.306)	(.456)	(.107)
Ln population density	.104***	-.007	-.007	.001	.026***	.001
	(2.922)	(-.545)	(-.97)	(.147)	(3.623)	(.15)
Tsetse fly	.196	.039	.018	.247***	.072	.047
	(.507)	(.326)	(.257)	(4.36)	(1.342)	(.576)
Constant	-.432	-.103	.17	-.615**	.547*	.316
	(-.241)	(-.209)	(.465)	(-2.157)	(1.875)	(.765)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13895	13586	11874	11323	11323	11323
R-squared	.112	.142	.115	.034	.052	.067

as bank loans and trade credits. In Table 5 Column 2 and 3, I show that higher temperature volatility is associated with higher likelihood of firms having bank loans and more fraction of inputs that can be brought through trade credits. In Table 5 Column 4 to 6, higher temperature volatility is associated with less complex application procedures of bank loan, lower value of required collaterals, and lower interest rates of bank loan. Again, those effects increase with the incentives of historical cooperation against weather risks.

I add country fixed effects into the specification, which omits all time-invariant country-level factors. My results therefore validate a within country relationship between temperature volatility and access to external finance. In addition to a set of firms' characteristics, I include ethnicities' features that are important to financial development as control variables.

3.6 Corporate Resilience to Crises

Given the above findings, and the facts that better access to credits could rescue firms from crises (Levine, Lin, & Xie, 2018; Ding, Levine, Lin, & Xie, 2021), I next explore whether climate risks have impacts on firms' survival and recovery from crises? Specifically, I test corporate resilience to two types of crises: systemic banking crises and COVID-19.

3.6.1 COVID-19

The pandemic caused a sudden and exogenous spike in credit risk of borrowers. Çolak & Öztekin (2021) show that banks become more hesitant to lend, resulting in a negative shock to loan growth, despite unprecedented government stimulus and cash injection measures intended to avoid credit supply disruptions. In face of COVID-19, firms take measures of reducing expenses, collecting receivables, delaying payments, and preselling to preserve liquidity (Block et al., 2021). When encountering substantial shortage of liquidity, can firms endowed with greater social capitals suffer less from financial constraints?

WES COVID-19 database provides information on firms' permanent closure due to COVID-19. Based on this data, I construct an outcome variable: *Closed permanently*, which takes a value of 1 if a firm has been closed, and 0 otherwise. I include firm covariates, ethnicity-level covariates, and country fixed effects, which are consistent with the specification in last section.

Table 6 shows that higher temperature uncertainty is associated with less likelihood of permeate closure of firms. Estimate of temperature uncertainty in column 2 is -7.679. When I add an interaction term between temperature uncertainty and spatial variation, the coefficient of temperature uncertainty alone becomes -2.501, while the coefficient of interaction term is -21.438. The results are consistent with my hypothesis. In column 5 and 6, I add an interaction term between temperature uncertainty and COVID-case density to test whether the influence of temperature uncertainty increases with the severity of COVID-19 infection of a country. The coefficient of this interaction is

significantly negative. It means that weather-induced social capitals are especially important for firms' continuity under COVID-19 when firms are facing more negative impacts from the crisis.

Table 6. Temperature uncertainty and firms' closure under COVID-19

This table reports regression results of the relation between temperature uncertainty and firms' closure under COVID-19. *Temperature uncertainty* is ethnicity-level inter-annual variability of temperature*. Spatial variation* is standard deviation of Temperature uncertainty within a given ethnicity. COVID-*case density* is a dummy variable, which equals to 1 if a country's number of COVID-19 cases over population exceeds the 75 percentile-level, and 0 otherwise. Ethnicity controls are malaria risk, an indicator of coast, slave trade, political centralization, Ln (pre-colonial population density), tsetse fly index, and other geographical features. Firm controls include firm size, firm age, manager experience, manager gender, foreign/state ownership in percentage, business group, exports, and indicators of industries at three-digit ISIC level. See the Appendix for more detailed variable definitions and data sources. Standard errors are clustered by ethnicities. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
			Closed permanently			
Temperature uncertainty	-7.672***	-7.679***	-2.502***	-2.501***	-6.894***	-6.975***
	(-3.581)	(-3.584)	(-11.461)	(-11.443)	(-3.204)	(-3.207)
Temperature uncertainty # Spatial variation			-21.484***	-21.438***		
			(-4.699)	(-4.692)		
Spatial variation			22.543***	22.503***		
			(6.134)	(6.124)		
Temperature uncertainty # COVID-case density					-.318**	-.287**
					(-2.625)	(-2.424)
COVID-case density					.241**	.183*
					(2.592)	(2.022)
Constant	18.356***	18.372***	3.519***	3.518***	16.645***	16.851***
	(3.44)	(3.443)	(5.787)	(5.779)	(3.11)	(3.119)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Wave FE	No	Yes	No	Yes	No	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3300	3300	3300	3300	3300	3300
R-squared	.083	.085	.083	.085	.084	.085

3.6.2 Systemic banking crises

I use a difference-in-differences methodology to assess whether firms in countries with higher levels of historical weather uncertainty receive more financing than similar firms in other countries. The specification in this section follows Levine, Lin, & Xie (2018), where key explanatory variable is the interaction between temperature volatility and a dummy of banking crisis. I rely on Laeven and Valencia (2013) to identify the start year of each crisis in a country, t. If a firm-year observation falls into crisis period [t, t+3], the dummy of banking crisis is assigned with a value of 1.

Following Levine, Lin, & Xie (2018), I firstly test differences in informal financing. In Table 7, both dependent variables measure increases in trade credits. In columns 1 to 3, *Trade credit financing/cogs* is the net increase in change in account payable scaled by the cost of goods sold. In columns 4 to 6, *Trade credit financing/total assets* is the net increase in change in account payable scaled by the value of total assets. Sample mean of two measures are both 0.02. I include firm fixed effects, year effects, and an assortment of time-varying firm characteristics as controls. If coefficient of key interaction term is positive, it means that social trust as captured by temperature uncertainty mitigates the fall in trade-credit financing.

In columns 1 and 4, I use full sample in the test. I find that the estimate of *Crisis* itself is significantly negative. Coefficient of interaction term is 0.139 in

column 1, which means that a standard deviation higher temperature uncertainty (0.16), trade-credit financing drops by 2.22% less during a systemic

Table 7. Corporate resilience through trade credit financing

This table reports regression results of the relation between temperature uncertainty and firms' newly obtained trade credit during banking crises [t-3, t+3], where t is the start year of a systemic banking crisis defined in Laeven and Valencia (2013). *Trade credit financing/cogs* is the net increase in trade-credit financing as a share of the cost of goods sold; *Trade credit financing/total assets* is the net increase in trade-credit financing as a share of total assets. An industry is classified as highly depending on external finance if one's dependence on external finance index is above median value (U.S. data over the 1980s, at the three-digit ISIC level). *Crisis* equals 1 in the start year of a crisis and for the 3 years afterward [t, t+3], and 0 otherwise [t-3, t-1]. *GDP* is short for *Ln (GDP per capita),* measured 3 years before the start year of banking crisis. *Private credit* is the ratio of private credit by deposit money banks and other financial institutions to GDP, measured 3 years before the start year of banking crisis. *Market cap.* is the ratio of stock market capitalization to GDP, measured 3 years before the start year of the banking crisis. *Anti-self-dealing* is an index of the extent to which minority shareholders are protected by the laws from being expropriated by insiders through self-dealing transactions. *Creditor rights* is an index of the laws providing creditors the legal ability to voice their opinions, get repaid, and affect the reorganization process. *Firm size (lag)* equals the natural logarithm of total assets lagged by 1 year. *Long-term debt (lag)* equals long-term debt divided by total assets lagged by 1 year. *Tobins' Q (lag*) equals the natural logarithm of [(market value of equity + book value of assets–book value of equity)/book value of assets] lagged by 1 year. Standard errors are clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Trade credit financing/cogs			Trade credit financing/total assets		
Dependence on External finance	All	High	Low	All	High	Low
Temp. uncertainty *	.139***	.276***	-.048	.069**	.111***	.006
Crisis	(3.39)	(4.009)	(-.492)	(2.625)	(2.947)	(.103)
Crisis	-.044*	-.048	-.052*	-.019*	-.007	-.028**
	(-1.872)	(-1.129)	(-1.978)	(-2.111)	(-.443)	(-2.252)
GDP * Crisis	0	0*	0	0	0*	0
	(-.942)	(-2.03)	(.663)	(-1.266)	(-2.077)	(-.182)
Private credit * Crisis	0	0	0	0	0	0
	(-.852)	(-.173)	(-1.413)	(-1.604)	(-1.722)	(-1.155)
Market cap. * Crisis	0	0	0	0	0	0
	(1.325)	(1.102)	(.705)	(1.522)	(1.235)	(.983)
Anti-self-dealing * Crisis	.018	-.016	.071*	.01	.005	.024
	(1.252)	(-1.228)	(1.838)	(1.362)	(.819)	(1.137)
Creditor rights * Crisis	.001	-.006	.009	.001	-.001	.004
	(.273)	(-1.05)	(1.347)	(.625)	(-.288)	(1.021)
Firm size (lag)	-.071***	-.077***	-.06***	-.062***	-.06***	-.068***
	(-13.37)	(-8.75)	(-5.367)	(-9.409)	(-9.057)	(-8.799)
Long-term debt (lag)	.065	.118**	-.005	.033	.033	.034*
	(1.65)	(2.342)	(-.113)	(1.378)	(.929)	(1.953)
Tobins' Q (lag)	.025**	.024**	.03	.003	.002	.007
	(2.797)	(2.177)	(1.684)	(1.384)	(.585)	(1.158)
Constant	1.427***	1.494***	1.256***	1.249***	1.184***	1.419***

	(13.447)	(8.672)	(5.36)	(9.63)	(9.271)	(8.932)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country cluster	17	17	17	17	17	17
Observations	9395	5742	3653	9508	5851	3657
R-squared	.22	.231	.202	.284	.274	.317

banking crisis. In columns 2 and 5, I use a sub-sample that contains firms in industries with high dependence on external finance. Sub-sample in columns 3 and 6 contains firms in industries with low dependence on external finance. Defined by Rajan & Zingales (1998), external finance is the amount of desired investment that cannot be finance by internal cash flows generated by the same business. Rajan & Zingales (1998) provide a list of 3-digit ISIC industry-level dependence on external finance index. Their calculation is based on 1980's U.S. firms' financial data, and my WES sample doesn't have any U.S. firm, thus the index could be viewed as exogenous to firms' economic conditions. The index measures to what extent do industries naturally rely on external finance. Influences of temperature uncertainty should differ across industries in a theoretically predictable manner that industries with high dependence on external finance are expected to receive greater impact than others.

The coefficient of interaction term is 0.276 in column 2, the double size as the value in column 1, while the coefficient in column 3 doesn't have explanatory power. This finding is consistent with what I expect that effects are more pronouncing on firms who technologically more rely on external finance. Such firms from countries with highest level of temperature uncertainty (0.929) are estimated to enjoy 16.99% less drop in trade credits than similar firms with average level of temperature uncertainty (0.35). The magnitude of influence is

not trivial. I observe similar patterns when using *Trade credit financing/total assets* as the outcome variable. To mitigate potential estimation bias caused by correlation between temperature uncertainty with national conditions of economy & institutions, I add macroeconomic interaction terms as controls in my specification.

The second factor in my examination that leads to heterogenous effects across industries is supply chain-relationship. In Nunn (2007), relationship-specificity is measured by proportion of goods' intermediate inputs that require relationship-specific investments. The measure classifies inputs that are neither bought and sold on an exchange nor reference priced as relationship-specific. If an input is sold on an exchange or is reference priced in trade publications, then the market for the input is thick, with many alternative buyers and sellers. Nunn (2007) show that ability to enforce contracts is important for relationship-specific investments. I expect that influences of temperature uncertainty on trade credits should be more pronouncing in industries that have tighter supply chain-relationship than others. Results in Table 8 are in line with what I expect. When outcome variable is *Trade credit financing/cogs,* coefficient of *Temp. uncertainty * Crisis* is 0.234 for firms in industries that have tight supply chain-relationship. The effects are quite comparable to firms in industries with high dependence on external finance. I don't find significant influences among firms who normally don't have a close supply chain-relationship.

Because bank credits are especially in short supply during banking crises, the channel through which social capitals facilitate firms' liquidity should mainly be through informal finance, instead of formal finance. I check whether temperature uncertainty exerts influences on formal financing during banking crises, as a placebo test. Formal financing channels that I test are 1) the amount

Table 8. Corporate resilience through trade credit financing

This table reports regression results of the relation between temperature uncertainty and firms' newly obtained trade credit during banking crises. *Trade credit financing/cogs* is the net increase in trade-credit financing as a share of the cost of goods sold; *Trade credit financing/total assets* is the net increase in trade-credit financing as a share of total assets. An industry is classified as relationship industry if one's inputs requiring relationship-specific investments is above median level (Nunn, 2007). *Crisis* equals 1 in the start year of a crisis and for the 3 years afterward [t, t+3], and 0 otherwise [t-3, t-1]. *GDP* is short for *Ln (GDP per capita),* measured 3 years before the start year of banking crisis. *Private credit* is the ratio of private credit by deposit money banks and other financial institutions to GDP, measured 3 years before the start year of banking crisis. *Market cap.* is the ratio of stock market capitalization to GDP, measured 3 years before the start year of the banking crisis. *Anti-self-dealing* is an index of the extent to which minority shareholders are protected by the laws from being expropriated by insiders through self-dealing transactions. *Creditor rights* is an index of the laws providing creditors the legal ability to voice their opinions, get repaid, and affect the reorganization process. *Firm size (lag)* equals the natural logarithm of total assets lagged by 1 year. *Long-term debt (lag)* equals long-term debt divided by total assets lagged by 1 year. *Tobins' Q (lag*) equals the natural logarithm of [(market value of equity + book value of assets–book value of equity)/book value of assets] lagged by 1 year. Standard errors are clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Trade credit financing/cogs		Trade credit financing/total assets	
Relationship-specific investments	High	Low	High	Low
Temp. uncertainty *	.217***	.077	.099***	.044
Crisis	(7.209)	(1.322)	(4.139)	(1.229)
Crisis	-.035*	-.06**	-.022*	-.02*
	(-1.898)	(-2.507)	(-1.981)	(-1.907)
Constant	1.61***	1.225***	1.408***	1.074***
	(8.614)	(4.747)	(6.282)	(9.029)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Macroeconomic interaction controls	Yes	Yes	Yes	Yes
Country cluster	17	17	17	17
Observations	4407	4988	4438	5070
R-squared	.239	.207	.303	.262

Table 9. Corporate resilience to banking crisis through equity and debt

This table reports regression results of the relation between temperature uncertainty and firms' issuances of equity and debt during banking crises. An industry is classified as highly depending on external finance if one's dependence on external finance index is above median value (U.S. data over the 1980s, at the three-digit ISIC level). *Crisis* equals 1 in the start year of a crisis and for the 3 years afterward [t, t+3], and 0 otherwise [t-3, t-1]. *GDP* is short for *Ln (GDP per capita),* measured 3 years before the start year of banking crisis. *Private credit* is the ratio of private credit by deposit money banks and other financial institutions to GDP, measured 3 years before the start year of banking crisis. *Market cap.* is the ratio of stock market capitalization to GDP, measured 3 years before the start year of the banking crisis. *Anti-self-dealing* is an index of the extent to which minority shareholders are protected by the laws from being expropriated by insiders through self-dealing transactions. *Creditor rights* is an index of the laws providing creditors the legal ability to voice their opinions, get repaid, and affect the reorganization process. *Firm size (lag)* equals the natural logarithm of total assets lagged by 1 year. *Long-term debt (lag)* equals long-term debt divided by total assets lagged by 1 year. *Tobins' Q (lag*) equals the natural logarithm of [(market value of equity + book value of assets–book value of equity)/book value of assets] lagged by 1 year. Standard errors are clustered by countries. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
		Equity issuance			Debt issuance	
Dependence on External finance	All	High	Low	All	High	Low
Temp. uncertainty *	.116	.248	.026	.096	.076	.046
Crisis	(.911)	(1.187)	(.276)	(1.291)	(.935)	(.738)
Crisis	-.08*	-.216**	.037	-.038***	-.009	-.024
	(-1.831)	(-2.715)	(.856)	(-3.936)	(-.387)	(-1.298)
Constant	7.556***	8.292***	5.02*	3.094***	2.427***	4.856***
	(3.956)	(4.734)	(2.035)	(9.617)	(7.059)	(12.452)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Macroeconomic interaction controls	Yes	Yes	Yes	Yes	Yes	Yes
Country cluster	17	17	17	17	17	17
Observations	8681	5502	3179	9690	5956	3734
R-squared	.379	.387	.36	.361	.351	.401

of new equity issuance, and 2) the amount of new debt issuance. In columns 1 and 2 of Table 9, outcome variable is *Equity Issuance.* It equals to the change in the book value of common equity plus the change in deferred taxes minus the change in retained earnings during year t, scaled by the book value of total asset at the beginning of period t. In columns 3 and 4, *Debt Issuance* equals the change in total debt during year t, scaled by total assets at the beginning of year t, where total debt is the sum of short-term debt and long-term debt excluding capitalized leases. Specification is similar to the one I use to test influences on trade credits. I show that estimates of the interaction term are not significant any more among all columns in Table 9. *Crisis* itself has negative coefficient, which means that during banking crises, firms have substantially less issuance of equity and debt. Results in Tables 7, 8 and 9 can be interpreted as: the shortage of formal finance can be compensated by informal finance better in countries with higher level of social capitals that accumulated through cooperation against weather risks in history.

3.7 Discussion

3.7.1 Alternative interpretations

Someone may worry that the positive relation between historical weather risks and access to finance might be driven by historical economic growth instead of social capitals. I address this concern in three ways. Firstly, I control measures of both modern economic development and historical development in my specifications, such as GDP per capita and historical population density. I also include ethnicity features that might be important for economic development

such as distance to coast, malaria index, slave trade, political centralization, and other geographic traits. Second, in my ethnicity-level analyses, I include country fixed effects into specifications, thus all time-invariant country-level features are captured, which include economic growth. Thirdly, I conduct an additional test on the relation between temperature uncertainty and historical economic development. I use pre-colonial population density, pre-colonial community size, and an indicator of city existing in year 1800 to measure economic development in the past. Results in Appendix table 5 show that there isn't a significant positive or negative relationship, which rule out this alternative interpretation.

Another concern is that weather uncertainty can lead to a sharp decrease of local population, and only people who are more resilient, brave, and intelligent, can survive in areas with extreme weather. Such people are able to build a better society. This interpretation means the influencing channel is human capitals, not social capital. There are two reasons that this explanation shouldn't be valid. Firstly, under the interpretation that a place with higher temperature uncertainty tend to have better human capitals, I should assume that population don't move a lot, otherwise migration of people can minimize the advantage of human capitals. However, I consider migration when I construct my country-level measure of temperature uncertainty. In Table 4, I show that the effects of migration-adjusted measure are stronger than unadjusted-ones', which means that my measure of temperature uncertainty captures culture that can persist through generations, not simply a location-invariant geographical endowment. Secondly, temperature uncertainty is

different from extreme weather conditions. Unlike natural disaster such as droughts, floods, hurricanes, wildfires etc., the measure is standard deviation of temperature across hundreds of years, thus it is not likely to cause natural selection, such as only better people left. In addition, I show that temperature uncertainty doesn't change historical population density (in Appendix table 5). Thus, this alternative explanation can be ruled out.

3.7.2 Measure of weather risks

I use volatility of temperature to measure climate risk instead of using precipitation data for several reasons. Firstly, contrary to temperature shocks, rainfall shocks were primarily insured against on a more local level, because that precipitation varies over much smaller areas (Buggle and Durante, 2021). As the spatial correlation of rainfall is lower than the correlation of temperature across space, shocks from rainfall can be insured locally but temperature cannot. Thus, temperature shocks instead of rainfalls induced trade across far away regions. Buggle and Durante (2021) show that temperature variability has a stronger and more robust effect on social trust today. Galor and Savitskiy (2018) also suggest that productivity in the Malthusian era is significantly correlated with various characteristics of temperature, but orthogonal to the corresponding measures of precipitation. As this study focuses the effects of climate uncertainty on large-scale cooperation, I believe temperature volatility is much appropriate in this context.

In this study, I focus on the influences of unpredictable temperature. I don't use natural disasters as the measure of weather uncertainty. Although

ancestors may cooperate after natural disasters, but sudden disasters are not expected to trigger large-scale cooperation in the long run. Natural disasters usually have destructive influences, in which case that people don't have time or abilities to take actions. However, it might be interesting to explore possible influences of frequency of natural disasters on culture in the future.

Extreme weather can lead to conflicts, which might influence social capitals and modern finance in a different way. I argue that my measure of temperature uncertainty captures the predictability of weather, which is different from extreme weather condition. I also examine the relation between temperature uncertainty and the frequency of historical conflicts. I measure the frequency of historical conflicts using the number of years when a countries had civil conflicts or inter-state conflicts happened from 1800 to 2007[16]. I don't observe any significant relation, as shown in Appendix table 6.

Another concern is that the effect of temperature volatility might be nonlinear. However, I don't observe nonlinear patterns in my analyses.

3.8 Conclusion

Fluctuation of temperature, precipitation, and extreme weather events such as droughts, flood and windstorms exert economically significant influences on income levels and growth rates (Dell, Jones, and Olken 2012; Hsiang and Narita 2012; Yang 2008); threaten firm assets, profits, capital markets, and household wealth (Dietz, Bowen, Dixon, and Gradwell 2016; Bansal, Kiku, and

[16] COW War Data, at https://correlatesofwar.org

Ochoa 2016; Baldauf, Garlappi, and Yannelis 2019). Accordingly, abnormal weather issues are gaining increasing attention from firm managers, investors, and analysts[17]. Although the number of studies about the temperate influences of extreme weather on financial markets is rapidly growing, we have very limited understanding about the influences of long-run climate risks on modern firms.

Drawing on the view that ancient climate risks increased people's incentives to cooperate in agriculture and trade activities, which turned to accumulation of social capitals and development of participative institutions. I hypothesize that the accumulation of social capitals caused by climate uncertainty provide beneficial environment for modern firms through more accessible finances. The endowment is especially important to relive firms' financial constraints under economic shocks. This is the first study that explores the long-run influences of climates risks on modern finance, deepening my understanding about cultural roots that lead to divergence of corporate resilience to crises.

I construct measures of ancient weather risks using various reliable weather data and examine my hypothesis at both country-level and ethnicity-level. Firstly, I validate the positive relation between ancient weather risks and culture of trust, large-scale cooperation. I then combine World Bank's household' and WES firms' data with my weather measures and find that ancient weather uncertainty is associated with easier access to finance. This

[17] Weather risks are cautiously taken account of when institutions and individuals make investment. Henry, Joseph and Wang (2018) show climate risks determine financing choices of listed firms. Choi, Gao, and Jiang (2019) find retail investors adjust their portfolios towards a low-carbon way when local temperature is abnormally high. Institutional investors regard climate risk to be important as well (Krueger, Sautner, and Starks 2019).

finding is robust to my various checks. Because cooperation in agriculture and trade activities is the key mediator, I show consistent evidence that impacts of weather uncertainty are pronouncing in areas with more incentives or advantages to cooperate to insure against such risks. Specifically, I identify that affected financing channels are mainly bank loans and trade credits. My findings are consistent with Pierce and Snyder (2018), Levine, Lin, and Xie (2018) that social capitals play an important role on trade credits. Weather uncertainty is also found to has positive association with households' access to bank services and FinTech adoption.

I test corporate resilience to crises of COVID-19 and systemic banking crises. Both types of crises make firm suffering from shortage of credits. I expect that long-run weather risks have positive impacts on firms' survival and recovery from crises because that greater level of social capitals can mitigate firms' financial constraints by enabling more lending from banks and supply chains. My results confirm above predicted relationship. My findings imply that cooperation driven by weather risks in history could benefit economic growth through its positive effects on firms' resilience to crises.

This study highlights the importance of social capitals for corporate resilience to crises by verifying the link between climate legacy of cooperation and finance. In this regard, I identify a distinct and positive role of climate change for development among other climate-economy studies. The legacy of cooperation should also play an important role in many other phenomena, which needs further investigations by academicians. It would be interesting to

explore whether climate volatility affects how firms cooperate better in addition to financial channels, such as, could firms' willingness to cooperate in ESG or innovative activities be explained by the climate legacy?

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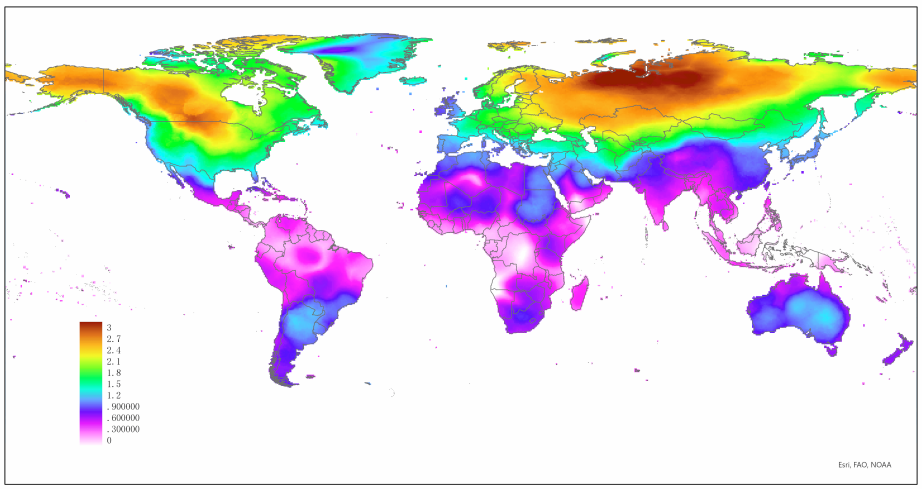
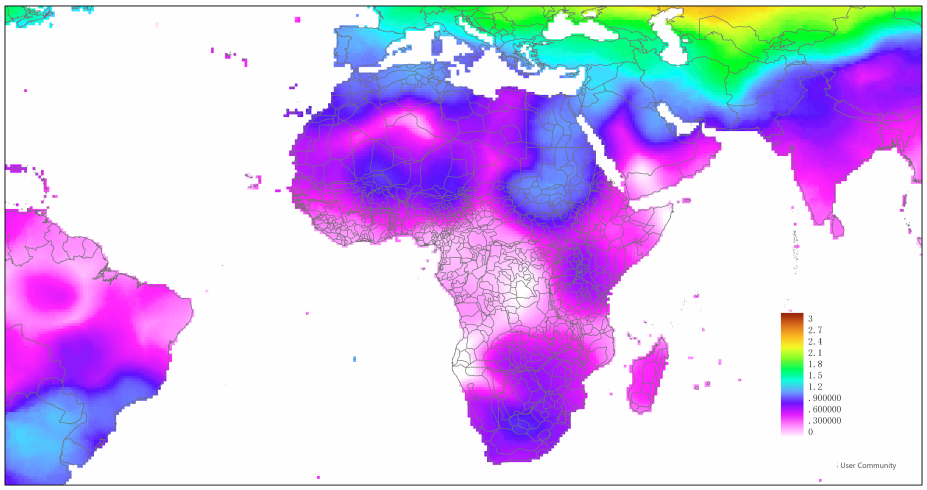
Appendix Figure 1. Spatial distribution of temperature uncertainty



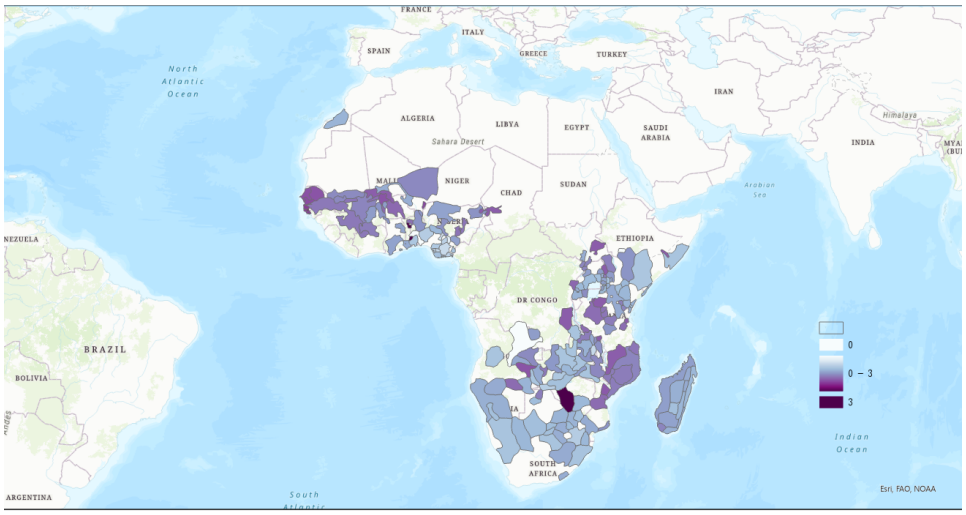
Temperature uncertainty by countries



Temperature uncertainty by ethnicities

Notes: This figure shows the spatial distribution of temperature uncertainty by countries, and by ethnicities in Africa. Areas in green color have the highest level of temperature uncertainty. White color indicates the lowest level of temperature uncertainty.

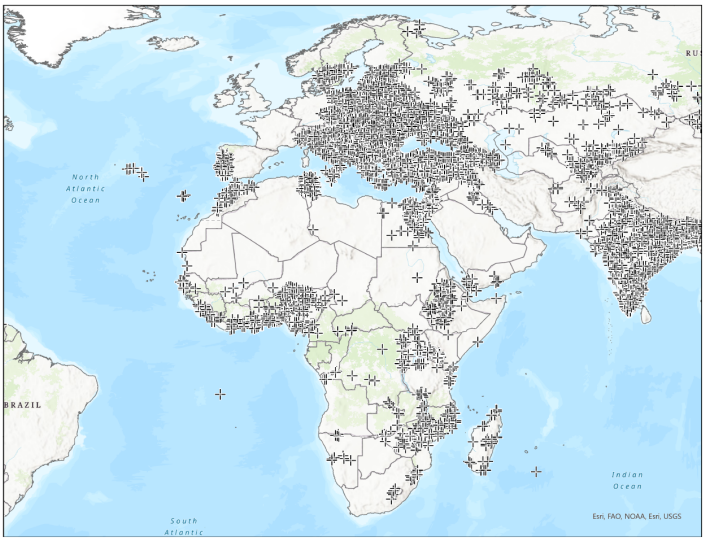
Appendix Figure 2. Inter-group trust across ethnicities



Inter-group trust by ethnicities

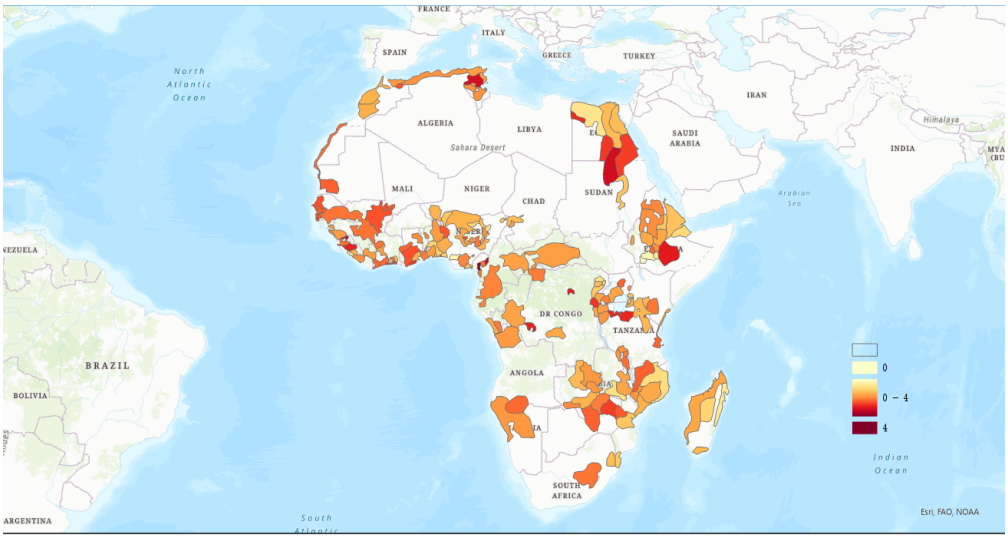
Notes: This figure shows levels of inter-group trust reported in Afrobarometer. The darker color, the higher level of trust.

Appendix Figure 3. Spatial distribution of firm locations



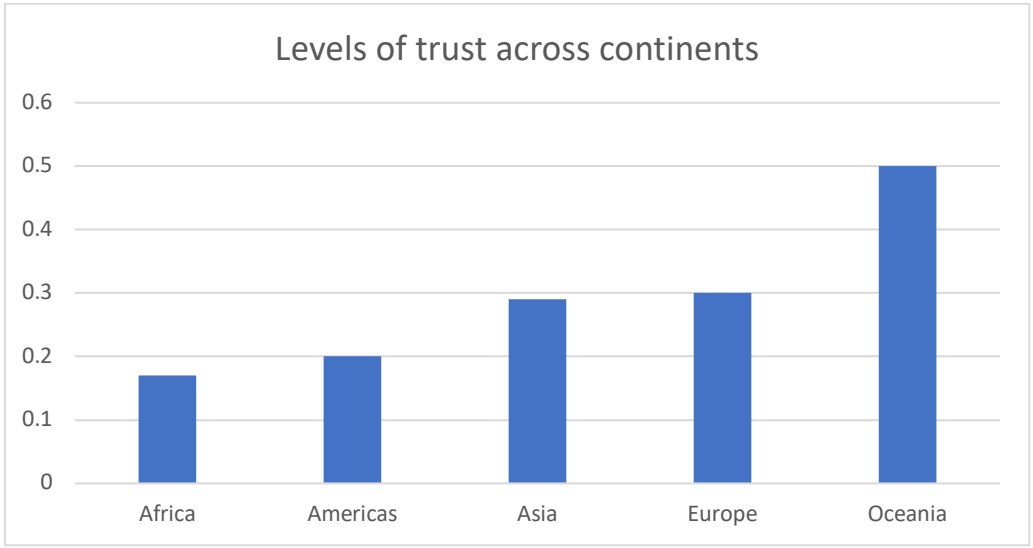
Notes: This figure shows the spatial distribution of firm locations in our WES sample.

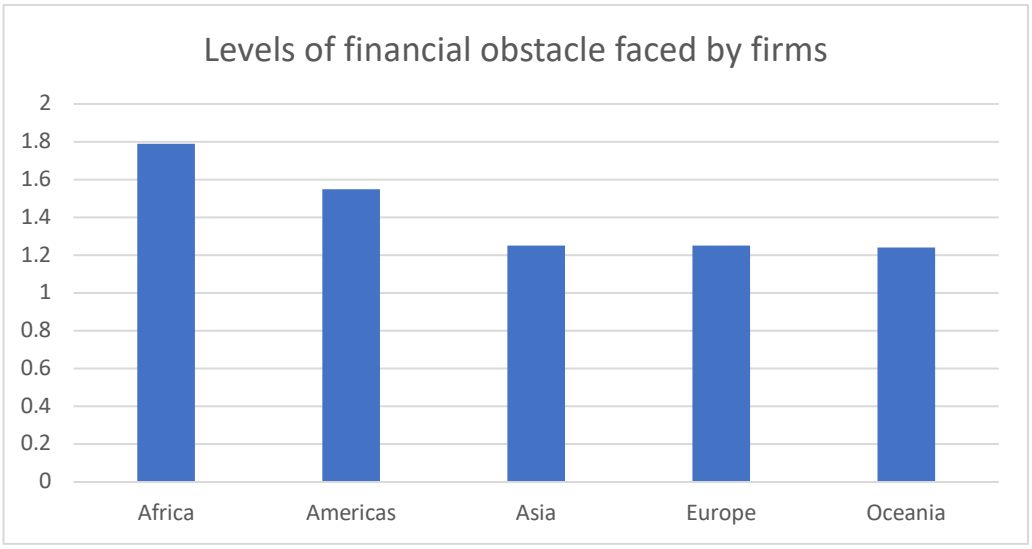
Appendix Figure 4. Firms' financial obstacle across ethnicities



Notes: This figure shows WES firms' financial obstacle across ethnicities. The darker color, the higher level of obstacle.

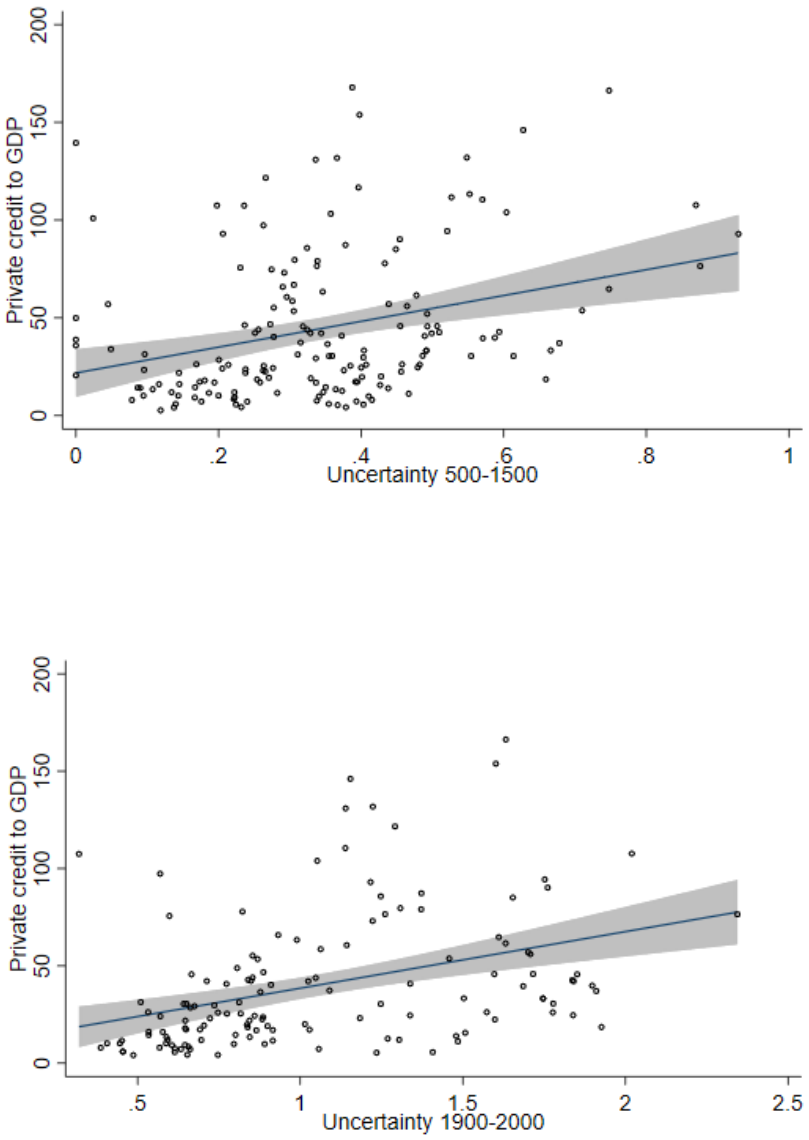
Appendix Figure 5. Trust and financial obstacles across continents





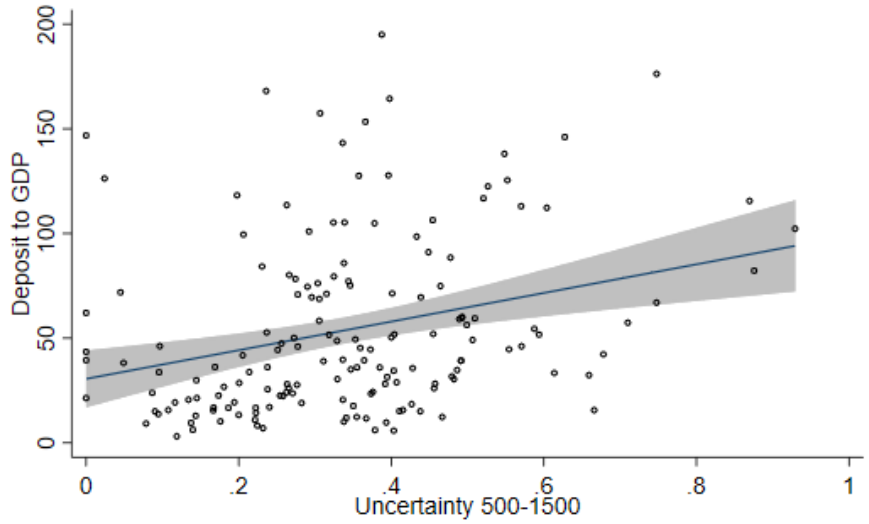
Notes: This figure shows the levels of trust and firms' financial obstacle across continents. Africa has the lowest level of trust, and African firms are reported to have the highest level financial obstacle, compared to others.

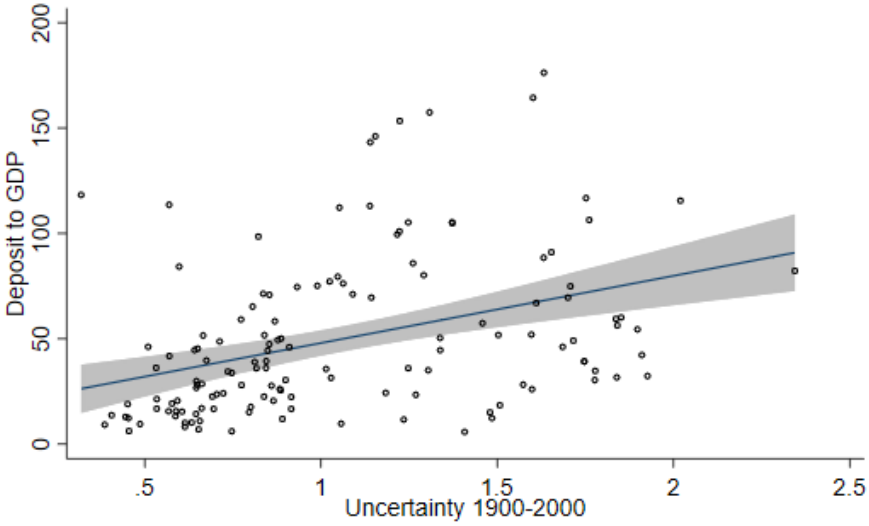
Appendix Figure 6. Temperature uncertainty and private credit to GDP



Notes: This figure shows the scatter plot between temperature uncertainty (500-1500 and 1900-2000) and the average ratio of private credit to GDP over 2000-2017.

Appendix Figure 7. Temperature uncertainty and deposit to GDP





Notes: This figure shows the scatter plot between temperature uncertainty (500-1500 and 1900-2000) and the average ratio of deposit to GDP over 2000-2017.

Appendix Table 1. Sample of WES firms by country

This table reports the number of ethnicities included in this study.

Country	Observation	# of ethnicity
Angola	785	
Benin	300	4
Botswana	610	
Burkina Faso	394	
Burundi	427	1
Cameroon	724	7
Central African Republic	150	5
Chad	303	2
Congo, Dem. Rep.	1228	13
Congo, Rep.	151	
Côte d'Ivoire	887	9
Djibouti	266	2
Egypt, Arab Rep.	7786	9
Eritrea	179	
Eswatini	457	1
Ethiopia	1492	20
Gabon	179	
Gambia	325	3
Ghana	1214	7
Guinea	373	2
Guinea-Bissau	159	
Kenya	2439	13
Lesotho	301	2
Liberia	301	4
Madagascar	977	7
Malawi	673	5
Mali	1035	3
Mauritania	387	2
Mauritius	398	
Morocco	1503	7
Mozambique	1080	13
Namibia	909	2
Niger	301	2
Nigeria	4567	42

Rwanda	813	6
Senegal	1107	2
Sierra Leone	302	3
South Africa	937	
Sudan	662	1
Tanzania	1232	10
Togo	305	6
Tunisia	1207	9
Uganda	1325	5
Zambia	1805	4
Zimbabwe	1199	7
Total	44154	240

Appendix Table 2. Variable definition and data source

Variable	Definition
Temperature uncertainty 1900-2000	Ancestry adjusted inter-annual temperature volatility, based on real weather data over the period from 1900 to 2000 CE.
Temperature uncertainty 500-1500	Ancestry adjusted inter-annual temperature volatility, based on stimulating historical weather data over the period from 500 to 1500 CE.
Ln GDP pc	Natural logarithm of the GDP per capita in 2005, from World Bank's World Development Indicators.
Transportation tech	The level of transportation technology adoption in 1500 CE, weighted average over ship that had successfully crossed the Atlantic Ocean/Pacific Ocean, that had reached the Indian Ocean from either Europe or the Far East, use of the compass for navigation and horses for transportation, from Comin, Easterly, and Gong (2010).
Communication tech	The level of communication technology adoption in 1500 CE, weighted average over the use of movable block printing, woodblock printing, books, and papers, from Comin, Easterly, and Gong (2010).
WES sample	
Financial obstacle	It ranges from 0 to 4, which is the level of financial obstacle a firm reported to WES, where the higher value, the severer issue of financial constraint.
Bank loan	An indicator that equals to one if a firm reported to have any loan from banks.
Trade credit	Firms' payables, % of material inputs or services paid to suppliers after delivery.
Reason: procedures	An indicator that equals to one if the main reason for not applying for new loans of a firm is "Application procedures were complex".
Reason: collaterals	An indicator that equals to one if the main reason for not applying for new loans of a firm is "Collateral requirements were too high".

Reason: interest rates	An indicator that equals to one if the main reason for not applying for new loans of a firm is “Interest rates were not favorable”.
Firm size	The number of employees, 1000 per unit
Firm age	Years of operation
Manager experience	Years of the top manager’s experience working in the firm’s sector
Female manager	Value is 1 if top manager is female
Foreign ownership	Proportion of foreign ownership in a firm (%)
State ownership	Proportion of government/state ownership in a firm (%)
Business group	An indicator that equals to one if a firm belongs to a business group formed by other firms
Export sales	Percentage of sales made as direct export
Closed permanently	It is assigned to value 1 if a firm reported to close permanently after the pandemic, and value 0 otherwise.
Worldscope sample	
Crisis	A dummy variable that equals 1 if a country is in a crisis period and 0 during the precrisis period
Trade credit financing/ cogs	The net increase in trade-credit financing as a share of the cost of goods sold
Trade credit financing/ total assets	The net increase in trade-credit financing as a share of total assets
Equity issuance	The change in the book value of common equity plus the change in deferred taxes minus the change in retained earnings during year t, scaled by the book value of total asset at the beginning of period t
Debt issuance	The change in TOTAL DEBT during a particular year t, scaled by total assets at the beginning of year t, where TOTAL DEBT is the sum of short-term debt and long-term debt excluding capitalized leases

Firm size	The natural logarithm of total assets
Long-term debt	Long-term debt divided by total assets
Tobins' Q	The natural logarithm of [(market value of equity + book value of assets−book value of equity)/book value of assets]

Appendix Table 3. Correlation between historical temperature data from 500 to 1500 and from 1900 to 2000

This table reports the correlation between our self-constructed temperature uncertainty measures.

Variables	(1)	(2)	(3)	(4)
(1) Temperature uncertainty 1900-2000	1.000			
(2) Temperature uncertainty ancestry adjusted 1900-2000	0.965	1.000		
(3) Temperature uncertainty 500-1500	0.748		1.000	
(4) Temperature uncertainty ancestry adjusted 500-1500		0.746	0.825	1.000

Appendix Table 4. Temperature uncertainty and European firms' access to finance

This table reports OLS regression results of European firms' access to finance on temperature uncertainty. Dependent variable *Financial obstacle* ranges from 0 to 4, which is the level of financial obstacle a firm reported to WES, where the higher value, the severer issue of financial constraint. *Temperature uncertainty* is NUTS3-level inter-annual variability of temperature in Europe. Firm controls include firm size, firm age, manager experience, manager gender, foreign/state ownership in percentage, business group, and exports. Standard errors are clustered by NUTS3 regions. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
		Financial obstacle		
Temperature uncertainty	-0.533***	-0.545***	-0.524***	-0.061
	(-6.053)	(-5.903)	(-5.547)	(-0.207)
Ln GDP per capita		-0.192***	-0.187***	Omit
		(-3.142)	(-3.067)	
Common law		0.035	0.055	Omit
		(0.634)	(0.998)	
Constant	2.107***	3.832***	3.764***	1.303***
	(13.487)	(6.221)	(6.078)	(2.670)
Firm controls	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Country FE	No	No	No	Yes
Obs.	13471	13471	13471	13471
R-squared	0.026	0.033	0.038	0.085

Appendix Table 5. Temperature uncertainty and historical economic growth

This table reports OLS regression results of historical economic growth on temperature uncertainty. Dependent variables are Pre-colonial population density in natural logarithm form, Pre-colonial community size, and an indicator of city existing in 1800. *Pre-colonial community size* ranges from 0 to 8, where the higher value, the larger size of communities in the ethnicity. *Temperature uncertainty* is ethnicity-level inter-annual variability of temperature. Ethnicity controls are malaria risk, an indicator of coast, slave trade, political centralization, tsetse fly index, and other geographical features. See the Appendix for more detailed variable definitions and data sources. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (pre-colonial population density)		Pre-colonial community size		City in1800	
Temperature	-1.115	.195	1.345	5.324	.256	.563
uncertainty	(-.833)	(.082)	(.598)	(1.278)	(1.107)	(1.391)
Constant	2.699***	.88	1.075	-.453	-.071	.469
	(3.107)	(.132)	(.714)	(-.033)	(-.472)	(.347)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity controls	No	Yes	No	Yes	No	Yes
Observations	110	90	142	105	128	105
R-squared	.353	.54	.194	.309	.263	.418

Appendix Table 6. Temperature uncertainty and historical conflicts

This table reports influences of historical temperature uncertainty on conflicts. Dependent variables, Civil conflict and Inter-state conflict are the number of years when a countries had specific conflicts happened from 1800 to 2007. The explanatory variable *Uncertainty* 500-1500 is the country-level inter-annual variability of temperature that covers period from 500 CE to 1500 CE. Country controls include land suitability, average ruggedness, average elevation, access to navigable waterways, years since the Neolithic transition, distance from the nearest technological frontier in the year 1500, and an indicator of landlocked country. See the Appendix for more detailed variable definitions and data sources. Standard errors are robust to heteroskedasticity. T-values are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)
	Civil conflict	Inter-state conflict
Uncertainty 500-1500	-4.175	3.411
	(-.657)	(.825)
Constant	11.446**	-2.254
	(2.171)	(-.657)
Observations	131	131
R-squared	.146	.184

Chapter 4. Government Support of Female-dominated Firms in the Covid-19

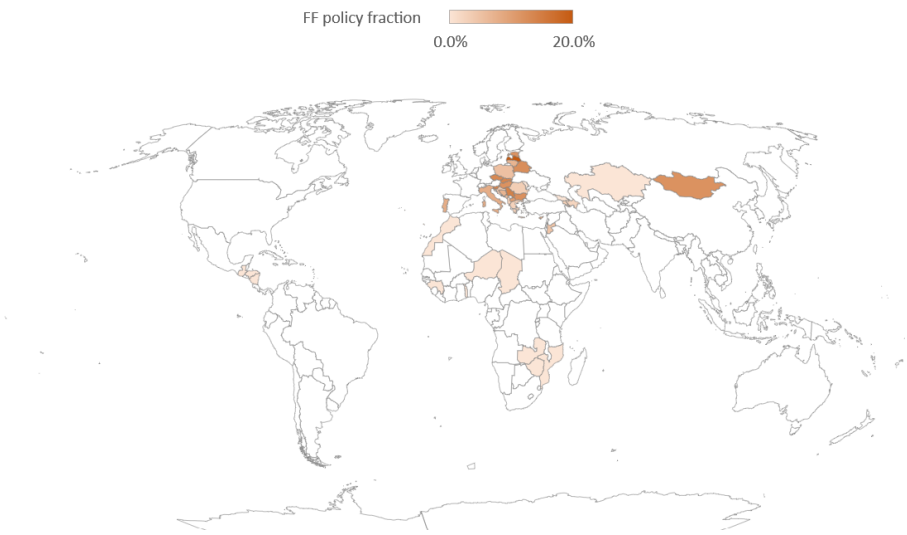
4.1 Introduction

Gender gaps are widely observed in economic activities such as in the workplace and entrepreneurial activities (Alesina et al., 2013; Johan & Valenzuela, 2021; Dutta & Mallick, 2022). Such gender inequality is often exacerbated by various shocks associated with financial crisis (Girón & Correa, 2016), natural disasters (Neumayer & Plümper, 2007) and the Covid-19 pandemic (Adams-Prassl et al., 2020; Brickell et al., 2020), manifested by the disproportionate impacts on the possession of resources, capabilities, and opportunities between men and women. According to the policy brief by United Nation on *the impact of COVID-19 on women*, economic impacts are larger on women who generally earn less, save less, and hold insecure jobs or live close to poverty. The recent literature confirms a substantial drop in labour force participation and income for women (Alon et al., 2020; Agarwal, 2021; Albanesi & Kim, 2021; Dang & Nguyen, 2021; Graeber et al., 2021). However, these analyses on gender gap largely focus on labour markets. It remains unclear about the vulnerability of firms which are dominated by female labours[18], in facing socio-economic hardships during the pandemic and about the effectiveness of mitigation policies. This study answers a call for research to address issues linked to the 'grand challenges' (Budhwar & Cumming, 2020)

[18] Female-dominated firms are firms that have more than 50% women in total workers.

by exploring the role of public support and policy environment in response to the gendered challenge.

Figure 1. Global distribution of female-friendly government policy



Note: This map shows global distribution of female-friendly government policy in Covid-19. FF policy fraction is the fraction of policy measures to compensate unpaid care over the total number of Covid-19 policy measures. Data source is COVID-19 Global Gender Response Tracker, https://data.undp.org/gendertracker/.

Given that women are disproportionately affected by the COVID-19 because of the nature of their jobs (e.g. service sectors, part-time, lower-income and less secure) and increased caregiving needs, Fortier (2020) and Craig & Churchill (2021) emphasise that government are held responsible for narrowing the gender disparity. In the policy brief of *the impact of COVID-19 on women*, the United Nation urges direct support to women-led businesses for governments to offer subsidies, state-backed loans, tax deferrals and exemptions. According to the United Nations Development Programme, about 38% countries have issued mitigation policies and measures with a gender lens as of 11th November 2021[19]. Figure 1 shows a distribution of the fraction of such

[19] *COVID-19 Global Gender Response Tracker*. Link: *https://data.undp.org/gendertracker/*.

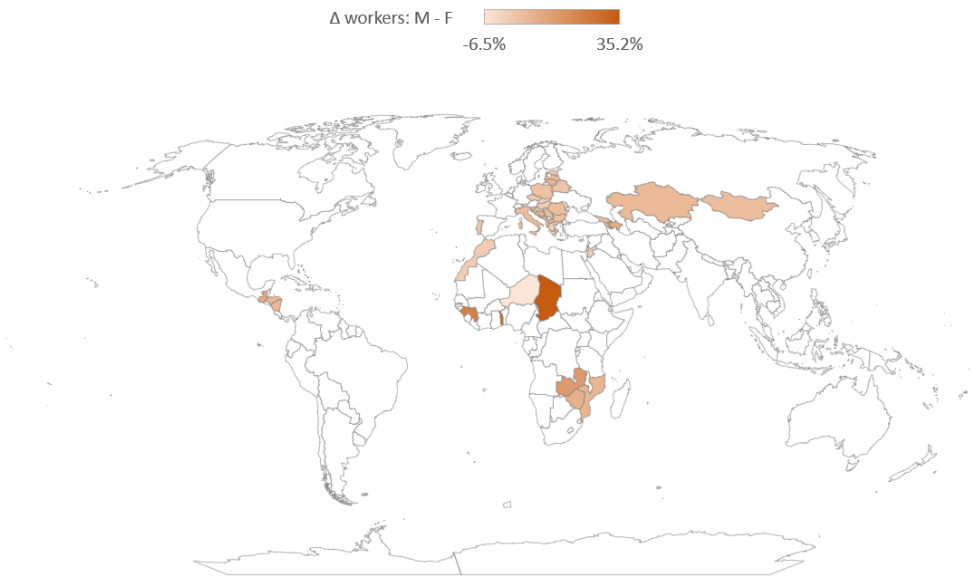
gender policies over total Covid-19 relevant policies across our sample countries, which ranges from 0 to 20%.

This study empirically assesses their effectiveness by comparing female-dominated firms and other firms in a global setting. Female-dominated firms are firms that have more than 50% women in total workers. This definition is the same as in An (2020), which shows that firms with majority female workers have less access to trade credits. I ask if female-dominated firms suffer more in facing the difficulties of the Covid-19 pandemic, do they receive more support from government? Drawing on Corporate Governance[20] Institutions (CGIs) theory, governments' decision-making is undertaken in the light of prevailing beliefs, norms, and rules of the collectivity (Chow, Petrou, & Procopiou, 2022), I hypothesize that gender difference in government support to firms is associated with both firm-specific operation/performance affected by COVID-19 and female-friendly policy environment of a country.

To perform our empirical analyses, I use the firm-level survey data from World Bank Enterprise Survey (WES thereafter) covering 31,463 firm-year observations from 156 sub-national regions in 41 countries[21]. World Bank surveyed firms before and after the outbreak, providing comprehensive information on the influences of COVID-19 such as firms' permanent closure, changes in sales, employment, liquidity, operation hours, sources of finance, aids from government, and expectation for recovery.

[20] CGIs explains variations in corporate governance among the different countries. It signals a country's deeply rooted social priorities (March & Olsen, 2005; Capron & Guillen, 2007).
[21] Link: https://www.enterprisesurveys.org/en/covid-19

Figure 2. Gender difference in changes of firms' employment



Note: This map shows global distribution of gender difference in percentage changes of firms' employment. Δ workers: M - F is changes of firms' employment between male- firms and female-firms. Darker colour means larger gender gap. Data source is World Bank's Enterprise Survey.

I first provide evidence of the lower resilience of firms which have more than 50% women in total workers. While these female-dominated firms, perform as good as male-dominated ones before the outbreak in terms of sales and operation than others, they are 2.1% more likely to close permanently during the pandemic than male-dominated firms during the pandemic as suggested by our model with region, year, and industry fixed effects applied (sample mean is 16.1%). Among the survived firms, female-dominated ones in service sector tend to experience 6.2% more decrease in workers, 6.7% more decrease in operation hours, and 4.2% more decrease in sales; while for firms in manufacturing sector, the values are 3.4%, 3.1%, and 2.5%. My findings are

not driven by other gender-related characteristics of firms, such as female ownership and female top manager, which I have controlled for. Figure 2 shows the distribution of the gendered influence of Covid-19 across counties. The gender difference is larger in African countries. In the most extreme case, female employee-dominated firms experience 35.2 % more decrease in total number of workers than male-firms.

In exploration of differences in firms' ways of financing under the pandemic, I document that female-dominated firms rely 2.5% more on government assistance as their main source of finance, but there are no differences for bank credits and equity financing. This directs us to explore how policy interventions are assigned between female-dominated firms and others, and determinants of the gender difference in government support. Governments support firms through fiscal relief, cash transfers, deferral of payments, access to new credits, and wage subsidies. I find that on average female-dominated firms are 3.5% more likely to receive any measure of government assistance. The gender difference is found in each category of assistance and total number of assistance measures received by firms. I check whether the gender difference is Covid-specific by estimating its association with severity of Covid-19 across countries or varied influence of Covid across industries. Results show that female-dominated firms receive more support than male-dominated firms when Covid cases and death caused by Covid-19 among the population are larger, and when firms are in industries with lower work-from-home ability.

Next, I test the relationship between gender difference in government support to firms and 1) firm-specific operation/performance affected by COVID-19, and 2) female-friendly policy environment of a country. I find that firms' poor performance only partially explains why female-dominated firms receive more support. I then conduct 1:1 PSM matching to obtain paired firm sample with similar characteristics and after-outbreak performance except for the gender fraction of workers. I still observe the gender difference in receiving government support. The results suggest that other factors in addition to firm-specific conditions are driving the difference. Therefore, I investigate the role of policy environment across countries. The *Covid-19 Global Gender Response Tracker* by United Nation monitors responses taken by governments worldwide and in particular gender-sensitive policies and women's participation in policy design. As what I expected, the results based on PSM sample show that only in countries with policy measures that target on women in difficulty, female-dominated firms obtain more public support, but this is not the case for countries without female-friendly policy environment.

To address the endogeneity issue that a female-friendly policy is more likely to be announced in countries where female workers are more adversely affected by Covid-19, I apply an instrumental approach to get predicted female-friendly policy environments which are unlikely driven by female-dominated firms' worse situation. The instrument is the fraction of female leadership in task forces in Covid-19 policy design. At the first stage, I show that women leaders in COVID-19 task forces play more positive role in design policy to relive

burdens on women. The predicted female-friendly policy environment still explains the gender difference in receiving government assistance.

Finally, I estimate to what extent female-friendly policies mitigate the difficulties faced by female-dominated firms. I do not observe improvements in female-dominated firms' performance and operation, which might be attributed to the relative short length of the period under observation. At least, female-dominated firms do not experience worse situations than other firms. Importantly, I do find that female-friendly policy has positive influence on female-dominated firms' expectation for recovery from the Covid-19. In countries with predicted female-friendly policy environment, these firms expect 1.7 fewer month to get back to their normal workforce level, and 3.9 fewer months to normal sales. The finding suggests that supporting policy measures make female-dominated firms optimistically towards the future.

This study contributes to the literature in two important ways. First, it links to the literature on the policy-based remedies of gender inequality (Pascall & Lewis, 2004; Zachorowska-Mazurkiewicz, 2009; Piscopo, 2015) and of Covid-19 (Clemens & Veuger, 2021; Kong & Prinz, 2020; Belghitar, et al., 2021; Brown, Martinsson & Thomann, 2021; Mitman & Rabinovich, 2021; Calabrese, Cowling, & Liu, 2022) by assessing the determinants and effectiveness of disproportionately more public support that was delivered to female-dominated firms, which are more vulnerable under the Covid-19. My results support Corporate Governance Institutions (CGIs) theory by uncovering that difference of policy environment across countries could explain why female-dominated firms receive more government assistance. Gender-sensitive policy measures

and female leadership in policy design are found to overcome the adverse impact by providing financial assistance. As societal and ideological biases may affect government decision-making, this study highlights the implications of gender diversity in the taskforce of Covid-19 related policies.

Secondly, this study enriches the ongoing discourse on the economic effects of the Covid-19 pandemic on organisation in management research (Budhwar and Cumming, 2020; Belitski et al., 2021; Mertzanis, 2021; Ataullah, Le, & Wood, 2022; Ghobadian et al, 2022) by focusing on female-dominated firms, which are especially vulnerable during the pandemic. I document the worse performance of these firms than other firms, more reliance on public support of them, and positive influences of female-friendly policy environment on their expectation about recovery. This study is most related to research about impacts of government intervention on firms, e.g. Calabrese, Cowling & Liu (2022), which examines the role of government support schemes that designed to support the capitalization of businesses during Covid-19.

I draw policy implications based on our empirical findings. Since firms with more woman production labourers have higher risk of permanent closure and poor performance, it is vital to apply an intentional gender lens, as suggested by the United Nation, to the design of fiscal stimulus packages and social assistance programmes to cope with the Covid-19 pandemic. For example, the mitigation policies should take workers' domestic duties into considerations, such as caring needs of children and elders, in deciding government grants to firms. Further, it is encouraging to observe the positive impact of including female leadership in Covid-19 policy-design task forces,

presumably because they better understand the needs and difficulties of female workers and female-dominated firms. The findings inform future efforts and policy response.

4.2 Related Literature and Conceptual Framework

4.2.1 Gender Inequality during the pandemic

The impacts of the COVID-19 pandemic are not gender-neutral. Different from previous recessions which typically reduced employment in male-dominated industries, Covid-19 affects women more adversely for some reasons. From the demand side of female labour, service occupations are affected most during COVID-19 (Dingel & Neiman, 2020), and those occupations are typically concentred in industries with high female employment shares, such as restaurants and hospitality. Even in the same industry, women's jobs tend to be given lower priority than men's (more part-time workers, with lower income, and being less secure). From the supply side of labour, school closures and reduced availability of social services because of the pandemic exacerbated demand for women's inputs on childcare and other domestic duties than that for men's (Adams-Prassl et al., 2020; Ellul et al., 2022; Power, 2020). Mothers with young children have reduced their work hours four to five times more than fathers (Collins et al., 2021). During the Covid-19, women can be affected disproportionately by occupational crowding, extended domestic work, hunger, and even domestic violence (Agarwal, 2021). Taking together, COVID-19 can disproportionately threaten women, and women-dominated companies and sectors, exaggerating gender inequality in economic security and wellbeing.

Scholars indeed discover a substantial drop in labour force participation and income for women. Alon et al. (2020) document that employment decline in the U.S. related to social distancing measures has a large impact on sectors with high female employment shares, and the impact is mainly driven by increase in childcare needs. Albanesi & Kim (2021) have consistent findings for the U.S. labour market. Dang & Nguyen (2021) show that women are 24% more likely to permanently lose their job than men, and expect their labour income to fall by 50 percent more, thus reduce their consumption, using microdata contains answers from China, South Korea, Japan, Italy, the UK and the US. Gender differences across industries explain the gender gaps in expected income loss.

Not only labour markets, women-led businesses also suffer more during COVID-19 than men'. Liu, Wei, & Xu (2021) document that businesses with a woman as top manager are subject to a higher likelihood of closure than men-led businesses. The gender gap is driven by lack of access to bank loans and more decrease in total number of employees, especially female workers. Graeber et al. (2021) show that self-employed women are about one-third more likely to experience income losses than their male counterparts, which is largely explained by the fact that women disproportionately work in industries that suffer more from the COVID-19 pandemic. Dutta & Mallick (2022) note that firms with majority female ownership perceive more financial constraints relative to other firms. As a result, they need to display extra positive signals for those investors who might possess stereotypical and gendered beliefs about

the abilities of entrepreneurs. Although important, influences of COVID-19 on female worker-dominated firms remain unclear.

4.2.2 Policy under Covid-19

Governments are making essential responses to assist firms in overcoming difficulties caused by the crisis. For instance, Sweden has program that allows firms to temporarily suspend payment of all labour-related taxes and fees. Such access to the lending program could prevent firms from encountering severe financial distress following the crisis (Brown, Martinsson, & Thomann, 2021). In the United Kingdom, government support schemes including the Coronavirus Business Interruption Loan Scheme (CBILS) and the Bounce Back Loan Scheme (BBLS) are designed to support the capitalization of businesses through this difficult time (Calabrese, Cowling, & Liu, 2022).

As the global public health crisis represents a major challenge to gender equality (Brickell et al., 2020), COVID-19 should not be gender-neutral. Consider more adverse impacts on women, governments should make efforts on mitigating such effects by taking into account the unpaid labour of care that falls on women in policymaking (Fortier, 2020). In practice, government policies in certain countries have integrated a gender lens to tackle the COVID-19 crisis. The Data Futures Platform (DFP), a project of the United Nations Development Programme, monitors responses taken by governments worldwide, while especially pays attention to gender-sensitive policies. According to data from DFP, 38% countries have issued mitigation policies and measures by 11th November 2021.

Policies are defined as gender-sensitive if they are designed to address women's economic and social security, including unpaid care work, the labour market and violence against women. Especially, gender-sensitive fiscal and economic measures provide support to female-dominated sectors of the economy, in order to protect women's employment and thereby their economic security. In Germany, for example, the government introduced a law, effective from 30 March 2020 until 31 December 2020, which allows persons who have custody of a child to claim compensation for lost income for up to six weeks. The amount is 67% of the lost income, capped at EUR 2,016 per month. The "Law on the Protection of Persons in the Event of Epidemic Situations of National Significance" provides for an extension of the Infection Protection Act (IfSG) until the end of 2020. Parents who are unable to work (even remotely at home) due to the closure of childcare facilities or schools may be entitled to compensation. Eligible recipients are employed carers of children under the age of 12 or disabled children who are dependent on assistance, if they have to look after their child themselves as a result of the closures and suffer a loss of income as a result, and if they have no other reasonable means of care. The DFP considers such a policy to be gender sensitive.

I obtained policy-level data from the website of DFP. It covers policies from 229 countries. Policy measures designed to protect women's economic security are classified as following types: providing credit lines, allowing loan deferral, offering subsidies, tax exemptions, and tax deferrals. Among 229 countries, there are 50 of them with at least one gender-sensitive policy to provide such financial support.

In addition to gender-sensitive policies, DPF also provides information of women's leadership and representation in national COVID-19 task forces. Defined by DPF, a COVID-19 task force is any institution that was created by the national government to lead the response to the pandemic across sectors of public health, economic recovery, enforcement, etc. For each task force, gender of leaders and proportion of female staff in a team are recorded. There are 64 countries with at least one female as a leader of task forces. Canada and New Zealand have 4 female leaders, ranking at the top. The mean value of global women's participation in task forces is only 23.66%.

4.3 Data

My firm-level data is from World Bank Enterprise Survey (WES thereafter). From outbreak of COVID-19 to the end of 2021, World Bank conducted in total 4 rounds of surveys among firms from 156 regions in 41 countries, providing a comprehensive view on influences of COVID-19 on firms globally. Survey questions include firms' permanent closure, changes in sales/employment/ operation hours, sources of finance, aids from government, and expectation for recovery. WES had surveyed sample firms about their performance and various characteristics before the outbreak, which enables us to conduct balance test on firms' past performance. As far as I know, only Liu, Wei, & Xu (2021) used this survey data to analyse impacts of COVID-19 on firms with female top managers.

In Table 1, I present summary statistics of WES sample. My variable of interest is *Female firm*, which is assigned a value 1 if a firm reported to have

over 50% females among total workers, and 0 otherwise. The mean value of this variable is 0.338, and standard deviation is 0.473. I additionally construct dummies of *Female owned* and *Female manager* to isolate other gender effects from my main variable of interest. In this sample, 20.2% firms are owned by females, and 17.4% of them have female top managers. My key outcome variables of the sample are relative change in firms' employment/operation hours/sales, *No. govt. assist.* and indicators of receiving government assistance measures by assistance type. The first set of measures are changes in firms' operation and performance between pre-COVID and post-COVID periods. I observe that average change in number of employees is -7.6%, in operation hours per week is -28.5%, and in sales is -20%. The second set of outcome variables are about government assistance received by firms. On average, a firm receive 0.832 mean of assistance from governments, and the maximum is 5 in this sample. Variables I used as auxiliary outcomes are answers about firms' expectation for recovery from the Covid-19. On average, firms expect 1.5 month to get back to their normal workforce level, and 4.6 months to normal sales. Firm-level controls include *Firm size, Firm age, Manager experience, Business group, Government ownership, Ownership* concentration, *Export business, and Domestic ownership*. See Appendix for detailed definition of all variables.

Table 1. Summary statistics

	N	Mean	SD	Min	Median	Max
Female firm	31463	.338	0.473	0	0	1
Female owned	31463	.202	0.402	0	0	1
Female manager	31463	.174	0.379	0	0	1
Firm size	31463	1.718	0.762	1	2	3

Lg firm age	31463	2.961	0.645	0	3.045	5.333
Lg manager exp.	31463	2.884	0.705	0	2.996	4.248
Business group	31463	.144	0.351	0	0	1
Govt. ownership	31463	.005	0.063	0	0	.99
Concentrated own.	31463	.882	0.322	0	1	1
Exporter	31463	.234	0.424	0	0	1
Domestic firm	31463	.894	0.308	0	1	1
Δ workers	31463	-.076	0.344	-1	0	2
Δ hours	31222	-.285	0.589	-1	0	1
Δ sales	30299	-.2	0.342	-1	-.15	4
Closed	24547	0.161	0.367	0	0	1
No. govt. assist.	31463	.832	1.187	0	0	5
Govt. assist.	31146	.456	0.498	0	0	1
Govt. cash	31117	.162	0.369	0	0	1
Govt. wage	31117	.334	0.472	0	0	1
Govt. defer pay	31117	.123	0.329	0	0	1
Govt. fiscal	31117	.137	0.344	0	0	1
Months to normal workforce	26820	1.511	4.559	0	0	180
Months to normal sales	25317	4.59	14.523	0	2	2023
Rely on govt.	18304	.145	0.352	0	0	1
Rely on banks	18304	.249	0.433	0	0	1
Rely on equity	18304	.533	0.499	0	1	1

4.4 Empirical Results

4.4.1 Impacts on operation, performance, and permanent closure

In this section, I test whether female-dominated firms are affected more adversely in terms of their operation, performance, and permanent closure than other firms. Before I examine these gender differences, I conduct a balance test that compares female-dominated firms and other firms' performance before the outbreak. I don't find significant difference in firms' operation hours per week, firms' production capacity, sales per million employees, and financial obstacles

between female-dominated firms and others before the outbreak. The balance test (see Table 2) ensures that my findings are not driven by pre-Covid differences and that the two groups of firms are comparable.

Table 2. Balance test on past performance

We test differences of past performance between female firms and male firms. Standard errors are clustered at the sub-national region level. The balance test includes sub-national region fixed effects and industry fixed effects.

	(1)	(2)	(3)
Variable	Male firm	Female firm	Difference
Hours/week	59.715	61.168	1.137
	(34.789)	(36.394)	(1.004)
Capacity[22] before Covid	77.332	77.885	0.543
	(22.623)	(22.356)	(0.539)
Sales/million employees	9.134	8.398	0.916
	(84.245)	(123.601)	(2.381)
Financial obstacle	1.261	1.153	-0.033
	(1.258)	(1.241)	(0.023)

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

I analyse how COVID-19 affects female-dominated firms and others differently using the following specification:

$$Y_i = \alpha_i + \beta 1\ FemaleFirm_i + \beta 2\ Firm\ controls_i$$

$$+ \beta 3\ YearDummies + \beta 4\ IndustryDummies$$

$$+ \beta 5\ SubNatinalRegionDummies + \varepsilon_i$$

, where *Yi* is either relative change in firms' employment/operation hours/sales or an indicator of firms' permanent closure. I include sub-national region

[22] It equals to amount of utilized capacity scaled by total capacity of a firm.

dummies to control for all time-invariant factors in a sub-national region, industry dummies to control for time-invariant features of industries, and year fixed effects for all yearly trends. Standard errors are clustered at sub-national region level.

Table 3 reports the gendered impacts on firms' operation and performance. The gendered impact of Covid-19 should exhibit different magnitudes between service sector and manufacturing sector, because the lock-down measures may disproportionally affect the service sector more, and the service sector usually has a higher fraction of female workers. Thus, I separate the sample into the service sector and the manufacturing sector when I estimate the difference. Results concerning the service sector are in odd columns, and results for the manufacturing sector are in even columns. The outcome variable in Columns 1 and 2 is the relative change of firms' number of workers after the outbreak of COVID-19 (in %). Estimates of *FemaleFirm_i* in Columns 1 and 2 are -0.062 and -0.034. Firms with more than 50% workers being women experience a 6.2% more decrease in employment than others in

Table 3. Impacts on firms' operation & performance

This table estimates the gender difference in impacts of Covid-19 on firms' operation and performance, specifically, fraction of changes in workers, operation hours and sales between pre- and post-Covid periods. The key explanatory variable, *Female firm* is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. We test firms in services sector and manufacturing sector separately. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ workers		Δ hours		Δ sales	
Sector	Service	Manuf.	Service	Manuf.	Service	Manuf.
Female firm	-.062***	-.034***	-.067***	-.031**	-.042***	-.025***
	(-6.761)	(-4.55)	(-6.339)	(-2.571)	(-4.964)	(-3.617)
Female owned	-.006	-.011	-.041***	-.056***	-.035***	-.021***
	(-.598)	(-1.257)	(-3.023)	(-4.168)	(-3.777)	(-2.761)
Female manager	.014	.006	.033**	-.003	0	-.007
	(1.119)	(.611)	(2.271)	(-.209)	(-.021)	(-.879)
Firm size	.004	.024***	.022***	.055***	.028***	.042***
	(.761)	(4.34)	(2.734)	(6.835)	(6.157)	(8.753)
Lg firm age	.022***	-.005	.008	-.002	.004	-.002
	(3.085)	(-.922)	(.78)	(-.169)	(.524)	(-.271)
Lg manager exp.	-.012	-.003	-.005	-.01	0	-.009**
	(-1.638)	(-.564)	(-.588)	(-1.28)	(-.046)	(-1.978)
Business group	.012	.006	.047***	.005	.035***	.016**
	(1.229)	(.646)	(3.164)	(.297)	(3.525)	(2.118)
Govt. ownership	.062*	-.019	.157***	.011	.116***	.105***
	(1.682)	(-.657)	(2.804)	(.231)	(3.006)	(4.191)
Concentrated own.	.006	.006	.002	.009	-.001	-.011
	(.606)	(.661)	(.127)	(.568)	(-.082)	(-1.13)
Exporter	.025*	.016**	.013	.01	.003	.018**
	(1.742)	(2.014)	(.718)	(.9)	(.303)	(2.581)
Domestic firm	-.032**	.008	.006	-.036**	.003	-.025***
	(-2.446)	(.818)	(.32)	(-2.245)	(.19)	(-2.922)
Constant	-.086***	-.09***	-.349***	-.299***	-.271***	-.186***
	(-3.443)	(-3.94)	(-10.084)	(-8.324)	(-12.516)	(-8.121)
Clusters			Sub-country regions			
Region FE			Yes			
Industry FE			Yes			
Year FE			Yes			
Observations	15301	16161	15759	16989	15257	16499
R-squared	.064	.054	.15	.142	.189	.196
Adj R^2	.054	.043	.14	.133	.18	.187

t-values are in parentheses
**** p<.01, ** p<.05, * p<.1*

the service sector, and 3.45% in the manufacturing sector. While the sample mean of employment change is -7.6 %, the magnitude of difference is not trivial.

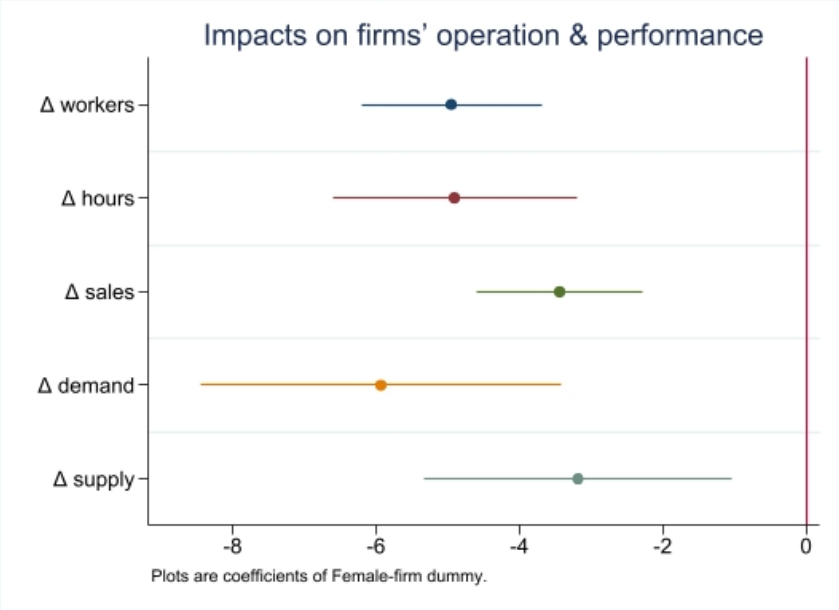
In Columns 3 and 4, I report the estimates of difference when the outcome variable is the change of firms' number of operation hours per week against the value in pre-COVID period. Female-dominated firms suffer 6.7% more decrease than others in service sector, and 3.1% in manufacturing sector. In Columns 5 and 6, I estimate gendered difference in the change of firms' sales compared to the value before Covid-19. While the sample mean of employment change is -20%, female-dominated firms have 4.2% more decrease than others in service sector, and 2.5% more decrease in manufacturing sector. The findings are robust when I use industry-clustered standard errors (see Appendix 6).

In Figure 3, I depict estimates for the gendered impacts of Covid-19 in a graph. In addition to three outcome variables in Table 3, I also show difference in the change of demand and supply of firms' products/services in the figure. The change of demand is found to have larger gender difference than other outcomes.

Female-dominated firms also face higher risk of permanent closure. In Table 4, the outcome variable is an indicator that reports whether a firm closed permanently after the pandemic. I found that female-dominated firms have 2.1% more chance to close permanently than others (sample mean is 16.1%). Our results are quite comparable to that in Martinez et al. (2019). They show the

rate of business failure caused by the global financial crisis is 3.06% for manufacturing firms, and 1.81% for service firms in Spain. The difference is

Figure 3. Gender difference in impacts from Covid-19



Note: The key explanatory variable, Female firm is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

driven by woman's fraction among production workers. Columns 3 and 4 show that non-production women workers don't have the same influences on firm closure, which suggests that gender of workers mainly affects firm through production activities. The number of observations in Table 4 is smaller than the number in Table 3, because that once a firm has closed, WES couldn't conduct interview the firm in following rounds of survey, which leads to fewer observations in Table 4. I also note that coefficients of controls related to gender, female ownership, and female top manager, are not significant at 10%.

Table 4. Impacts on firms' closure

This table estimates the gender difference in impacts of Covid-19 on closure of firms. *Closed* indicates whether a firm closed permanently after the pandemic. The key explanatory variable, *Female firm (prodct.)* is assigned to value 1 if a firms has more than 50% females among its total production workers, and value 0 otherwise. We also test the effects of non-production women labour force, but there isn't a similar pattern to that of production women labour force. Standard errors are clustered at the sub-national region level or industry-level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)
		Closed		
Female firm (prodct.)	.021***	.021***		
	(2.839)	(3.938)		
Female firm (nonprd.)			.002	.002
			(.356)	(.266)
Female owned	-.013	-.013	-.009	-.009
	(-1.534)	(-1.773)	(-1.103)	(-1.192)
Female manager	.014	.014	.013	.013
	(1.244)	(1.195)	(1.241)	(1.187)
Firm size	-.007	-.007	-.003	-.003
	(-1.406)	(-1.244)	(-.637)	(-.578)
Lg firm age	-.028***	-.028***	-.027***	-.027***
	(-4.678)	(-4.782)	(-4.57)	(-4.568)
Lg manager exp.	-.009*	-.009**	-.009*	-.009*
	(-1.858)	(-2.263)	(-1.727)	(-1.877)
Business group	-.013*	-.013	-.012	-.012
	(-1.673)	(-1.555)	(-1.45)	(-1.445)
Govt. ownership	.041	.041	.033	.033
	(1.198)	(1.713)	(.983)	(1.309)
Concentrated own.	.016**	.016*	.017**	.017*
	(2.046)	(1.912)	(2.296)	(1.847)
Exporter	-.018**	-.018**	-.016**	-.016**
	(-2.255)	(-2.835)	(-2.086)	(-2.418)
Domestic firm	-.025**	-.025**	-.021**	-.021**
	(-2.558)	(-2.653)	(-2.134)	(-2.359)
Constant	.293***	.293***	.277***	.277***
	(12.551)	(13.831)	(11.638)	(11.545)
Clusters	Regions	Industries	Regions	Industries
Region FE			Yes	
Industry FE			Yes	
Year FE			Yes	
Observations	24547	24547	23331	23331
R-squared	.085	.085	.086	.086
Adj R^2	.078	.078	.078	.078

t-values are in parentheses
**** p<.01, ** p<.05, * p<.1*

4.4.2 Government assistance

Since I find that female-dominated firms are affected more during the pandemic, I ask how governments provide support to this vulnerable group, and what are the determinants of government assistance.

Decreased liquidity should be one of main challenges that faced by firms, while governments could help to relieve the burden by providing financial support. WES COVID-19 survey asked firms a question about their financial source after the outbreak, i.e. “Whether a firm uses government grants/ bank loans/equity/delayed payments as the main source of finance since COVID-19 began?”. Based on such questions, I construct outcome variables including firms’ reliance on government grants, bank loans, and equity financing. All of them are dummy variables, with value of 1 if firm’s answer is “Yes”, and 0 otherwise. Only part of firms in the sample answered these questions, which makes the number of observations in this section smaller than in the full sample. Summary statistics show that 14.5% firms rely on government grants; 24.9% of them use bank loans; 53.3% of them rely on equity finance. If female-dominated firms are affected more by the Covid-19, I expect to find that they also receive more financial support from governments.

Table 5 shows estimates of gender gap in firms’ reliance on financial channels during COVID-19. Outcome variable in Columns 1 and 2 is firms’ reliance on government support. I find that female-dominated firms have 2.5% more likelihood of using government grants as main financial source. From Columns 3 to 6, I don’t observe difference in other financial sources including

bank loans and equity financing. As I observe that women-dominated firms rely more on government grants than other financing sources, the finding highlights

Table 5. Main source of finance

This table estimates the gender difference in main financial source that firms can rely on during the outbreak of Covid-19. Dependent variables are dummies, assigned to value 1 if a firm can rely on the specific financial source. The key explanatory variable, *Female firm* is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	Govt.		Banks		Equity	
Female firm	.025***	.025***	-.012	-.013	-.003	-.001
	(3.046)	(3.018)	(-1.332)	(-1.492)	(-.28)	(-.096)
Female owned	.011	.012	-.013	-.004	.006	-.001
	(1.115)	(1.323)	(-.861)	(-.296)	(.399)	(-.041)
Female manager	-.004	-.004	-.03**	-.026*	.015	.013
	(-.426)	(-.4)	(-2.164)	(-1.829)	(.992)	(.807)
Firm size		.002		.059***		-.039***
		(.309)		(8.186)		(-4.462)
Lg firm age		-.003		.019**		-.005
		(-.396)		(2.376)		(-.477)
Lg manager exp.		.005		-.002		0
		(.799)		(-.344)		(-.031)
Business group		-.002		-.002		-.015
		(-.214)		(-.134)		(-1.184)
Govt. ownership		.041		-.13		.091
		(1.002)		(-1.532)		(.991)
Concentrated own.		-.015		-.007		.022
		(-1.399)		(-.468)		(1.587)
Exporter		.005		-.01		-.006
		(.49)		(-.677)		(-.508)
Domestic firm		.004		.044**		-.05***
		(.316)		(2.588)		(-2.937)
Constant	.133***	.133***	.261***	.079**	.52***	.631***
	(41.806)	(4.659)	(66.209)	(2.382)	(107.072)	(15.726)
Clusters	Sub-country regions					
Region FE	Yes					
Industry FE	Yes					
Year FE	Yes					
Observations	18995	18995	18995	18995	18995	18995
R-squared	.22	.221	.104	.114	.253	.257
Adj R^2	.213	.213	.095	.105	.246	.249

t-values are in parentheses
**** p<.01, ** p<.05, * p<.1*

the importance of government assistance to address the gendered challenge by Covid-19.

I then test whether female-dominated firms receive more public support than others, as I expect that governments should allocate more resource on vulnerable ones. In Table 6, outcome variables are total number of assistance measures received by firms, an indicator of whether a firm received any public support measure or not, and four indicators of the category of public support received by firms which includes fiscal relief, cash transfers, deferral of payments, and wage subsidies. On average, 45.6% of firms in my sample get public support. I show that female-dominated firms are 3.5% more likely to receive any measure of government assistance. Specifically, they are 5.3% more likely to receive wage subsidies, 2.1% more for receiving fiscal relief, 1.8% more for receiving cash transfers, and 1.8% more for deferral of payments. Receiving wage subsidies or not has the highest magnitude of the difference, which is reasonable. Because that my explanatory variable is defined by the gender fraction of workers, I expect that the difference of government support is largely explained by the support measure which targets on workers, for instance, wage. The findings are robust when I use industry-cluster standard errors (see Appendix 6).

Someone might concern that is the gender difference in receiving government support a trend related to Covid-19, or is it a trend all the time? In Table 7, I show that the gender difference is Covid-specific by estimating its association with severity of Covid-19 across countries or varied influence of

Covid across industries. I add an interaction into the baseline specification. In Columns1 and 4, the interaction is *Female firm* * *Cases*. *Cases* is a national

Table 6. Measures of government assistance

This table estimates the gender difference in receiving government assistance after Covid-19. Dependant variables are total number of government assistance measures received by a firm, and indicators of receiving government assistance measures by assistance type. The key explanatory variable, *Female firm* is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1) Num. govt.assist.	(2) Govt. assist.	(3) Govt. wage	(4) Govt. fiscal	(5) Govt. cash	(6) Govt. defer pay
Female firm	.112***	.035***	.053***	.021***	.018***	.018***
	(5.026)	(3.786)	(6.457)	(3.507)	(2.632)	(2.86)
Female owned	.079***	.016	.019*	.009	.021**	.017*
	(2.669)	(1.321)	(1.758)	(1.167)	(2.53)	(1.952)
Female manager	-.046	-.002	-.003	-.008	-.005	-.013
	(-1.502)	(-.183)	(-.259)	(-.882)	(-.646)	(-1.548)
Firm size	.059***	.03***	.032***	.011**	-.003	.009*
	(2.791)	(3.843)	(4.825)	(1.981)	(-.426)	(1.771)
Lg firm age	-.023	.006	-.002	-.004	-.006	-.007
	(-1.254)	(.857)	(-.322)	(-.78)	(-1.112)	(-1.232)
Lg manager exp.	-.019	-.012**	-.013**	-.002	.001	-.006
	(-1.139)	(-2.238)	(-2.245)	(-.433)	(.129)	(-1.529)
Business group	-.009	-.003	-.006	-.006	.002	-.003
	(-.283)	(-.227)	(-.575)	(-.698)	(.154)	(-.278)
Govt. ownership	-.087	-.03	-.049	-.029	-.011	.019
	(-.979)	(-.574)	(-1.231)	(-1.127)	(-.77)	(.912)
Concentrated own.	-.019	-.006	-.003	-.006	0	-.004
	(-.661)	(-.613)	(-.278)	(-.73)	(-.01)	(-.451)
Exporter	-.008	.008	-.001	-.012*	.002	-.001
	(-.374)	(.71)	(-.074)	(-1.861)	(.259)	(-.146)
Domestic firm	.009	-.004	-.016	-.02**	.016*	.014
	(.299)	(-.274)	(-1.201)	(-2.372)	(1.929)	(1.383)
Constant	.781***	.41***	.311***	.157***	.156***	.13***
	(9.936)	(14.149)	(10.928)	(7.045)	(6.608)	(5.488)
Clusters			Sub-country regions			
Region FE			Yes			
Industry FE			Yes			
Year FE			Yes			
Observations	34034	32590	32556	32556	32556	32556
R-squared	.247	.24	.215	.173	.207	.13
Adj R^2	.242	.236	.21	.168	.203	.125

t-values are in parentheses
**** p<.01, ** p<.05, * p<.1*

level time-varied measure of Covid-19 severity by Oxford[23], which equals to 7-day average Covid cases per million of population in a country. In Columns 2 and 5, the interaction is *Female firm * Death*, where the *Death* is 7-day average death caused by the pandemic per million of population. Both interactions can estimate how the difference in receiving public support change with the severity of Covid-19 in a country. Estimates of the interaction show that the size of difference increases with Covid-19 cases and death among population. Specifically, for every 1 death per million of population, female-dominated firms have 2.1% higher possibility of receiving any support measure than other firms.

Next, I examine whether the difference is associated with industrial level influences of Covid-19 by interacting *Female firm* with industrial *work-from-home ability.* Dingel & Neiman (2020) constructed an industrial *work-from-home index*, where the higher value of this index, the better ability of adapting to work-from-work by the nature of an industry. Based on this index, I assign firms into groups of low/medium/high ability of work-from-home. In columns 3 and 6, both coefficients of *Female firm * WFH low* and *Female firm * WFH medium* are positive, and the coefficient of former interaction is larger. My results suggest that the gender difference in receiving public support is mainly found among industries that are more unable to work from home. Results in Table 7 confirm that the gender difference in receiving government support is a Covid-19 specific phenomenon.

[23] https://covid19.oii.ox.ac.uk/tracker/

Table 7. Government assistance and Covid-19

This table shows that gender bias in government assistance is partially explained by severity of Covid-19 and industries' inability to work from home. Dependant variables are total number of government assistance measures received by a firm, and an indicator of receiving any government assistance measure. The key explanatory variables are interaction terms between *Female firm* and Covid-19 cases and death among population, and two indicators of inability to work from home: *WFH low,* and *WFH medium.* Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	No. govt. assist.			Govt. assist.		
Cases # Female firm	.001*** (3.658)			.001*** (3.773)		
Death # Female firm		.045*** (3.292)			.021*** (3.573)	
WFH low # Female firm			.174*** (3.052)			.059** (2.541)
WFH medium # Female firm			.11* (1.672)			.038 (1.442)
Female firm	.07*** (2.735)	.078*** (3.122)	-.014 (-.235)	.015 (1.601)	.019** (2.041)	-.008 (-.351)
Female owned	.079*** (2.65)	.078*** (2.61)	.079*** (2.675)	.016 (1.3)	.015 (1.258)	.016 (1.327)
Female manager	-.046 (-1.509)	-.046 (-1.475)	-.048 (-1.557)	-.002 (-.193)	-.002 (-.134)	-.003 (-.225)
Constant	.782*** (9.951)	.779*** (9.905)	.78*** (9.93)	.41*** (14.172)	.408*** (14.118)	.409*** (14.128)
Clusters			Sub-country regions			
Region FE			Yes			
Industry FE			Yes			
Year FE			Yes			
Firm controls			Yes			
Observations	34034	33763	34034	32590	32320	32590
R-squared	.247	.252	.247	.241	.242	.24
Adj R^2	.243	.247	.243	.236	.238	.236

t-values are in parentheses
*** p<.01, ** p<.05, * p<.1*

Table 8. Government assistance conditional on performance

This table shows that gender bias in government assistance is partially explained by firms' bad performance due to Covid-19. Dependant variables are total number of government assistance measures received by a firm, and an indicator of receiving any government assistance measure. The key explanatory variables are interaction terms between *Female firm* and three indicators of firms' bad performance: *Workers decrease, Hours decrease,* and *Sales decrease.* Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	No. govt. assist.			Govt. assist.		
Workers decrease # Female firm	.1*** (3.251)			.03** (2.358)		
Workers decrease	.136*** (5.717)			.047*** (5.389)		
Hours decrease # Female firm		.07** (2.073)			.019 (1.474)	
Hours decrease		.199*** (7.532)			.08*** (7.29)	
Sales decrease # Female firm			.055 (1.57)			.04*** (2.933)
Sales decrease			.252*** (8.084)			.101*** (9.215)
Female firm	.07*** (3.005)	.076*** (3.457)	.067** (2.54)	.021** (2.053)	.023** (2.259)	.008 (.652)
Female owned	.08** (2.606)	.07** (2.334)	.069** (2.265)	.015 (1.192)	.012 (.985)	.011 (.89)
Female manager	-.05 (-1.647)	-.042 (-1.368)	-.041 (-1.337)	-.002 (-.118)	-.001 (-.063)	-.003 (-.2)
Constant	.775*** (9.442)	.732*** (9.352)	.69*** (8.61)	.395*** (13.253)	.381*** (13.348)	.362*** (12.551)
Clusters			Sub-country regions			
Region FE			Yes			
Industry FE			Yes			
Year FE			Yes			
Firm controls			Yes			
Observations	31463	32749	31758	31146	32337	31412
R-squared	.243	.242	.246	.245	.245	.251
Adj R^2	.239	.238	.242	.241	.24	.246

t-values are in parentheses
*** p<.01, ** p<.05, * p<.1*

How do governments allocate financial support among firms? I contend that one of important determinants of the allocation should be to what extent a firm's operation and performance affected by the Covid-19. I test the prediction by interacting Female-dominated firm with firm-specific adverse impact of Covid-19. In Table 8, I use *Workers decrease, Hours decrease*, and *Sales decrease* to capture the adverse impact. The three indicators take value of 1 if a firm is reported to experience decrease in number of employees/operation hours/sales after the Covid-19, and value of 0 otherwise. Results show that the gender difference is indeed explained by the worse performance of firms, but only partially, which implies that there are other factors that simultaneously cause the difference.

4.4.3 Female-friendly policy environment

The Corporate Governance Institutions (CGIs) theory recognizes that different countries have distinct corporate governance systems, which are shaped by historical, cultural, and institutional factors. Different models of corporate governance have a significant influence on decision-making within corporations and can also shape government policies and regulations related to business and economic activities. In line with CGIs theory, governments' decision-making is undertaken in the light of prevailing beliefs, norms, and rules of the collectivity of the focal country (Chow, Petrou, & Procopiou, 2022). I hypothesize that in addition to firm-specific impacts from the Covid-19, gender difference in government support to firms is associated with policy environment of a country. I next explore the possible influence of policy environment by

focusing on policy environment that most related to the gender difference, female-friendly policy environment.

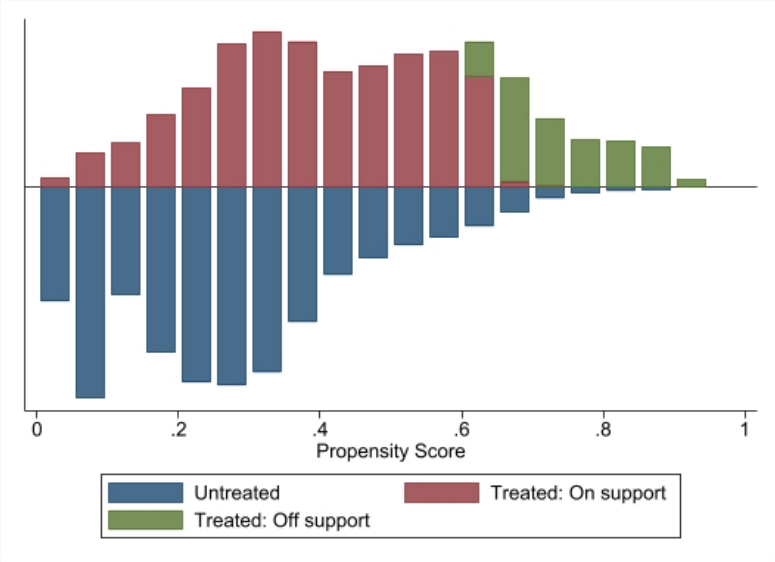
Data Futures Platform (DFP) monitors responses taken by governments worldwide, and they collect information about policies which have integrated a gender lens. If a policy measure targets on moderating burden that Covid-9 unproportionally add to women, the measure is counted as gender-sensitive, such as measures that designed to compensate unpaid care. Based on DFP, I construct two measures for national female-friendly policy environment, *FF policy dummy* and *FF policy fraction*. *FF policy dummy* indicates whether a country has any policy measure to compensate unpaid care[24]. It either takes value of 1 or 0. *FF policy fraction* is the fraction of policy measures to compensate unpaid care over the total number of Covid-19 policy measures. Such a measure of the female-friendly policy environment is designed to capture the political and cultural environment at country level that is friendly to female workers, rather than to directly support companies with a high proportion of female employees.

I perform PSM 1:1 matching to ensure that my treated group and controls group have very similar firm characteristics except for the gender fraction of women. This method could isolate effects from firm-specific performance affected by the Covid-19 (shown in Table 8) as I want to focus on national policy

[24] According to DFP, a policy to compensate unpaid care refers to measures aimed at addressing the rising demand for unpaid care by purposes of 1) Compensating parents or other family members that provide care to children, older persons or persons with disabilities with cash transfers ("cash-for-care"); 2) Providing paid leave for those with care responsibilities; 3) Strengthening services for populations with intense care needs (e.g. children, older persons, persons with disabilities). Sources at https://data.undp.org/gendertracker/.

environment only. I match paired firms using firm characteristics and performance measures including firm size, firm age, manager experience, business group, ownerships, exports, firms' changes in workers, in operation hours, in sales, sub-national region fixed effects, industry fixed effects, and year fixed effects. Figure 4 report the common support distribution of my PSM matching. I note that when I use the PSM matched sample to re-assess the specification I used for producing Table 6, I still find the gender difference in receive government support. This finding also proves that the difference couldn't solely explained by firm-specific features.

Figure 4. Common support distribution of PSM matching



Note: We perform 1:1 PSM matching using firm characteristics and performance measures including firm size, firm age, manager experience, business group, ownerships, exports, firms' changes in workers, in operation hours, in sales, sub-national region fixed effects, industry fixed effects, and year fixed effects.

I capture the influence of policy environment on gender difference in receiving government support using the following specification:

$$Y_i = \alpha_i + \beta 1\, FemaleFirm_i + \beta 2\, FemaleFirm_i * FF\ policy$$

$$+\beta 3\, Firm\ controls_i + \beta 4\, YearDummies + \beta 5\, IndustryDummies$$

$$+ \beta 6\, SubNatinalRegionDummies + \varepsilon_i$$

Table 9. Policy environment using PSM matched sample

This table estimates the effects of female-friendly policy environment to assist female firms. Dependant variables are total number of government assistance measures received by a firm, and an indicator of receiving any government assistance measure. The key explanatory variables are interaction terms between *Female firm* and measures of female-friendly policy environment: FF policy dummy and FF policy fraction. *FF policy dummy* indicates whether a country has any policy measure to compensate unpaid care, and *FF policy fraction* is the fraction of policy measures to compensate unpaid care over the total number of Covid-19 policy measures. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)
	No. govt. assist.		Govt. assist.	
FF policy dummy #	.218***		.079***	
Female firm	(5.717)		(4.286)	
FF policy fraction #		1.188***		.572***
Female firm		(3.725)		(3.478)
Female firm	-.048*	.038	-.018	.004
	(-1.766)	(1.129)	(-1.212)	(.292)
Female owned	.108**	.11**	.027*	.027*
	(2.469)	(2.495)	(1.778)	(1.81)
Female manager	-.093**	-.095**	-.034**	-.035**
	(-2.268)	(-2.324)	(-2.096)	(-2.174)
Constant	.914***	.913***	.485***	.485***
	(9.147)	(9.177)	(12.789)	(12.842)
Clusters	Sub-country regions			
Region FE	Yes			
Industry FE	Yes			
Year FE	Yes			
Firm controls	Yes			

Observations	16062	16062	16062	16062
R-squared	.229	.228	.234	.234
Adj R^2	.22	.219	.225	.225

t-values are in parentheses
**** p<.01, ** p<.05, * p<.1*

, where *Yi* is either total number of assistance measures received by firms, or an indicator of whether a firm received any public support measure or not. Key explanatory variable is the interaction between *Female firm* and *FF policy dummy/fraction.* The specification includes a set of firm controls, sub-national region dummies, industry dummies, and year fixed effects. Standard errors are clustered at sub-national region level.

In Table 9, coefficients of interaction term are all positive. In Column 3, the coefficient is 0.079. Because this result is based on PSM matched firms, the estimate means that keep firms' characteristics similar, female-dominated firms in countries with female friendly policy environment are 7.9% more likely of receiving public support than other firms. In countries without such policy environment, I don't observe the gender difference, because the coefficient of *Female firm* alone is not significant at 10%.

4.4.4 An IV approach: gender of COVID-19 task forces

FF policy is a proxy of female friendly policy environment. It might be a concern that *FF policy* is associated with the vulnerability of female-dominated firms during COVID-19 in each country. If female-friendly policy is more likely to be announced in countries that female workers are more adversely affected by the

Covid-19, my estimates in Table 9 might be biased. To address the endogeneity issue, we apply an instrumental approach. Ideally, predicted female-friendly policy environment affects firms' receiving of assistance only through policy design, and it is not correlated to female-dominated firms' worse situation.

The instrument I use is the fraction of female leadership in task forces in Covid-19 policy design. I contend that female leaders in COVID-19 task forces are associated with more female-friendly policy environment for two reasons. Literature have shown that more women's political representation is associated with increase in social policy spending (Bolzendahl & Brooks, 2007; Bolzendahl, 2009; Coscieme et al., 2020), indicating more welfare state efforts driven by female political leaders. Gender inequality, as one of major social issues, is also likely to invoke female leaders' efforts towards sustainable development. Secondly, female leaders may understand vulnerability of women labours better, thus make COVID-19 policy measures designed in more female-friendly ways.

At the first stage, *F.policy teams* is the fraction of policy teams that are dominated by female members over total number of Covid-19 policy teams. The higher value of this fraction, the more female-friendly this policy environment is likely to be. In Table 10 Column 1, I show that women leadership in COVID-19 task forces is a good predictor of female-friendly policy environment. At second stage, I drop firm in countries that without any Covid-19 task force from my sample. Results based on the predicted female-friendly policy environment is consistent with my findings in Table 9. I still observe that predicted female-friendly policy environment explain why female-dominated firms receive more

government support. Coefficients of the interaction between *Female-dominated firm* and *FF policy dummy/fraction* based on the IV approach are larger than coefficients in Table 9, which suggests that the endogeneity issue I proposed leads to under-estimated effects of the policy environment.

Finally, I explore the whether the female-friendly policy environment essentially improve female-dominated firms' situation under the COVID-19. I first look at firms' expectation for getting recovered. I construct two outcome

Table 10. Female-friendly policy environment - IV method

This table estimates the effects of female-friendly policy environment using an IV approach. Female-friendly policy environment, FF policy dummy and FF policy fraction, are predicted by the fraction of policy teams that are dominated by female members over total number of Covid-19 policy teams. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

A. Predicted FF policy dummy

	(1)	(2)	(3)	(4)	(5)	(6)
	First stage	Second stage				
		No. govt. assist.	Govt. assist.	Govt. wage	Govt. fiscal	Govt. defer pay
F.policy teams # Female firm	.569***					
	(4.03)					
FF policy dummy # Female firm		.454**	.208**	.192*	.123**	.096**
		(2.323)	(1.971)	(1.949)	(2.078)	(2.278)
Female firm	.687***	-.213	-.121	-.093	-.069	-.05
	(14.548)	(-1.499)	(-1.514)	(-1.231)	(-1.519)	(-1.536)
Constant	-.005	1.866***	.672***	.488***	.547***	.486***
	(-.246)	(17.194)	(16.53)	(13.02)	(17.434)	(17.253)
Observations	29430	29430	28068	28035	28035	28035
R-squared	.808	.239	.207	.185	.164	.128
Adj R^2	.807	.234	.203	.18	.159	.123

B. Predicted FF policy (%)

	First stage	Second stage				
		No. govt. assist.	Govt. assist.	Govt. wage	Govt. fiscal	Govt. defer pay
F.policy teams # Female firm	.068*** (6.086)					
FF policy fraction # Female firm		3.803*** (2.582)	1.703** (2.337)	1.57** (2.236)	1.002** (2.48)	.783** (2.429)
Female firm	.056*** (10.008)	-.112 (-1.229)	-.072 (-1.497)	-.046 (-.994)	-.04 (-1.451)	-.027 (-1.232)
Constant	0 (-.068)	1.938*** (16.941)	.704*** (16.819)	.518*** (12.854)	.566*** (17.761)	.501*** (17.4)
Observations	29430	29430	28068	28035	28035	28035
R-squared	.706	.238	.208	.184	.164	.128
Adj R^2	.705	.234	.204	.18	.159	.123

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

variables according to WES questions “What is the number of months firms expect will take to return to normal level of workforce/sales?”. I test the question using WES firms sample round 2 to 4 only, considering that policy environment unlikely make changes on firms at the very beginning of Covid-19. I apply the IV approach again. In Table 11, I show that in countries with predicted female-friendly policy environment, these firms expect 1.7 fewer month to get back to their normal workforce level, and 3.9 fewer months to normal sales. The finding suggests that supporting policy measures make female-dominated firms optimistically towards future, which is a signal of getting performance improved in the future.

Because I show that female-dominated firms experience more adverse impacts from the Covid-19 on their employment, operation hours, and sales, I check does policy environment reduce such gender gap. According to results in Table 12, I don’t observe improvement in female-dominated firms’ performance and operation. Coefficients of interaction terms are all positive though insignificant. This might be attributed to the relative short length of current observing window. At least, they are optimistic about recovery. I might observe substantial improvement later.

Table 11. Policy environment and firms' expectation on recovery - IV method

This table estimates the effects of female-friendly policy environment on firms' expectation on recovery from Covid-19. Dependant variables are the number of months that firms expect will take to return to normal level of workforce or sales. The key explanatory variables are interaction terms between Female firm and measures of female-friendly policy environment: FF policy dummy and FF policy fraction. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)
	Months to normal workforce		Months to normal sales	
FF policy dummy #	-1.701**		-3.905*	
Female firm	(-2.166)		(-1.748)	
FF policy fraction #		-14.547**		-32.645*
Female firm		(-2.17)		(-1.784)
Female firm	1.762**	1.403**	4.159**	3.278**
	(2.382)	(2.404)	(2.174)	(2.29)
Female owned	.122	.108	.698	.67
	(1.025)	(.9)	(1.241)	(1.195)
Female manager	.009	.044	.14	.22
	(.068)	(.343)	(.381)	(.574)
Constant	2.648***	2.361***	8.643***	7.981***
	(7.183)	(5.985)	(12.154)	(10.723)
Clusters	Sub-country regions			
Region FE	Yes			
Industry FE	Yes			
Year FE	Yes			
Firm controls	Yes			
Observations	14216	14216	13669	13669
R-squared	.071	.069	.033	.032
Adj R^2	.063	.062	.025	.024

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

Table 12. Policy environment and firms' operation & performance - IV method

This table estimates the effects of female-friendly policy environment on firms' operation and performance, specifically, fraction of changes in workers, operation hours and sales between pre- and post-Covid periods. The key explanatory variables are interaction terms between Female firm and measures of female-friendly policy environment: FF policy dummy and FF policy fraction. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ workers		Δ hours		Δ sales	
FF policy dummy #	.028		-.093		-.026	
Female firm	(.573)		(-.981)		(-.475)	
FF policy fraction #		.24		-.783		-.227
Female firm		(.579)		(-1.052)		(-.472)
Female firm	-.06	-.054*	.017	-.004	-.014	-.019
	(-1.38)	(-1.647)	(.213)	(-.067)	(-.311)	(-.544)
Female owned	-.01	-.01	-.052***	-.053***	-.024***	-.025***
	(-1.217)	(-1.197)	(-3.846)	(-3.884)	(-2.989)	(-2.996)
Female manager	.018	.017	.001	.003	-.001	0
	(1.532)	(1.453)	(.058)	(.213)	(-.095)	(-.033)
Constant	-.014	-.009	-.484***	-.499***	-.321***	-.326***
	(-.457)	(-.295)	(-10.395)	(-9.838)	(-13.043)	(-12.254)
Clusters			Sub-country regions			
Region FE			Yes			
Industry FE			Yes			
Year FE			Yes			
Firm controls			Yes			
Observations	16174	16174	16234	16234	15907	15907
R-squared	.049	.049	.131	.132	.155	.155
Adj R^2	.042	.042	.125	.126	.148	.148

t-values are in parentheses
*** p<.01, ** p<.05, * p<.1*

4.4.5 Robustness check

I try an alternative instrument variable to predict countries' female-friendly policies. The instrument I apply is the cultural practice of bride price in countries. Bride price is a transfer of money and/or other valuable assets that is made at marriage from the groom and/or his parents to the bride's parents. The payment of a bride price at the time of marriage is a custom that has deep historical roots, which is prevalent among patrilineal societies (Ashraf, Bau, Nunn, & Voena, 2020). I contend that in countries with such custom, societies are less likely to have culture and values that treat women and men as equal. Because policy-makers and policy-making process are very likely affected by such inequal culture, it is possible that the cultural practice of bride price is associated with less female-friendly policy environment.

Murdock's (1967) Ethnographic Atlas provides information on transfers made at marriage. Following Giuliano & Nunn (2018), I construct a country-level measure of bride price practice. *Bride price* is the fraction of ancestral population who have such custom. In Table 13, I show that at first stage, higher value of *Bride price* predicts less female-friendly policy environment. At second stage, predicted female-friendly policy environment is positively associated with more government assistance to female firms, which is consistent with my baseline results.

I show the sample distribution of the fraction of females among total workers in Figure 6. There are some firms are around that threshold of 50%. I

redo my main analysis using firm sample that excluding firms in the 45-55% range. My results are still robust (in Appendix Table 7).

Table 13. Alternative IV approach: gender norm of bride price

This table estimates the effects of female-friendly policy environment using an IV approach. Female-friendly policy environment, FF policy dummy and FF policy fraction, are predicted by the fraction of ancestral population who have custom of bride price. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

A. Predicted FF policy dummy

	(1)	(2)	(3)	(4)	(5)	(6)
	First stage	Second stage				
		No. govt. assist.	Govt. assist.	Govt. wage	Govt. fiscal	Govt. defer pay
Bride price # Female firm	-.628***					
	(-6.711)					
FF policy dummy # Female firm		.255***	.094***	.099***	.049*	.072***
		(3.572)	(2.871)	(3.123)	(1.935)	(2.611)
Female firm	.855***	-.066	-.035	-.022	-.014	-.032
	(20.95)	(-1.391)	(-1.542)	(-.936)	(-.739)	(-1.508)
Constant	-.006	1.871***	.674***	.49***	.548***	.486***
	(-.307)	(17.187)	(16.597)	(13.13)	(17.492)	(17.303)
Observations	29430	29430	28068	28035	28035	28035
R-squared	.85	.241	.211	.188	.166	.129
Adj R^2	.849	.237	.206	.183	.162	.124

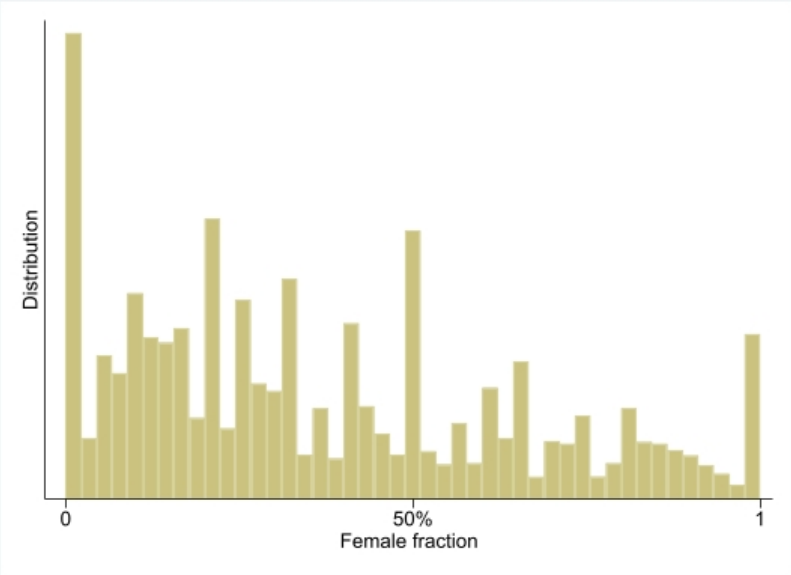
B. Predicted FF policy (%)

	First stage	Second stage				
		No. govt. assist.	Govt. assist.	Govt. wage	Govt. fiscal	Govt. defer pay
Bride price # Female firm	-.065*** (-9.298)					
FF policy fraction # Female firm		2.473*** (3.386)	.884*** (2.871)	.928*** (3.008)	.46* (1.893)	.676** (2.467)
Female firm	.074*** (12.731)	-.031 (-.778)	-.02 (-1.129)	-.006 (-.308)	-.006 (-.391)	-.021 (-1.149)
Constant	0 (-.13)	1.917*** (16.956)	.691*** (16.997)	.507*** (13.384)	.557*** (17.316)	.499*** (16.927)
Observations	29430	29430	28068	28035	28035	28035
R-squared	.747	.24	.211	.187	.166	.128
Adj R^2	.746	.236	.207	.183	.162	.123

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

Figure 6. Distribution of the fraction of female over total workers



Note: This figure shows distribution of the fraction of female over total workers in our firm sample.

Finally, I check that my results are robust when I use the fraction of female over total workers as the explanatory variable. Results are reported in Table 14. The results show that higher fraction of female workers, more adverse impacts on firms' performance, and more government supports to female firms.

Table 14. Fraction of female workers as independent variable

This table estimates the gender difference in impacts of Covid-19 on firms' operation and performance, and the gender difference in receiving government assistance after Covid-19. The key explanatory variable, *Female fraction* is the portion of female workers among total workers of a firm. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

A. Firms' operation & performance

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ workers		Δ hours		Δ sales	
Sector	Service	Manuf.	Service	Manuf.	Service	Manuf.
Female fraction	-.094***	-.052***	-.107***	-.06***	-.06***	-.057***
	(-5.742)	(-3.594)	(-5.386)	(-2.745)	(-4.031)	(-3.999)
Female owned	-.006	-.01	-.04***	-.055***	-.035***	-.02**
	(-.542)	(-1.201)	(-2.939)	(-4.074)	(-3.725)	(-2.591)
Female manager	.014	.007	.034**	-.001	-.001	-.005
	(1.104)	(.734)	(2.325)	(-.069)	(-.074)	(-.61)
Constant	-.074***	-.083***	-.335***	-.289***	-.264***	-.175***
	(-2.979)	(-3.517)	(-9.56)	(-7.954)	(-11.861)	(-7.535)
Observations	15301	16161	15759	16989	15257	16499
R-squared	.063	.053	.15	.142	.189	.197
Adj R^2	.052	.043	.14	.133	.179	.188

B. Government assistance

	(1) Num. govt.assist.	(2) Govt. assist.	(3) Govt. wage	(4) Govt. fiscal	(5) Govt. cash	(6) Govt. defer pay
Female fraction	.24***	.086***	.113***	.044***	.035***	.039***
	(6.185)	(5.119)	(7.422)	(4.224)	(2.791)	(3.765)
Female owned	.074**	.014	.016	.009	.021**	.016*
	(2.5)	(1.143)	(1.537)	(1.057)	(2.463)	(1.849)
Female manager	-.056*	-.007	-.008	-.01	-.007	-.015*
	(-1.839)	(-.545)	(-.661)	(-1.095)	(-.776)	(-1.748)
Constant	.736***	.391***	.289***	.148***	.149***	.122***
	(9.39)	(13.208)	(10.046)	(6.577)	(6.395)	(5.137)
Observations	34034	32590	32556	32556	32556	32556
R-squared	.247	.241	.216	.173	.207	.13
Adj R^2	.243	.236	.211	.168	.203	.125

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

4.5 Conclusion

COVID-19 is challenging ways of doing business in many aspects, and especially challenges firms that having female workers as their major workforce because women are disproportionally affected by lockdown and social distance measures, increasing unpaid domestic work, and unemployment. In this study, I analyse how female-dominant firms survive and perform during the pandemic, compared with male-dominant firms. Do female-dominated firms receive more government support, and why? Could policy responses targeted to support women's vulnerability reduce the gender gap? I combine a survey on global SMEs' performance post-COVID-19 with national policy responses to provide empirical evidence.

I discover a gender gap in firms' permanent closure and performance during COVID-19. Controlling for region, year and industry effects, a firm with over 50% women among production workers has a 2.1% higher probability to be closed permanently than others. Among survived firms in the service sector, women-dominated firms suffer a 6.2% larger decrease in workers, a 6.7% larger decrease in operation hours, and a 4.2% larger decrease in sales. The gendered impact on firms in manufacturing sector is slightly more moderate. The phenomenon calls for attentions from policy makers. However, only 38% countries have issued mitigation policies and measures aiming to address women's economic and social security threatened by the outbreak.

I further show that women-dominated firms mainly rely on government grants as source of finance compared to other ways of financing, and they indeed receive more government support than other firms. This suggests that governments' financial support plays an essential role for assisting female-dominated firms. I explore the factors that attribute to the gender difference in government support. Both firm-specific performance and national policy environment could explain the gendered phenomenon. I focus on influences of female-friendly policy environment. Women leadership in COVID-19 task forces could predict more female-friendly policy environment, and such policy environment could potentially moderate difficulties faced by female-dominated firms. I show that female-dominated firms feel more optimistic on recovery from the crisis.

My findings have policy implications. COVID-19 might disadvantage women's wellbeing in the long-run, but not many countries have designed policy

measures to COVID-19 to assist the more vulnerable female workers. Governments are advised to offer more support to woman and woman dominated firms. In addition to providing tax cut/lines of credit/subsidies, a feasible way could be encouraging more females to take part into policy design in combating COVID-19, considering female leaders in policy-making forces play important roles for wellbeing of women workers. I also note that as I don't observe a substantial improvement in firms' performance in countries with female-friendly policy environment, policymakers should be cautious when they allocate financial resources to vulnerable firms. It is important to evaluate whether the public support meaningful, or just a waste of resources. It's interesting and essential for researchers to assess the effectiveness of government assistance to vulnerable firms when more data is available.

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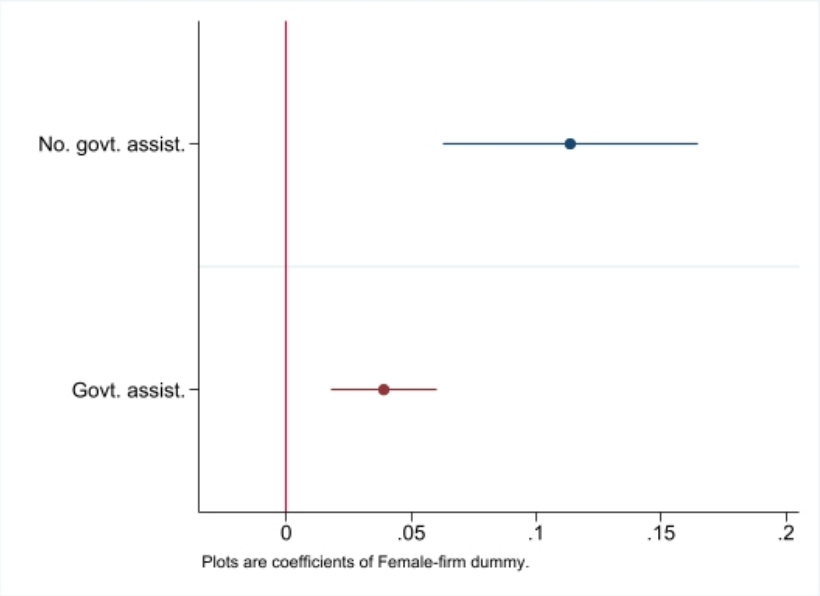
Appendix Figure 1. Gender difference in receiving government assistance measures using PSM matched sample



Note: This graph shows coefficients of *Female firm*. Dependant variables are total number of government assistance measures received by a firm, and an indicator of receiving any government assistance measure. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

Appendix Table 1. Distribution of sample by countries

Country name	Freq.	Percent	No. regions
Albania	326	1.04	3
Armenia	705	2.24	3
Azerbaijan	72	0.23	3
Belarus	506	1.61	4
Bosnia and Herzegovina	187	0.59	3
Bulgaria	1465	4.66	6
Chad	88	0.28	1
Croatia	981	3.12	2
Cyprus	491	1.56	1
Czech Republic	1215	3.86	4
El Salvador	724	2.30	4
Estonia	734	2.33	3
Georgia	1171	3.72	4
Greece	1589	5.05	4
Guatemala	334	1.06	2
Guinea	85	0.27	1
Honduras	284	0.90	2
Hungary	1900	6.04	7
Italy	1148	3.65	5
Jordan	1383	4.40	5
Kazakhstan	594	1.89	11
Latvia	418	1.33	3
Lithuania	504	1.60	3
Malta	557	1.77	1
Moldova	657	2.09	3
Mongolia	495	1.57	3
Montenegro	125	0.40	1
Morocco	1548	4.92	8
Mozambique	459	1.46	7
Nicaragua	338	1.07	4
Niger	45	0.14	2
North Macedonia	647	2.06	3
Poland	1985	6.31	7
Portugal	2263	7.19	6
Romania	1386	4.41	8
Serbia	266	0.85	3
Slovak Republic	931	2.96	4
Slovenia	679	2.16	2
Togo	44	0.14	2
Zambia	1256	3.99	4
Zimbabwe	878	2.79	4
Total	31463	100.00	156

Appendix Table 2. Variable definition

Variable	
Female firm	It is assigned to value 1 if a firm has more than 50% females among its total workers, and value 0 otherwise.
Female owned	It is assigned to value 1 if any firm's owner is female, and value 0 otherwise.
Female manager	It is assigned to value 1 if any firm's top manager is female, and value 0 otherwise.
Firm size	It classifies firms into 3 categories based on the number of firms' employees. Values from 1 to 3 represent small, medium, large firms, respectively.
Lg firm age	Years of operation in log form.
Lg manager exp.	Years of the top manager's experience working in the firm's sector in log form.
Business group	It is assigned to value 1 if a firm belongs to a large business group, and value 0 otherwise.
Govt. ownership	Proportion of government ownership in a firm
Concentrated own.	It is assigned to value 1 if more than 50% ownership of a firm belongs to one person, and value 0 otherwise.
Exporter	It is assigned to value 1 if a firm is an exporter, and value 0 otherwise.
Domestic firm	It is assigned to value 1 if more than 90% ownership a firm belongs to domestic investors, and value 0 otherwise.
Δ workers	It measures changes in firms' number of workers between pre- and post-Covid periods.
Δ hours	It measures changes in firms' operation hours/week between pre- and post-Covid periods.
Δ sales	It measures changes in firms' sales between pre- and post-Covid periods.
Closed	It is assigned to value 1 if a firm reported to close permanently after the pandemic, and value 0 otherwise.
No. govt. assist.	The number of government assistance measures received by a

	firm
Govt. assist.	It is assigned to value 1 if a firm received any government assistance measure, and value 0 otherwise.
Govt. cash	It is assigned to value 1 if a firm was assisted by receiving cash transfer from government, and value 0 otherwise.
Govt. wage	It is assigned to value 1 if a firm was assisted by receiving wage subsidies from government, and value 0 otherwise.
Govt. defer pay	It is assigned to value 1 if a firm was assisted by delaying payment to government, and value 0 otherwise.
Govt. fiscal	It is assigned to value 1 if a firm was assisted by receiving fiscal relief from government, and value 0 otherwise.
Months to normal workforce/sales	It is the number of months that firms expect will take to return to normal level of workforce or sales.
Rely on govt.	It is assigned to value 1 if a firm reported to use government grants as main source of finance, and 0 otherwise.
Rely on banks	It is assigned to value 1 if a firm reported to use bank loans as main source of finance, and 0 otherwise.
Rely on equity	It is assigned to value 1 if a firm reported to use equity as main source of finance, and 0 otherwise.

Appendix Table 3. Tabulation of female firm by sector

Service firm	Female firm		
	0	1	Pct.
0	11152	5010	30.99
1	9688	5613	36.68
Pct.	46.48	52.83	

Appendix Table 4. Type of gender-sensitive policy under Covid-19

Type	Freq.
Cash for care	38
Childcare services, including for essential workers	52
Family/parental/childcare leave	56
Long-term care for older persons and care for persons with disabilities	34
Paid sick leave	11
Pension	1
School feeding	1
Unemployment benefit	4

Appendix Table 5. Number of gender-sensitive policy by country

This table shows the number of gender-sensitive policies that support firms in each country[25].

Country	no	Country	no	Country	no
Canada	11	Austria	2	Andorra	1
Belgium	7	Trinidad and Tobago	2	Montserrat	1
Argentina	6	Peru	2	Albania	1
Netherlands	6	Cabo Verde	2	Malaysia	1
Australia	6	Estonia	2	Singapore	1
United States	6	Norway	2	Isle of Man	1
Spain	6	Greece	2	Bahrain	1
Slovenia	5	China	2	Guyana	1
Bulgaria	5	Jordan	2	Algeria	1
France	5	Iceland	2	Montenegro	1
South Africa	4	Cuba	2	Bahamas	1
Italy	4	Ireland	2	Cayman Islands	1
Czechia	4	Finland	2	Ukraine	1
Chile	4	Lithuania	2	San Marino	1
Germany	4	Switzerland	2	Romania	1
Latvia	4	Barbados	2	United Arab Emirates	1
Republic of Korea	4	Russian Federation	2	Armenia	1
United Kingdom	4	Bolivia	2	Brazil	1
Serbia	4	Poland	2	Bosnia and Herzegovina	1
Hungary	3	United States Virgin Islands	2	Kosovo	1
Portugal	3	Egypt	2	Tunisia	1
Uzbekistan	3	Seychelles	2	Saint Lucia	1
Costa Rica	3	Denmark	2	Mexico	1
India	3	Cyprus	2	Kuwait	1
Sweden	3	Croatia	1	Burundi	1
North Macedonia	3	Malta	1	Belarus	1
Mongolia	3	State of Palestine	1	Samoa	1
New Zealand	3	Saint Vincent and the Grenadines	1	New Caledonia	1
Luxembourg	3	Turkey	1	Angola	1
Cook Islands	3	Azerbaijan	1	Finland	1
Japan	3	Indonesia	1		
Slovakia	3	Kyrgyzstan	1		

[25] Source: Data Futures Platform, at https://data.undp.org/gendertracker/.

Appendix Table 6. Alternative clusters

This table checks robustness of our results in table 3 and 5 by using alternative standard error clusters. The key explanatory variable, *Female firm* is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. Firm controls include firm size, firm age, manager experience, business group, ownerships, exports. Standard errors are clustered at industry-level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

A. Impacts on firms' operation & performance

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ workers		Δ hours		Δ sales	
Sector	Service	Manuf.	Service	Manuf.	Service	Manuf.
Female firm	-.062***	-.034***	-.067**	-.031*	-.042*	-.025***
	(-9.586)	(-7.97)	(-2.761)	(-1.862)	(-2.506)	(-3.512)
Female owned	-.006	-.011	-.041***	-.056***	-.035**	-.021***
	(-1.503)	(-1.315)	(-4.431)	(-3.306)	(-3.649)	(-3.324)
Female manager	.014*	.006	.033***	-.003	0	-.007
	(2.503)	(1.079)	(4.5)	(-.136)	(-.056)	(-.816)
Constant	-.086***	-.09***	-.349***	-.299***	-.271***	-.186***
	(-7.623)	(-4.67)	(-5.762)	(-9.248)	(-6.333)	(-6.077)
Clusters	Industries					
Region FE	Yes					
Industry FE	Yes					
Year FE	Yes					
Firm control	Yes					
Observations	15301	16161	15759	16989	15257	16499
R-squared	.064	.054	.15	.142	.189	.196
Adj R^2	.054	.043	.14	.133	.18	.187

B. Measures of government assistance

	(1) No. govt.assist.	(2) Govt. assist.	(3) Govt. wage	(4) Govt. fiscal	(5) Govt. cash	(6) Govt. defer pay
Female firm	.112***	.035**	.053***	.021***	.018***	.018***
	(4.438)	(2.378)	(4.313)	(3.38)	(4.133)	(6.647)
Female owned	.079***	.016**	.019*	.009*	.021**	.017***
	(3.444)	(2.124)	(1.954)	(1.998)	(2.239)	(3.519)
Female manager	-.046**	-.002	-.003	-.008	-.005	-.013**
	(-2.766)	(-.209)	(-.228)	(-1.248)	(-.79)	(-2.212)
Constant	.781***	.41***	.311***	.157***	.156***	.13***
	(9.934)	(11.098)	(8.236)	(9.333)	(4.873)	(6.539)
Clusters	Industries					
Region FE	Yes					
Industry FE	Yes					
Year FE	Yes					
Firm control	Yes					
Observations	34034	32590	32556	32556	32556	32556
R-squared	.247	.24	.215	.173	.207	.13
Adj R^2	.242	.236	.21	.168	.203	.125

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

Appendix Table 7. Excluding firms in the 45-55% range

This table estimates the gender difference in impacts of Covid-19 on firms' operation and performance, and the gender difference in receiving government assistance after Covid-19. The key explanatory variable, *Female firm* is assigned to value 1 if a firms has more than 50% females among its total workers, and value 0 otherwise. Standard errors are clustered at the sub-national region level. All specifications include sub-national region fixed effects, industry fixed effects, and year fixed effects.

A. Firms' operation & performance

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ workers		Δ hours		Δ sales	
Sector	Service	Manuf.	Service	Manuf.	Service	Manuf.
Female firm	-.059***	-.028***	-.068***	-.035***	-.04***	-.031***
	(-6.041)	(-3.268)	(-5.59)	(-2.699)	(-4.416)	(-3.921)
Female owned	-.002	-.01	-.03**	-.054***	-.035***	-.018**
	(-.149)	(-1.142)	(-2.062)	(-3.878)	(-3.648)	(-2.289)
Female manager	.01	.005	.03**	-.01	.003	-.01
	(.851)	(.51)	(1.996)	(-.692)	(.286)	(-1.178)
Constant	-.089***	-.093***	-.358***	-.291***	-.278***	-.189***
	(-3.396)	(-4.166)	(-9.297)	(-7.699)	(-11.692)	(-7.954)
Observations	13851	14654	14259	15434	13804	14979
R-squared	.063	.055	.15	.144	.191	.194
Adj R^2	.051	.043	.139	.134	.181	.184

B. Government assistance

	(1) Num. govt.assist.	(2) Govt. assist.	(3) Govt. wage	(4) Govt. fiscal	(5) Govt. cash	(6) Govt. defer pay
Female firm	.121***	.039***	.06***	.023***	.017**	.019***
	(5.234)	(3.935)	(6.801)	(3.563)	(2.203)	(2.779)
Female owned	.08***	.018	.02*	.013	.018**	.017*
	(2.637)	(1.408)	(1.77)	(1.512)	(2.019)	(1.91)
Female manager	-.035	0	.002	-.009	-.001	-.013
	(-1.187)	(-.034)	(.185)	(-1.08)	(-.073)	(-1.607)
Constant	.774***	.399***	.305***	.156***	.158***	.131***
	(9.773)	(13.64)	(10.898)	(6.963)	(6.553)	(5.392)
Observations	30870	29548	29516	29516	29516	29516
R-squared	.243	.238	.211	.169	.207	.13
Adj R^2	.238	.233	.206	.164	.201	.125

t-values are in parentheses

**** p<.01, ** p<.05, * p<.1*

Chapter 5. Discussion and Conclusion

5.1 Key Findings and Strengths

This thesis intends to explain financial outcomes through exploring long-lasting culture and institutions, especially with a welling to provide implications to build firms' resilience to crises. By learning from history, chapter 2 suggests that currently under-developed regions may find it helpful to improve their design of law to protect private property rights and effectiveness of administrations, in order to provide firms with a more ideal institutional environment. Chapter 3 discovers uncertainty of historical weather as an unexpectedly source of environmental endowment to modern finance. It highlights the importance of social trust for firms to overcome unexpected economic shocks. Chapter 4 shows the vulnerability of female-dominated firms under COVID-19, and it tries to explain the observed gender differences by examining the roles of social norms. I argue that one of the most important meanings of History & Finance approach is to identify what mechanism matters to financial markets, then to guide governments' interventions and foster long-run growth.

Property rights institution is critical in the process of financial development. In Chapter 2, I argue that the formation of property rights institutions can be traced to Neolithic Transformation, when the hunter-gatherers became the first farmers, and the agricultural endowment positively influences financial activities today. My results show that early Neolithic transformation predicts better financial development and property rights institutions of global countries, less financial constraints among firms, and easier access to finance for households. My results based on ethnicity-level

records provide evidence on how Neolithic transformation influenced formation of property rights norms in pre-industrial period, which help to explain the persistence of development.

In Chapter 3, I examine the influences of the accumulation of social capital in history and corporate resilience to crises. The weather-induced social capital reduces financial obstacles for firms and enhances corporate resilience to crises through more accessible finances. Results show that pre-industrial weather uncertainty endowed firms with less financial obstacle, especially in areas with more incentives or advantages to cooperate historically to insure against weather risks. Long-run weather risks have positive impacts on firms' survival and recovery from crises of systemic banking crises and COVID-19 because that greater level of social capital can mitigate firms' financial constraints by enabling more lending from banks and supply chains. I verify the accumulation of social capital as an influencing channel by showing the links between temperature volatility and cooperation in 1500 CE, social trust nowadays.

In Chapter 4, I examine gender differences in the operation of global firms during the COVID-19 pandemic and the effectiveness of mitigation policies. I document that firms with more than 50% women of total workers are more likely to be permanently closed than others, and suffer more decrease in number of workers, operation hours, and sales. Women-dominated firms mainly rely on government grants as source of finance compared to other ways of financing, and they indeed are more likely to receive government support than other firms. Both firm-specific conditions and country-factors are driving

the difference. I find that female-friendly policy environment makes female-dominated firms more optimistic about a recovery from the crisis.

Three studies in this thesis have two common advantages regarding the data sources and methodologies. The first one is historical data sources. I use historical culture and values as important and persistent channels to explain current outcomes. The historical data sources are rarely exploited in finance studies but are deserves more attention. Second, I use GIS tools to connect firms' information with location-specific factors, which enable me to examine with-in country variation, thus avoid that my results are driven by unobservable country-level covariates.

For my analyses in Chapter 2, one strength is that property rights institutions are measured using comprehensive data sources, including countries' ability of laws protect private property rights, the degree to government enforces those laws, convenient and equal access to property rights, ethnic groups' rules or customs on private properties (land and movables), individuals' reported confidence in court system and norms related to property rights institutions, and firms' reported quality of court system as the measure. The positive relation between early transition and property rights institutions is robust among all dimensions of analyses. Results in Chapter 2 are robust to location-specific Neolithic transition measures.

Main advantage of the study in Chapter 3 is the use of historical weather risks to capture social capital. The exogenous nature of weather risks helps to mitigate reverse causality issue, as it is unlikely that historical weather can be affected by modern economic activities. Also, historical weather risks vary with

specific location of firms, thus the captured local social capital could better explain within-country spatial divergency in access to finance. I detect previous accumulation of social capital at ethnicity-level, given that national boarders have changed dramatically in the long history, and that norms usually transit along cultural groups. To address the concern of omitting national factors which are correlated with both weather and financial development, I include country fixed effects into specifications, thus all time-invariant country-level features are captured.

In Chapter 4, I use the tradition of bride price as an instrument to predict the possibility of female-friendly policy environment during the Covid-19 crisis, which helps to solve endogeneity problem. The firm data set I used in this study provides comprehensive information about firms' performance, perceptions, and sources of finance after outbreak of the pandemic. My analysis timely documents the vulnerability of firms with females as major labour force, and provides implications for policy-makers.

5.2 Contributions

Chapter 1 contributes to two streams of literature. Firstly, it adds to finance literature by identifying the timing of Neolithic transition as a long-lasting determinant of financial development, and especially emphasizing the importance of property rights institutions. The study explores effects of agricultural lifeways on emergency of property rights institutions, and how persistent institutions shape modern finance. It speaks to literature on the relation between property rights and finance. Secondly, the work relates to studies on agricultural origins of economic behaviour, including differences in

beliefs and values regarding gender role (Alesina, Giuliano, and Nunn, 2013), the prevalence of long-term orientation and its associated preference for technological adoption, education, saving and smoking (Galor and Özak, 2016), individual outcomes of education and wealth (Michalopoulos, Putterman, and Weil, 2019), civil conflicts (Iyigun, Nunn, and Qian, 2017), modern agglomeration (Dickens and Lagerlöf, 2021) etc. D'Arcy, Nistotskaya, and Olsson (2021) document transition to agricultural production and property rights to land have been a key institution for economic development. This study contributes to this stream of literature by firstly linking early farming practices to early property rights institutions which could explain divergency of financial development today.

The study in Chapter 3 speaks to literature on resilience of firms against crises, i.e. banking crises (Levine, Lin, & Xie, 2018), climate risk (Huang, Kerstein, & Wang, 2018), epidemics, and other natural disasters (Salvato, Sargiacomo, Amore, & Minichilli, 2020). Firms' characteristics that deemed to be essential to corporate resilience include such as corporate culture (Li, Liu, Mai, & Zhang, 2021), access to finance, CSR practices (Lins, Servaes, & Tamayo, 2017), ownership (Ding, Levine, Lin, & Xie, 2021). Secondly, it builds on literature that highlight the importance of social capitals for financial markets (Guiso, Sapienza, and Zingales, 2004; Guiso, Sapienza, and Zingales, 2008; D'Acunto et al., 2018; Levine, Lin, and Xie, 2018; Levine et al., 2020). This study is the first to explore the role of pre-industrial climate as environmental endowment of social capital accumulation, which thereafter facilitate firms with better access to finance, especially important for firms suffering from negative

shocks. This study also contributes to weather-economy literature (see Dell et al., 2012 for a comprehensive review). My results imply that climate uncertainty might foster long-run growth if social capitals accumulated through human's mitigation behaviours.

My study in Chapter 4 links to the literature on the policy-based remedies of gender inequality (Pascall & Lewis, 2004; Zachorowska-Mazurkiewicz, 2009; Piscopo, 2015) and of Covid-19 (Clemens & Veuger, 2021; Kong & Prinz, 2020; Belghitar, et al., 2021; Brown, Martinsson & Thomann, 2021; Mitman & Rabinovich, 2021; Calabrese, Cowling, & Liu, 2022) by assessing the determinants and effectiveness of disproportionately more public support that was delivered to female-dominated firms, which are more vulnerable under the Covid-19. My results support Corporate Governance Institutions (CGIs) theory by uncovering that difference of policy environment across countries could explain why female-dominated firms receive more government assistance. Secondly, this study enriches the ongoing discourse on the economic effects of the Covid-19 pandemic on organisation in management research (Budhwar and Cumming, 2020; Belitski et al., 2021; Mertzanis, 2021; Ataullah, Le, & Wood, 2022; Ghobadian et al, 2022) by focusing on female-dominated firms, which are especially vulnerable during the pandemic.

5.3 Criticisms of the Persistence Literature and Future Research

The History & Finance literature is in line with a group of scholarly papers on "persistence" (Cioni, Federico and Vasta, 2020), which note that the shadows of the past, related to gender attitudes, trust, investment in human capital, etc., seem to loom large in the modern era. While persistence studies examine the

historical roots of different economic outcomes in the present or recent past, the history and finance literature focuses particularly on outcomes in financial markets. However, there are persistent concerns about the generalizability and plausibility of persistence theory (Voth, 2021), which are also relevant to my research and should be carefully considered.

One of the main challenges for the persistence literature is that some of the hypothesised links with current outcomes may be mediated by others. Because the explanatory variable can be multifaceted and touch on many aspects of the past, there is a wide range of variables that can appear on the left-hand side of an econometric equation. For example, it is impossible to take into account all the massive and rapid changes that have taken place in recent decades when applying persistence theory. Some extreme cases are difficult to fit into the persistence framework. China has a long history of development and used to be far ahead of most of the world for a considerable period of time, but after the industrial revolution it lagged behind many Western countries and did not establish its first modern bank until 1897 (Lin et al., 2021). China has then seen a dramatic improvement in many aspects of national strength over the past 40 years. Many changes can happen in the blink of an eye in history, which seems quite difficult to capture and identify individually. Other countries with long histories, such as Iraq and Turkey, are now less developed than younger countries such as Britain and Denmark. This suggests that historical development doesn't necessarily guarantee development today. Such a puzzle, called reversal, is still debated in economic studies (Acemoglu, Johnson and

Robinson, 2002; Olsson and Paik, 2020), which to some extent contradicts the persistence argument.

It is not surprising that economic development can reverse when some of the things that are fundamental to development (such as culture and institutions) have changed for some reason. Once key channels that enable persistence change, persistence can be broken. To make the persistence literature more compatible with the reversal phenomenon, one should account for even small shocks to transmission as much as possible, or use an excellent experimental design to rule out alternative interpretations. Voth (2021) notes that almost every persistence study faces the challenge of disproving economic geography as an alternative interpretation. Basic geographic features such as access to the coast and terrain suitable for housing an expanding population are stable patterns that could always have direct effects on economic performance (Voth, 2021). It is quite difficult to distinguish cultural or institutional persistence from stable economic geography.

My chapters 2 and 3 deal with the issue discussed above. It's quite difficult to establish a causal link between factors far in the past and modern outcomes. The factors I focus on are only small pieces of a puzzle in a long history. Even though I have controlled for a large set of important covariates, used multiple measures & samples, applied IV method and country fixed effects to partially address this endogeneity issue, it is impossible to rule out all alternative influencing channels. Ideally, it would be better to test the influences of institutions and culture on modern finance in a difference-in-difference setting (DiD) or a regression discontinuity design (RDD). Because the factors which I

focus on are mainly historical features, which makes difficult to find historical panel data to conduct DiD analysis, however, spatial RDD would be a possible method to apply in my future studies. I will also put more effort into providing insights by presenting evidence based on first-hand historical data.

I note that the historical factors examined in my thesis are only one of many possible determinants of current financial development. The identification of these factors depends on geographical information on both historical changes and modern firms. It should be noted that regions that have similar geographical conditions to each other can still be very different in their current business patterns. For example, both within Scotland and probably sharing the same weather conditions and timing of agricultural transition, Glasgow was one of the most important cities in the UK for manufacturing such as shipbuilding, engineering and construction, while Edinburgh's economy is mainly based on financial services, scientific research, higher education and tourism. The Scottish banking system has also developed differently from the English banking system, which is centred on the City of London. Free banking in Scotland, which benefited greatly from the support of local merchants through specific factors such as interlocking shareholdings and the general factor of social cohesion, was more stable in the face of shocks than central banking in England (Dow and Smithin, 1992). Similarly, regions in China tend to have different business patterns. Beijing, the capital, has a strong presence of state-owned enterprises and government-related industries. The city focuses on sectors such as government services, education, research and development. Meanwhile, Shanghai and Guangzhou, as major commercial centres,

emphasise innovation, technology and high-value industries such as finance, manufacturing and information technology. These differences may be due to factors such as geography or policy. Although I've looked at within-country variation, the variables I've examined cannot explain institutional differences caused by other significant events, such as the industrial revolution, or regional-specific contexts that don't apply to universal firms.

In addition to property rights institutions and culture of trust, there are other deep-rooted factors explain patterns or behaviours in financial markets, such as the development of technology (Lin et al., 2021), culture and norms that tight to modern entrepreneurship or banking systems (Chen, Ma, and Sinclair, 2022), values related to equal access to finance (Alesina et al., 2013), etc. I will keep my exploration in the History & Finance field, meanwhile try my best to address the common challenges in the persistence studies as discussed in this section.

Finally, I note that the persistence literature is challenged by its implications for economic policy. One might assume that the persistence literature implies that any further efforts to improve the poor situation of a region could do little to change the disadvantages that have been established in history. Thus, policy makers would find persistence theory less helpful in advising on economic development. In response to this doubt, I would argue that one of the main purposes of the persistence literature and the history and finance approach is to identify the mechanism that matters for modern economic outcomes, which may be legal institutions or culture, and then to use it to guide government intervention and promote long-term growth. My view is in line with

Voth (2021) that “a deeper understanding of the determinants of riches and poverty can guide policy interventions towards more realistic ‘levers of riches’.”

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