# Horsemen of the Apocalypse: the Mongol Empire and the Great Divergence*

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September 23, 2024

**Abstract**

Why did the Industrial Revolution take place in Europe, but did not in India or China? This paper uses a novel dataset and builds a general model to study the origin of economic transformations of the Late Middle Ages that ultimately led to the Industrial Revolution and the Great Divergence. Through modern econometric techniques, I exploit the Mongol Invasions of the 13th century to account for the role of violence, commerce, and technology in the structural transformations of Eurasia from the Middle Ages into the Modern Era. I show theoretically and verify empirically how the large-scale violence and new trade opportunities brought by the Mongol Empire allowed Western Europe to catch up and surpass the levels of income and technical capacity of the great Asian civilizations. Furthermore, I found that the impact of the Mongol Conquests persisted and deepened at least into the 19th century. The Mongol Invasions of the 13th century can be regarded as a fundamental cause of the Rise of Europe and the Decline of Asia. Moreover, the rise and fall of the Mongol Empire is a key event in understanding the transition from a Malthusian world into a world of sustained economic growth and inter-regional inequality.

**Keywords**: Mongol Empire, Great Divergence, Industrial Revolution, Economic Growth, Trade, Violence, Technology transfer

**JEL classification**: C02, N3, N4, N7, O14, O33, O47.

*I am specially thankful with my advisors Juan Sebastian Galán and Hernando Zuleta for their guidance. I thank my thesis juries Leopoldo Fergusson and Felipe Valencia for their insightful comments. I want to thank my friends and professors for their support and comments along the journey of this research: Jose Betancourt, Andrés Dávila, Manuel Fernández, Alan Gómez, Sergio González, Shuhei Kitamura, Diana León, María del Pilar López-Uribe, Omar Licandro, Nicolás Losada, Douglas Newball, Santiago Pérez, Pablo Querubín, James Robinson, Rafael Santos, Santiago Torres, Alejandra Torres, Jorge Tovar, and participants of LACEA-LAMES 2022, RIDGE 2022, IX UDEP Workshop, IX CEPR Economic History Seminar, Semillero Macro, ADES, and CEDE jr Seminar. All remaining errors are our own.

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"*Now, by virtue of the strength of Eternal Heaven, my might and power have been increased by Heaven and Earth, and the whole nation is unified under my sole rule.*" - Genghis Khan.[1]

## 1 Introduction

# Part I

# Introduction

After 300.000 years of the emergence of anatomically modern humans; 12.000 years after the Neolithic Revolution; and over 5.000 years since the first civilizations; only up until the past two centuries, the world economy has experienced sustained growth in income per capita and technological development. Less than 4% of the history of civilization, since the Industrial Revolution, has humanity escaped the Malthusian Trap and achieved the means to create stable and increasing material wealth. Simultaneously, the past two centuries have witnessed both income and technical capacity has widely diverged between nations and societies. The timing and causes of this Great Divergence, are still matters of debate, and so are the causes of the transition from a stagnant world economy, into thriving and continuously growing economies. Studies on the Great Divergence seek to explain the origins of the wealth of nations and those of the differences of income and development across societies.

This paper explores the role of trade and violence in the transition from the Malthusian regime into sustained economic growth, through the transformation of economic structures. I document that the structural transformations in Eurasian economies that led to the Industrial Revolution in Western Europe, and to the Great Divergence were triggered by the long-scale demographic and technological changes brought by the rise and expansion of the Mongol Empire during the 13th century. Here, I show theoretically and verify empirically how the long-scale violence and new trade opportunities brought by the Mongol Empire led to both the Rise of Europe and the Decline of Asia, which would ultimately lead to the Great Divergence, and the liberation from the Malthusian trap.

The Great Divergence literature recognizes the Industrial Revolution in the 19th century as the moment in which income divergence between the richest economies and the rest of the world grew to orders of magnitude unparalleled in the history of human civilization (Acemoglu, Johnson, &

[1]See Onon (2001, p.210).

Robinson, 2008; Broadberry & Gupta, 2006; Pomeranz, 2000). However, there is little consensus on how rich or how poor did nations reach the 19th century, and to why the Industrial Revolution occurred in Western Europe and did not in China or India. Along the Middle Ages, the Great Asian Civilizations of China, India ,and the Islamic World lead the world in terms of income, technical capacity, and scientific production (Maddison, 2007; Mokyr, 1990; Pomeranz, 2000; Voigtländer & Voth, 2013). Asian economies were more dynamic than those in Europe, and by the early 1000s, the world economic center was the Indian Ocean (Gunder Frank, 1998). Nevertheless, between the 16th and 18th centuries, the economic center of the world gravitated towards the North Atlantic(Acemoglu et al., 2008; Mokyr, 1990; Voigtländer & Voth, 2013); and by the early 19th century, Western European powers had already higher income levels and better productive and military technology than the most advanced regions in Asia (Allen, 2009; Broadberry & Gupta, 2006; Maddison, 2007).

The timing of the Great Divergence is in itself a matter of debate. While it is clear that the Industrial Revolution deepened any existing income gaps, there is little consensus about when those gaps appeared. Moreover, it is still a matter of debate when did Western Europe catch up with China and India (Parthasarathi & Pomeranz, 2019). While some studies set the beginning of the Divergence process as late as the early 19th century (Allen, 2009; Brenner & Isett, 2002), others set it around the Rise of Europe due to the Conquest of the Americas, expansion of trade in the Atlantic (Acemoglu, Johnson, & Robinson, 2001b; Acemoglu et al., 2008) and European incursions into the East (Broadberry & Gupta, 2006), or even as early as the Black Plague in the 14th century (Ashraf & Galor, 2011; Voigtländer & Voth, 2009, 2013).

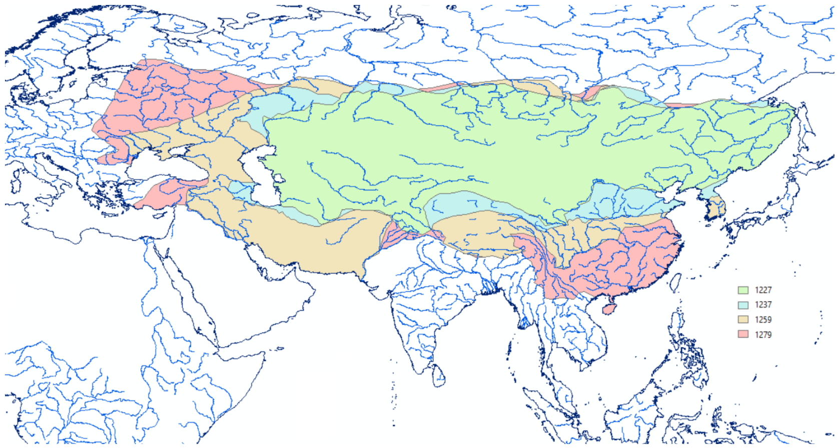
Along the mentioned periods, the Renaissance, the Scientific Revolution, and the Enlightenment took place in Europe. An important spoor of scientific discoveries, major inventions, and engineering advances took place since the 14th century in Europe (Mokyr, 1990), beginning with the mobile-type printing in the 15th century, and deriving into the steam and electromagnetic induction engines in the 18th and 19th centuries. In contrast, Asian technological advances were relatively stagnant since the 17th century, when this region had participated and contributed vastly to the progress of knowledge during the Middle Ages (Parthasarathi, 2011). The technological advantage allowed Europe to grow faster into the Capitalist system and industrialization and gave a fundamental advantage in warfare against the rest of the world (Parthasarathi & Pomeranz, 2019), 2019). It can be argued, that European colonialism prevented several regions of the world from industrializing and developing at the pace of their colonizer (Acemoglu, Johnson, & Robinson, 2001a; Nunn, 2009). While at the same time, European colonialism even reversed the fortunes of the colonies: some of the poorest colonies in the 1500s, became wealthier by the 1800s, than those that were wealthier in the 1500s. Thus, the Great Divergence is not just about why some regions grew and industrialized quickly, but also about why some did not or could not.

The state of this debate can be summarized as follows: a catch-up process of Europe with Asia since the Black Plague; European advantage in technical progress and its military capacity since the 16th century allowed it to benefit from commerce, conquest, and extraction while preventing other regions to flourish; with the development gap with Asia closed or even reversed, the fundamental innovations that lead to Capitalism and Industrialization also opened a gap of income in favor of Western Europe and deepened the preexisting economic and technological advantages of this region against the rest of the world.

However, some matters arise. How did Europe catch up with Asia? Did Asian economies stagnate or decline? Or, was this catch-up mainly the Rise of Europe? This are prevailing points of debate around the Great Divergence and I argue part of it is due to the omission of Economic History literature to a major cause of the Great Divergence, the event that triggered some of the dynamics that lead to the Decline of Asia and the Rise of Europe: the rise and fall of the Mongol Empire in the 13th century.

The Mongol Empire is the largest contiguous empire in human history. It was also a short-lived empire, it rose in 1206 CE, reached its peak of extension in 1279 CE, split in 1294 CE, and its last remnants dissolved by 1368 CE. At its maximum extent, it controlled more than 24 million sq. km. from the Korean Peninsula in East Asia to the Danube Valley in Eastern Europe, and from the Baltic Sea in Northern Europe to the Indus Valley in South Asia (see figure 1) (De Hartog, 2004). Second only to World War II, the Mongol Devastation is regarded as one of the deadliest events of human history (White, 2011). On the other hand, the Empire revitalized the Silk Road, which was rendered nearly irrelevant since the Fall of Rome (Di Cosmo, 2010), and thus reactivated large scale commerce between the East and the West, in what is know as the *Pax Mongolica*. As a consequence, the trade flows in Eurasia allowed fundamental innovations such as the mobile-type printing and gunpowder to reach Europe from Asia (Andrade, 2016; Christensen, 2014), which would push Europe into the Renaissance and the Era of Exploration after the 14th century Black Plague (that was itself introduced by the Mongols in 1346, during the Siege of Kaffa) (McLynn, 2015).

Figure 1: Expansion timeline of the Mongol Empire 1206-1294




**Note:** Expansion of the Mongol Empire. 1227: by the death of Genghis Khan; 1237: the beginning of the incursions in Europe; 1259: by the death of Möngke Khan; 1279: peak of the Empire.
**Data:** Anderson et al. (2009); Che and Lan (2021); Ciociltan (2012); Craughwell (2008); Kennedy (2002); May (2018); McLynn (2015); Onon (2001); Pederson et al. (2014)

It was through the destruction of cities, the mass slaughter of population, the sabotage of the means of production, the raids of cities' wealth and the unintended transfer of technology and knowledge from the great Asian civilizations into Europe, that the Mongol Empire may have paused economic growth in Asia, and reduced the levels of development achieved there. Furthermore, it may have allowed Western Europe to catch up and overcome the levels of Asian economic development, to match up and even surpass the Asian economic growth rates. Is in this sense that the emergence, expansion and decline of the Mongol Empire may be on its own a historical event with the relevance of the Industrial Revolution, the Neolithic Revolution, the Conquest of the Americas, the Colonization of Africa or the World Wars. However, there is not yet an empirical study with modern econometric techniques on the matter.

In this paper, I present theory and evidence that points towards the Mongol Invasions being a cause of the Divergence. The unique nature of this empire, and the fast and profound changes it brought with it over the whole Eurasian region radically shifted the world economic and political centers from Asia into Western Europe. I argue, the Mongol Invasions can be treated as a natural experiment to test the effects of a bundle of treatments in the long-run development of Eurasia. Specifically, this paper is an attempt to answer three broad questions: did the Mongol Empire cause a development and growth lag on the invaded or conquered territories? Did the direct effects of the Mongol Invasions persist long enough in time, as to regard them as a cause of the Great Divergence? If so, through which mechanisms? I tackle this question both theoretically and empirically.

I hypothesise the Mongols triggered structural transformation across Eurasia that would favour the transit of Western Europe towards Capitalism, while leading Asian economies into stagnation. The combination of technological transfer through trade, and population and labour decline due to the Mongol Invasions and the war effort, pressed for a new social division of labour. In Western Europe, this changes increased wealth, and favoured urbanization. While in Asia, the Mongol Conquests lead to a decline of cities, and gains from trade and lower population were outmatched by the devastation caused.

To test for this hypothesis, I first model a Medieval economy subject to Malthusian pressures, class conflict, war, commerce and seasonality. This captures some of the most relevant characteristics of the 13th century economy, and allows me to analyse shocks of the nature of the Mongol Invasions. I introduce the use of biological modelling for population dynamics, and econo-physics and graph theory elements in commerce, spatial dynamics and seasonality. The model derives in empirically testable predictions around the effects of the expansion of the Empire. In the spirit of the unifying theory of growth, the model predicts how the Mongol shock triggered the transition from Feudalism into Capitalism.

For the empirical section, I construct a novel data set comprising population, urbanization, land use, trade, and geographical variables for more than 1300 Eurasian settlements over the course of 18 centuries, since the Rise of the Roman Empire, into the Industrial Revolution. Likewise, I constructed a trade network for the Middle Ages, based upon previous literature and the location of the Eurasian settlements.

As mentioned earlier, the Mongol Invasions brought with it a bundle of treatments, mainly (but, likely among others): a violence shock, a commerce shock, a land use shock and a technological-productivity shock. Thus, the counterfactual to the Mongol Invasions of Eurasian settlements must be understood as the absence of the excess of violent deaths, destruction of cities and means of production, and delayed reactivation of the Silk Road trade, with its effect on technology transfer and flow of ideas, among the conquered and invaded areas. It is worth mentioning, that the measure of economic development and growth I will be using is the population density and changes in population density, respectively, as these variables are highly correlated with the level and evolution of the total factor productivity (TFP) in a Malthusian world (Ashraf & Galor, 2011; Galor & Weil, 2000).

To tackle the three guiding questions of this research I execute several identification strategies. First, through a Differences in Differences (DID) model, I show that there is a relevant drop in the levels population density of the conquered territories relative to those unconquered. Moreover, I find this gap persists and accentuates in the centuries to follow, and remains open up until at least the beginning of the 19th century, when the Malthusian measure of development is rendered invalid. This implies that the Mongols created a development gap between their conquered territories (mostly China, the Islamic World and Eastern Europe), and those unconquered, that persisted up until the Industrial Revolution. Afterwards, I test a local effect in the economic growth rates in the Western frontier of the Empire using a spatial Regression Discontinuity Design (RDD). I show that the conquered territories had their economic growth rates per century vastly contracted, relative to those unconquered. These two results show that the Mongol Invasions not only relatively contracted the economic activity of the conquered territories, also affected their ability to recover. Thus, any existing development gap in favour of the conquered territories would be shortened or reversed, making it easier for the unconquered to catch up on or expand said development gap.

Because the Mongol Devastation is a bundle of treatments, the challenge here is to identify separately the effect of each relevant aspect in the long-run growth and development of Eurasia. For this, I attempt different strategies depending on the aspect I am trying to capture. For the effect of the Mongol administration and institutions, I track the western-most battles involving the mongols before 1294 CE and compare conquered, invaded but unconquered and neither invaded nor conquered territories. All the effect of the Mongol institutions and administration would be captured by the conquered group, because the invaded but unconquered group would clean some of the effects of violence and commerce. For the commerce mechanism, I create a graph and a transition matrix in between settlements, that captures connectedness and centrality of each settlement. I test how these measures of commerce exposure evolve with the Mongol administration of the Silk Road. Finally, I document correlations between the Mongol Conquest and structural change along Eurasia, by showing the evolution of the factor shares of labour, land, and "capital".

All my results point towards the Mongol Invasions as a relevant cause of the shift in paths of growth and development between Western Europe and Asia. The Mongols set the stage for the transition from Feudalism to Capitalism, the dynamics that led to the Industrial Revolution in Europe, and ultimately to the Great Divergence.

This paper contributes to Economic literature in several dimensions. First, it tackles simultaneously the Rise of Europe and the Decline of Asia. Second, it reconciles the structural and conjunctural approaches to the Great Divergence debate, as I argue that the rise and fall of Mongol Empire was a fortuitous event which could only cause long-run scars due to its interaction with the structural characteristics of the Eurasian societies, and its very effect over the structures themselves. Third, it contributes to the Unifying Theory of Growth and to Cliodynamics, as I am able to explain theoretically and test empirically the transit out from the Malthusian regime into a world of sustained economic growth. Last but not least, I propose ways to measure several dimensions of economic growth and development many centuries into the past, and the data sets to make it.

This is, to the best of my knowledge, the first exercise of its kind to test for the long run effects of the Mongol Invasions over Eurasia.

Part I continues as follows. In *Historical Backround*, I synthesize the History of the Mongol Empire, the European Industrialization and the Great Divergence, highlighting events that illustrate why the Mongol Conquests could have an impact in the long run. In *related literature*, I discuss explanations to observed modern differences in development and the reasons why the Industrial Revolution took place in Europe.

The rest of the paper is segmented in 5 parts. In *Part II* I construct an economic growth model to derive testable hypothesis around the mechanisms for the empirical results. *Part III* introduces a novel dataset that allows to test my hypothesis and the model predictions empirically. In *Part IV*, I identify the causal effect of the Mongol Invasions in Eurasian growth rates and its persistence. In Parts *V*, I isolate the violence mechanism, the commerce and technology mechanism, and the structural change mechanism. In *Part VI*, I discuss the implications of my results, limitations and further extensions. I run a series of robustness checks, present the proof to propositions, lemmas and theorems, and explain the dataset build up in detail in the *Appendix*.

## 2 Historical Background

It all begun on present day Northern China, near the Gobi Desert around the first decade of the 13th century. After Temujin was crowned Khan of the Great Mongol State in 1206, having defeated rival tribes and clans, and uniting the remaining ones under his command; when he assumed the title of Genghis Khan, the Universal Leader (De Hartog, 2004; Nicolle, 1990). Afterwards, impulsed by favorable climate change of increased wetness on the Gobi Dessert provoking an expansion of fertile lands and grasslands on the Mongol Steppe, able to hold a larger population of warriors, horses and cattle, Genghis Khan increased and mobilized his armies into conquest (Che & Lan, 2021; Di Cosmo, 2020; Pederson et al., 2014).

Between 1207 and 1210, the Chinese Region of Western Xia was invaded and successfully annexed to the Mongol Rule, although it wasn't an easy conquest, due to well defended cities. The rest of Xia remained as a tributary state and was constantly invaded until Genghis Khan's death, when it was brutally annexed definitely and under direct control of the Empire in 1227. The resistance of Xia to Mongol rule provoked that once Yinchuan, the capital, fell, population was massacred (De Hartog, 2004; Nicolle, 1990). Still in the time of Genghis Khan, in 1215, the Mongols invaded the Jin Dynasty territory, successfully capturing Zhongdu (today, Beijin), and annexing half of Jin's Empire to the Mongol Empire. The Conquest was completed by Ögedei Khan in 1234 (De Hartog, 2004; Nicolle, 1990). Meanwhile, Genghis Khan's oldest son unified and annexed the Turkic and Mongol peoples and Siberian Tartars in Central Asia to the Empire.

From the conquests in China perhaps the most valuable aspect for the Mongols was the annexation of the Han Dynasty, which was mainly due to treason and defection from prominent Han generals who pledge allegiance to the Great Khan. From the Hans, Genghis Khan's army received siege machinery, better war technology, which proved decisive on the invasions to come (Franke, 1966; Meri & Bacharach, 2006). Today, there is evidence the Mongols became then the first gunpowder empire (Haw, 2013).

Chinese technology was deployed on the battle field and sieges on Khwaresmia's (Persia and Central Asia) invasion, between 1219 and 1221. This marked one of the most deadly events of the Mongol Conquests, only over-passed by the Chinese dead toll. The capital, Samarkand was taken in less than a week. The Mongol terror tactics heavily rested in destroying cities which posed long resistance. With Samarkand, they seemed to have functioned (McLynn, 2015) as the city offered little Resistance. One of the main cities on the Syr Darya river, Bukhara was poorly fortified and was easily captured, although with resistance. Defenders were killed, but craftsmen and artisans were pardoned and enslaved and sent back to Mongolia. This was not the case for Urgench, which proved to be the hardest conquest in Khwaresmia. When the city fell, more than a million civilians were massacred (De Hartog, 2004; McLynn, 2015). Later, in 1221 during the siege of Nishapour, Genghis Khan's son-in-law was killed. In reprisal, every living thing was set to die when the city fell, skull pyramids where erected with human, cat, horse, dog and cattle skulls; only few hundred craftsmen where pardoned (McLynn, 2015). Herat, in modern day Afghanistan, surrendered after the event without resistance, and was pardoned (De Hartog, 2004). Here it successfully ended the conquest of Central Asia and Persia. Genghis Khan died in 1227 CE.

After Khwarezmids were defeated, the Mongols marched over Eastern Europe in 1237, under the command of Batu Khan, by order of the new ruler, Ögedei Khan, after expanding through modern-day Russia on the remaining 1220s. Bulgaria, the Caucasus, the Caspian Sea, and the Kievan Rus were all sacked and conquered by 1240 (Haw, 2013). Kiev, one of the most advanced cities in Eastern Europe was brought down to ashes (Anderson et al., 2009).

In the 1250s, the expansion over China and the Middle East began once again, under the rule of the new Khan, Möngke Khan. Under his rule, the Yuan Dynasty was imposed over China, after defeating and conquering the Song Dynasty. By 1256, the Mongols began the invasions on Mesopotamia and Palestine, characterized by the use of Chinese engineers and generals on the battle fields and sieges, acquired technology and brain power were deployed against the remaining Middle East. Baghdad was put under siege, slaughtered and burnt in 1258 (McLynn, 2015; Meri & Bacharach, 2006). Afterwards, crises struck.

Möngke Khan died in 1259, and a dispute for succession arose. His brother Hulagu retired a large portion of the Mongol forces from the Middle East to take the rule of the Empire. This weakened the Empire on Syria-Palestine, where the territory was disputed by Mamluk Muslims and Christian Crusaders (Nicolle, 1990). This led to the definite defeat on the Mongol forces on the Middle East on 1260 in the Battle of Ain Jalut, since then, the Empire was unable to control any territory past Syria in the Near East (De Hartog, 2004).

A civil war for succession took place between 1260 and 1264, where Kublai Khan emerged victorious, although his rule remained challenged. Definite defeats in Hungary and Egypt, plus a series of unfortunate events on the attempts to invade Japan (two typhoons), prevented the Empire from expanding more, and reached its peak in 1279. By the end of Kublai rule in 1294, the Mongol Empire split into four khanates, sealing the end of the Mongol Empire (De Hartog, 2004).

Mongols imposed a law system tolerant of other cultures and religions, in which power was transmitted through a parliament-like structure composed of great generals who chose the Great Khan (De Hartog, 2004; Nicolle, 1990). Mixed forms of administration, combining the traditional forms of governance on the occupied territories were implemented. Communication was fundamental, and the Mongols developed a system of posts and mail through the Empire, communicating the Far East, the Middle East and Western Europe. After territories were pacified, commerce and trade was promoted, the almost absolute control over the Silk Road, allowed this trading route to flourish once again, in what came to be known as the *Pax Mongolica* (Di Cosmo, 2010; H. Kim, 2009).

On the other hand, history shows us that the Mongol invasions meant serious infrastructure damage and population decline during the expansion period (McLynn, 2015). However, the flow of ideas and technology along Eurasia did not stop. Chinese technology arrived eventually to Western and Central Europe (Andrade, 2016), while knowledge was lost on the Middle East and Central Asia during the sieges, the destruction of cities, and massacres (Meri & Bacharach, 2006). Although under the Mongol rule the invaded territories would begin to recover, the fall of the Empire led to disputes for territory along Eurasia, affecting the recovery of the once-conquered lands.

Although technology transfer may be considered an externality of the Mongol rule, the Mongols also introduced purposefully systems of land organization, and reforestation as natural defense barriers. The Mongol economy reflected the needs for war effort based primarily on the use of heavy cavalry and siege machinery. Jointly with population decline, this large scale changes in the uses of land and mass plantation of forests were so important, that as a whole, the Mongol invasions, rule and continuous war effort caused the drop of Earth's mean temperature, a "Little Ice Age"(Putnam et al., 2016).

Along with the long-scale conquest of Eurasia, the Mongol Empire carried several Asian technologies and developments into Europe. Notably, war technology, siege machinery (Halperin, 1982) and gunpowder (Andrade, 2016; Haw, 2013); but also, civil technologies, like paper and the movable type printing (Christensen, 2014).

On one hand, the introduction of warfare technology into Europe and West Asia would have several effects. First, the contention and even expulsion of Muslim empires from Europe (Anderson et al., 2009); second, the rise of the Ottoman Empire, which created strong incentives to European exploration and establishment of colonies along the African, Indian, and Chinese coasts due to the harsh trade conditions imposed over the Silk Road (Anderson et al., 2009; Finkel, 2007; Inalcik, 1997); third, it gave European empires fundamental advantages in the conquest and colonization of the Americas, Africa, and the Indian Ocean (Anderson et al., 2009; Broadberry & Gupta, 2006; Gunder Frank, 1998).

On the other hand, the printing was fundamental in the spread of knowledge, key to the Renaissance and the Scientific Revolution (Jara-Figueroa, Yu, & Hidalgo, 2019; Weinberg, 2015), and fostered the spread of Protestantism (Becker & Woessmann, 2009), which led to increased literacy in Central and Northern Europe. All of these derived in an increase in human capital, which allowed the development of more and better technologies, ultimately leading to industrialization (Squicciarini & Voigtländer, 2014).

Simultaneously, the European urbanization process was accelerated in the decades following the Mongol Devastation and the Black Plague, beyond Asian urbanization rates (Voigtländer & Voth, 2013). The world population declined from around 450 million in 1200 CE to less than 375 million in 1400 CE (Biraben, 1980; Durand, 1974; Haub, 1995; McEvedy & Jones, 1978), predominantly due to these events. This radically changed the economic structure of Eurasia, thanks to Malthusian dynamics. As the land-to-labour ratio increased, the per capita income rose across the continent, triggering the demand for luxury goods and manufactures, less intensive in labour, and more intensive in skills and intermediate goods (Voigtländer & Voth, 2013). This prompted the growth of cities in Eurasia. However, Europe benefited the longer and the most from this urbanization and pre-industrialization process. Decades after the Plague, population recovered in Asia, with fewer wars, less violence, and better sanitation than in Europe leading to low mortality rates. In contrast, the relatively increased European war capacity and frequent conflicts, poor sanitation in cities, and the increasing trend in the marrying age for women led to both high mortality and low birth rates in Europe (Voigtländer & Voth, 2009). This situation allowed Europe to maintain high income levels for longer, fostering the growth of cities and structural change in favour of manufacturing sectors (Brenner & Isett, 2002; Galor & Moav, 2002; Galor & Weil, 2000; Kremer, 1993; Voigtländer & Voth, 2009, 2013).

Thus, the Mongol Invasions and the Black Plague ultimately led to increased European war capacity, diffusion of knowledge, and fast urbanization, deriving in an increase in scientific and technological progress, and a radical change in the economic structure. Proto-capitalist societies began to develop in cities around manufacturing sectors and merchants (Pirenne, 2014), while agrarian productivity grew and the rural population migrated massively into the cities. When the steam engine was developed by 1760 CE, all was set for the Industrial Revolution to emerge in Western Europe.

# 3 Why the Mongols?

Many other Empires had risen and fallen before the Mongols, what made the Mongol Empire special? I will argue, five aspects: its extension, its lifespan, its violent expansion, its capacity to communicate far apart regions, and its random emergence[2].

At its peak in 1279, the Mongol Empire controlled six times the area of the Roman Empire, four to five times the Achaemenid and Macedonian Empires, and more than twice the Umayyad Caliphate, at their respective peaks (Anderson et al., 2009). This extent allowed the Mongols to have affected various regions, hundreds of millions of people, and far-apart locations over the same time span like no other empire before, and almost none after.

However, by extension, area, and territorial dispersion, some European colonial empires could rival the Mongols. Literature has found the effect of these empires on some of the within- and in-between-region differences in income and development levels (Acemoglu et al., 2001a; Dell, 2010; Feyrer & Sacerdote, 2009; Lowes & Montero, 2021; Lowes, Nunn, Robinson, & Weigel, 2017; Nunn,

[2]See table 22

2008, 2009; Nunn & Wantchekon, 2009); nevertheless, it was because of the advantages gained by Europe as a result of the Mongol Invasions that these empires could flourish. As is elaborated in the results, the Conquest of the Americas, the Colonization of Africa and South Asia, and the Industrial Revolution did not diminish the direct effects of the Mongol Devastation; at the very least, these events amplified them.

Secondly, the Mongol Empire was relatively short-lived, peaking in 73 years and splitting in 88. In contrast with long-lived empires such as the Persians, Romans, Chinese, Ottomans, and European colonial empires, the regional economies and societies would not have enough time to adapt, recover, and stabilize from the conquest periods before the shock of the fall of the empire came. The fall of an empire may be traumatic as it leaves a void of power that different actors try to fill and capture (Tilly, 1990; Turchin, 2007, 2009, 2019). Thus, the Mongol Empire brought fast and profound changes and conflicts to a vast region of the world in a short period of time. Other empires, such as the Inca, Macedonian, and Aztec, were also short-lived but were either less violent or more effective in their use of violence, deploying it against armies and not civilian populations; much smaller, unable to affect radically different cultures, societies, and economies; or appeared at a time and place in which the human population was small and dispersed (Anderson et al., 2009).

Third, violence. The Mongol Empire is responsible for more than 40 million violent deaths over Eurasia; more than a fourth of the Persian-Khwarezmian Empire was slaughtered in less than a decade. Chinese cities suffered violent sieges and mass rapes and slaughters, and the Muslim world and Eastern Europe saw major cities such as Baghdad and Kiev burnt to the ground (De Hartog, 2004; McLynn, 2015; Meri & Bacharach, 2006; White, 2011). Although Mongol territories then experienced a period of peace before the fall of the Khanates (Di Cosmo, 2010), populations and cities would not recover until well after the Black Plague (Biraben, 1980; Durand, 1974; Haub, 1995; McEvedy & Jones, 1978). Also, unlike the Romans, the Mongols rarely incorporated territory peacefully.

Fourth, commerce and communication between most of the known world were restored and facilitated by the Mongols. The commercial flow, as well as the technology and knowledge exchange between Asia and Europe, flourished while the Silk Road was controlled by the Khanates (Christensen, 2014; Di Cosmo, 2010). Again, to unseen scales during the Middle Ages. Although the Romans and Chinese originally formed the Silk Road, and it was active for various centuries, during the Mongol times the road was active for a shorter time, until it was economically blocked by the Ottomans (Inalcik, 1997). These abrupt changes in commerce pushed the Europeans to explore alternate routes, leading to the beginning of African and South Asian colonization, the Discovery of the Americas, and the violent incursion of European merchant companies in the Indian Ocean

(Anderson et al., 2009; Broadberry & Gupta, 2006; Gunder Frank, 1998).

Finally, the emergence of the Mongol Empire was fortuitous. Along the Medieval Warm Period (∼1000 CE) (Broecker, 2001; Crowley & Lowery, 2000; Hughes & Diaz, 1994), increased humidity over the Central Asian Steppe in the late 12th century led to an expansion of the pasture lands and grass quality (Pederson et al., 2014). The nomadic tribes and clans saw their war capacity increased, as more horses could be bred, and more warriors could be fed. Conflicts became more frequent and involved fast-growing armies. Clans merged into increasingly larger armies until, in 1206 CE, they united under a single leader, Genghis Khan (De Hartog, 2004). It was random climate change that led to the rise of the Mongols. Other empires have more gradual rises, and their history tends to be tied to man-caused events. With the Mongols, this was not the case.

Thus, it was the unique combination of structural characteristics, fortune, and timing that made this Empire so special and capable of changing the course of history. The scale of the Mongol Empire by the measures of territory, violence, and the transformation of world trade is unmatched by any other pre-industrial society.

# 4 Related Literature

## 4.1 Population Dynamics

Sustained economic growth is a rather recent phenomenon; it has existed for the past two centuries (Maddison, 2007). Malthusian dynamics dominated demographics and economics along the millennia before the Industrial Revolution (Ashraf & Galor, 2011; Hansen & Prescott, 2002). Shocks to population, productivity, and the development of certain technologies could have deep effects on the economic structure and performance.

Within the Malthusian regime, war and disease could bring temporary improvements in the standard of living and rises in per capita income. In parallel, improvements in productivity had temporary effects on living standards, as increases in per capita income would translate into increases in population. Thus, population growth rates followed the growth of the economy (Ashraf & Galor, 2011; Galor & Weil, 2000).

Between the 13th and 15th centuries, Malthusian dynamics explain fundamental changes in the Eurasian economic structure. The Black Plague of the 14th century wiped out between a third and a half of the European population (Jedwab et al., 2020). This led to a noticeable increase in wages as the land-to-labour ratio increased. The rise in production and income fostered the demand for manufactured goods, intense in labour and tools, rather than land. This fostered a fast expansion of cities, both in terms of population and economic output (Voigtländer & Voth, 2009, 2013).

Although the Plague also killed tens of millions in Asia, and this continent suffered the worst part of the Mongol Devastation, the same mechanisms that allowed Europe to benefit from it were not present. Asian cities had better sanitation, and the continent was more peaceful during the *Pax Mongolica* than Europe (Kitamura, 2022; Voigtländer & Voth, 2013). Western European cities grew faster but were remarkably unhealthy, and the continent experienced constant, long, and increasingly deadly conflicts. Under the Malthusian regime, the Black Plague (and arguably the Mongol Invasions) created a cycle that could sustain high mortality rates and high wages for several generations in Europe, while it did not in Asia (Allen, 2009; Brenner & Isett, 2002; Voigtländer & Voth, 2013).

Simultaneously, birth rates in Europe remained low due to a change in nuptiality patterns. After the Plague, women delayed marriage due to a strong increase in demand for their labour in cities (Voigtländer & Voth, 2009).

The Mongol Invasions brought the Plague to Europe during the Siege of Kaffa in 1346 CE and carried with them Chinese gunpowder and siege technology, increasing the destructive potential of European warfare (McLynn, 2015).

## 4.2 Commerce, Ideas and Technology

After the fall of the Roman Empire, the Silk Road was rendered nearly irrelevant. European commerce with China and India fell dramatically, and the economic center of the world moved to the Indian Ocean during the Middle Ages (Broadberry & Gupta, 2006; Gunder Frank, 1998). Constant territorial disputes, fragmented authority, and insecurity rendered the Silk Road irrelevant for Eurasian commerce. However, by the late 13th century, the whole extent of the Road was within the Mongol borders. The Empire promoted trade with European city-states and kingdoms in order to extract rents through taxation and tribute and provided security along its borders (Di Cosmo, 2010).

Along with the invasions, the expansion of commerce with Europe allowed for the transfer of technology and knowledge. The secretive Chinese states were overthrown and replaced with the rent-seeking Mongol rule, thus paper, printing, and gunpowder made their way into Europe. During the Renaissance, the amount of books multiplied after Johannes Gutenberg improved upon the Chinese printing technology into the movable-type printing press. This led to the rise of arts and sciences, as knowledge became widespread over Europe (Buringh & van Zanden, 2009; Jara-

Figueroa et al., 2019).

On the other hand, gunpowder would be crucial in two major events that led to the discovery and conquest of the Americas: the *Spanish Reconquista* of the Iberian South and the Fall of Constantinople in 1453 (Anderson et al., 2009).

Furthermore, technology and knowledge create more and better technology and knowledge. Be it by transfer or endogenous development, technological progress is the main driver of economic growth (Aghion & Howitt, 2009; Mokyr, 1990; Romer, 1990). The arrival of the heavy plough in the 11th century into Europe (Andersen, Jensen, & Skovsgaard, 2013), or the introduction of the potato after the 16th century (Nunn & Qian, 2011), expanded the European population, increased the relevance and size of cities, and further improved technology and knowledge heading into the Enlightenment. By the 18th century, the development of the steam engine in England led to the Industrial Revolution. With the development of the electromagnetic induction engine, the Industrial Revolution accelerated, deepened the existing gaps in income and development between Western Europe and North America and the rest of the world, and derived into the modern observed development gaps—the Great Divergence (Mokyr, 1990; Pomeranz, 2000).

In the 20th century, the South Korean industrial policy of technology adoption (Lane, 2021) and the Soviet transfer of technology into China (Cheremukhin, Golosov, Guriev, & Tsyvinski, 2015) took two of the poorest world economies into high- and middle-income economies, respectively. This stresses the importance of commerce in technology transfer and, consequently, economic development.

## Part II

# Model

## 5 Set up

I model a pre-industrial world economy, where any particular society is modelled as the interaction between a population of households, a ruling class, and an exterior sector. Then, I model the Mongol shocks and how would these economies perform in the long run as a consequence of the dynamic imprinted by the Mongols.

An Individual Economy ($\boldsymbol{E}_i(t)$) is the set of a representative individual with life utility $W_i$, a production technology $Y_i(t)$, a ruling class with utility function $U^R(\cdot)\Omega(\cdot)$, a population $(L_i(t))$, and a territory $(\boldsymbol{X}\}_i(t))$.

$$\boldsymbol{E}_i(t) = \{W, Y, U^R(\cdot)\Omega(\cdot), L, \boldsymbol{X}\}_i(t)$$

The timing of the model goes as follows in every instant $t$ for every economy $i$:

- The Ruling Class $(\cdot^R)$ observes its territory, population, and the probability of withholding power by the end of the period $(\Omega(\cdot;t))$ and decides the agrarian labour $(L_A)$, the consumption (and import, if any) of agrarian $(C^R_A)$ and manufacture $(C^R_M)$ goods, and the army size $(L_D)$ and its quality $(q)$.
- Households $(\cdot^H)$ observe the available time after serfdom $(L_A)$ and military service $(L_D)$, their stock of agrarian goods $(\xi(t))$ and income, and the population growth rate $(\eta(t))$. They decide how to spend the remaining time between leisure $(L_0)$ or opening a manufacture sector $(Y_M)$, and their consumption of agrarian $(C^H_A)$ goods and/or manufactures $(C^H_M)$.
- Starting from equilibrium in time $t$, a Mongol-like shock strikes and produces a discrete change in technology diffusivity $(\nu)$, capital endowment $(K(t))$, and population $(L(t))$.

## 5.1 Agents

### 5.1.1 Households

Consider a Ramsey-like representative household in continuous time (Aghion & Howitt, 2009). Households had little autonomy in the Middle Ages under feudal, noble, cast, and monarchic systems (Anderson et al., 2009). The social division of labour was mainly directed from those in power, and not all labour was productive labour.

Each household is endowed a unit of time which can be used in 4 activities: agrarian labour $(L_A)$, manufacture labuor $(L_M)$, military service $(L_D)$, and leisure $(L_l)$. Thus, the total endowment of labour within an economy is $L = L_A + L_M + L_D + L_l$. Agrarian and military labour are commanded by the ruling class. Therefore, households only get to choose either their leisure time and weather or not to open a manufacture sector and work $L_M$ there. Take the manufacturing goods $(\cdot_M)$ as numerary.

Households would also choose their consumption of agrarian goods $(C^H_A)$, at price level $P_A$. Preferences associated with agrarian output are non-homothetic, and are modeled with an Stone-

Geary-like function, with critical point in the subsistence level ($\zeta_A$).

Agrarian production is subject to seasonal cycles, known to households. Adapting Zuleta (2011) to this set-up in continuous time, households store agrarian goods at rate $\dot{S}$. Which can be used as pure storage for later consumption ($\xi$), or can be transformed into capital/intermediate inputs ($K$) for a manufacture sector. Stored goods depreciate (rot) at rate $\delta$. Assume a linear technology for converting agrarian stock ($S$) into capital ($K$):

$$\dot{S} = \dot{\xi} + \dot{K} \tag{1}$$

The household labour income is $\langle \boldsymbol{w}, \boldsymbol{L} \rangle = w_A L_A + w_D L_D$. Where $\boldsymbol{w}$ is the wage vector[3].

Thus, households face a resource restriction given by:

$$Y_M + \langle \boldsymbol{w}, \boldsymbol{L} \rangle + P_A(1-\delta)\xi = P_A C_A^H + H(w^* - \langle \boldsymbol{w}, \boldsymbol{L} \rangle)\langle \boldsymbol{P}, \boldsymbol{C} \rangle + P_A \dot{S}$$

Where $\langle \boldsymbol{P}, \boldsymbol{C} \rangle = P_A C_A + C_M$ is the consumption expenditure vector.

Whenever a reserve income $w^* > \zeta_A P_A$ is surpassed and manufacture goods are available, households demand them. To an extend $\zeta_M$, manufactured goods are unnecessary. These assumptions will allow us to examine demand-pressure to open a manufacture sector. Thus, the household has a utility function defined by parts:

$$\begin{aligned} U^H(\boldsymbol{C}, \boldsymbol{L}) &= H(\langle \boldsymbol{w}, \boldsymbol{L} \rangle - w^*)U_-^H(C_A^H, L_l) + H(w^* - \langle \boldsymbol{w}, \boldsymbol{L} \rangle)U_+^H(C_A^H, C_M^H, L_l) \\ &\equiv H(-\Delta w^*)U_-^H(C_A^H, L_l) + H(\Delta w^*)U_+^H(C_A^H, C_M^H, L_l) \end{aligned} \tag{2}$$

Where $\Delta w^* \equiv w^* - \langle \boldsymbol{w}, \boldsymbol{L}$, and $H(\cdot)$ is the Heaviside function:

$$H(x) := \begin{cases} 1, if x \geq 0 \\ 0, if x < 0 \end{cases}$$

Finally, households discount time given an impatience rate ($\rho$) and the population growth rate $\eta$. This last aspect reflects impatience due to mortality (Blanchard, 1985). If the household observes

[3]In all rigour, $\langle \boldsymbol{w}, \boldsymbol{L} \rangle = w_A L_A + w_D L_D + w_M L_M$ but as households own the manufacture sector, “they are paying these wages to themselves”.

population contractions, it will behave *as if* it was less patient. And the converse is true: if the household observes population expansions, it will behave *as if* it was more patient.

Assume the following specific forms for the utility function:

$$U^H_-(C_A, L_l) = \beta \ln[L_l] + (1-\beta)\ln[C^H_A - \zeta_A] \tag{3}$$
$$U^H_+(C^H_A, C^H_M, L_l) = \beta \ln[L_l] + \epsilon \ln[C^H_M + \zeta_M] + (1-\beta-\epsilon)\ln[C^H_A - \zeta_A] \tag{4}$$

Therefore, the household problem is:

$$\max_{L_M, L_l, C_A, C_M, \dot{S}, \dot{K}, \dot{\xi}} \int_0^\infty e^{-(\rho-\eta)t} U^H(\boldsymbol{C}, \boldsymbol{L}) dt$$
$$s.t \quad \begin{cases} Y_M + \langle \boldsymbol{w}, \boldsymbol{L} \rangle + P_A(1-\delta)\xi = P_A C^H_A + H(w^* - \langle \boldsymbol{w}, \boldsymbol{L} \rangle)\langle \boldsymbol{P}, \boldsymbol{C} \rangle + P_A \dot{S} \\ L_M + L_l = L - L_A - L_D \\ \dot{S} = \dot{\xi} + \dot{K} \end{cases}$$

And its associated Lagrangian:

$$\mathcal{L}^H = \int_0^\infty e^{-(\rho-\eta)t} U^H(\cdot) + \lambda_1 \Big( Y_M + \langle \boldsymbol{w}, \boldsymbol{L} \rangle + P_A((1-\delta)\xi - C^H_A - \dot{S}) - H(\Delta w^*) C^H_M \Big) + \lambda_2 \left( L - \langle \boldsymbol{1}, \boldsymbol{L} \rangle \right) + \lambda_3 (\dot{S} - \dot{\xi} - \dot{K}) dt \tag{5}$$

With First Order Conditions (F.O.C) given by the Euler-Lagrange Equation:

$$\frac{d}{dt}\frac{\partial \mathcal{L}^H}{\partial \dot{\boldsymbol{x}}} - \frac{\partial \mathcal{L}^H}{\partial \boldsymbol{x}} = 0$$

With $\boldsymbol{x} \in \{L_M, L_l, C_A, C_M, S, K, \xi\}$

### 5.1.2 Ruling Classes

The Ruling Class also consumes agrarian good (necessary, as with households), and manufacture good when available. It also commands labour in the agrarian sector ($Y_A$), which they own; and demand military service ($L_D$). The army has the function of keeping the ruling class in power, protecting it from foreign invasion and internal revolts. They can increase the power of the army either increasing its numbers ($L_D$), or the quality of their soldiers ($q$). The army can only be sustained if the rulers can pay for their subsistence level.

The probability of holding power $\Omega(\cdot)$ depends on the utility of their subjects (less probability of revolt) $U^H(\boldsymbol{C}, \boldsymbol{L})$, and the power of their army (better chances of containing revolt or an invasion) $(q, L_D)$. This aspect of internal conflict is key, as treason was a mechanism through which the Mongols annexed territories (De Hartog, 2004).

The sources of income of the ruling class is the agrarian sector revenue and tax collection from capital $(K(t))$.

Different to households, the ruling class always has knowledge of/access to manufactured goods. Whenever $Y_{M_i}(t) = 0$, they import them if they have sufficient income.

Assuming specific functional forms:

$$U^R(C_A^R, C_M^R) = \pi \ln[C_A^R - \zeta_A] + (1 - \pi) \ln[C_M^R + \zeta_M^R] \tag{6}$$

Let the probability function be as:

$$\Omega(q, L_D, U^H) = \Omega_q(q)^\alpha \Omega_L(L)^\theta \Omega_U(U^H)^{1-\alpha-\theta} \tag{7}$$

Such that for $x_i \in \{q, L_D, U^H\}$:

$$\begin{aligned}
&\Omega_i(\cdot) \in [0, 1] \\
&\sum_i \Omega_i(\cdot) \in [0, 1] \\
&\frac{\partial \Omega_i}{\partial x_i} = r\Omega_i \left(1 - \frac{\Omega_i}{\bar{\Omega}_i}\right) \\
&\sum_i \bar{\Omega}_i(\cdot) \in \left[\sum_i \Omega_i(\cdot), 1\right]
\end{aligned}$$

Note this logistic behavior on the probabilities achieve two important aspects: first, they bound $\Omega(\cdot) \in [0, 1]$; second, improving any aspect $x_i$ increases survival probability quickly if $x_i$ is low, while exhibiting diminishing returns in probability when said dimension is high. Say, this implies that no dimension among $x_i$ can be improved infinitely as to guarantee the survival of the ruler.

Thus, the ruling class problem is:

$$
\max_{L_D, L_A, C_A^R, C_M^R, q, \tau} \Omega(\cdot) U^R(\boldsymbol{C})
$$

$$
s.t \quad \begin{cases} P_A(Y_A - C_A^R) + \tau_K K(t) \geq w_A L_A + (P^A \zeta^A + q) L_D + C_M^R \\ \Omega = \Omega(U^H(\boldsymbol{C}, \boldsymbol{L}), q, L_D) \end{cases}
$$

And its associated Lagrangian:

$$
\mathcal{L}^R = \Omega(\cdot) U^R(\boldsymbol{C}) + \lambda (P_A(Y_A - C_A^R) + \tau_K K(t) - w_A L_A - (P^A \zeta^A + q) L_D - C_M^R) \tag{8}
$$

## 5.2 Production

Every economy is small and open, produces and/or imports/export agrarian and manufactured goods. Therefore, the value of the economies' production in terms of manufactures is given by:

$$
Y_i(t) = P_A Y_{Ai}(t) + Y_{Mi}(t) \tag{9}
$$

### 5.2.1 Agrarian Output

The agrarian sector ($Y_A$) is owned by the Ruling Class, owners of land ($Z_A$). Agrarian output is increasing $\frac{\partial Y_A}{\partial L_A} > 0$ with diminishing returns $\frac{\partial^2 Y_A}{\partial L_A^2} < 0$ in agrarian labour, and land ($Z_A$) is a fixed factor. This guarantees the existence of an stationary state in agrarian output (Galor & Weil, 2000). Agrarian labour productivity ($A^\phi B^{1-\phi}$) progresses stochastically conditional on the available internal technology, the social division of labour, and technology transfer (Andersen et al., 2013; Romer, 1990). The endogenous component contributes a fraction $\phi$ to the TFP growth; while technology transfer contributes a fraction $1 - \phi$.

Also, dealing with mostly not-equatorial economies, it is reasonable to think seasons will have an effect in agrarian productivity. For instance, let the TFP $A^\phi B^{1-\phi}$ be the average TFP. The seasonal component $Q(t)$ should exhibit regular peaks and valleys of productivity. Given a frequency $\omega_0$, which I model following the Harmonic Oscillator:

$$
\ddot{Q} = -\omega_0^2 Q \tag{10}
$$

With solution:

$$
Q(t) = Q_0 \sin(\omega_0 t) \tag{11}
$$

Therefore, the agrarian output is given in general form by:

$$Y_A = (A_A(t)^{\phi} B_A(t)^{1-\phi} + Q(t))F_A(L_A, Z_A) \tag{12}$$

Assume for simplicity:

$$F_A = L_A^{\alpha} Z_A^{1-\alpha}$$

Fundamentally, seasonal cycles will create incentives to store agrarian goods (Zuleta, 2011), which could be transformed into capital and start a local manufacture sector that pushes the economy into a long-run growth path.

### 5.2.2 Manufactures and Capital

Initially, there is not a manufacturing sector. Households open and own the manufacturing sector once they have accumulated enough capital (greater or equal than a critical level $K_0$). Households do not demand manufactured goods before they reach a wage income greater than $w^*$, but the ruling class does whenever they consume beyond their subsistence level. Also, households provide labour to this sector. Labour time is offered from the remaining time available after the ruling class has determined defense and agrarian labour. Thus, the manufacturing labour also costs leisure time. Then, only if $K(t) \geq K_0$ and $\frac{\partial Y_M}{\partial L_M} \geq \frac{\partial U^H(\boldsymbol{C},\boldsymbol{L})}{\partial L_l}$, can $Y_{Mi}(t) > 0$.

As with the agrarian output, manufacturer TFP grows stochastically conditional on the production factors available, and technology transfer through commerce and proximity to technological frontiers. The endogenous component contributes a fraction $\psi$ to the TFP growth; while technology transfer contributes a fraction $1 - \psi$.

Therefore, the manufacturer output is given in general form by:

$$Y_M = \begin{cases} A_M(t)^{\psi} B_M(t)^{1-\psi} F_M(L_M, K; t), & if \quad K(t) \geq K_0 \\ 0, & else. \end{cases} \tag{13}$$

## 5.3 Demographics

I adapt the Malthusian Dynamics to a logistic growth equation, common in Biology and Ecology to study animal population dynamics in scarce resources contexts (Tsoularis & Wallace, 2002):

$$\eta(t) = \frac{\dot{L}}{L} = n\left(1 - \frac{L}{\bar{L}(P_A\zeta_A)}\right) \tag{14}$$

Here, I assume that household population is much larger than the ruler's. Thus, the former can be neglected. The population carrying capacity ($\bar{L}(P_A\zeta_A)$) is the limit to which population would converge in the long run, *ceteris paribus*, and it is determined by the consumption of agrarian goods. $\bar{L}(P_A\zeta_A)$ is the equilibrium population given by Malthusian Dynamics: when $L > \bar{L}(P_A\zeta_A)$, population shrinks; when $L > \bar{L}(P_A\zeta_A)$, population grows (Galor & Moav, 2002; Galor & Weil, 2000; Kremer, 1993).

For tractability, $\eta$ is taken as given in the household problem. Say, there is no family planning, if *per capita* consumption of agrarian goods goes beyond subsistence level, children survive and population grows. And the converse, if agrarian consumption is less than the subsistence level, there is hunger, and population declines.

## 5.4 Spatial Dynamics

Existing world technology is diffused geographically. If a pair of economies are somehow connected by trade, the technology available in one of them will eventually be known and adopted by the other. While every point in between increases its potential of becoming a permanent settlement. Along the Middle Ages, the burgs emerged as settlements of merchants (Pirenne, 2014; Verhulst, 1989).

The diffusion of technology is modelled following the Heat Equation:

$$\begin{aligned} \frac{\partial A}{\partial t} &= \nu \nabla^2 A \\ \frac{\partial A}{\partial t} &= \nu \left(\frac{\partial^2 A}{\partial x_1^2} + \frac{\partial^2 A}{\partial x_2^2}\right) \end{aligned} \tag{15}$$

Where $\mathbf{x} = (x_1, x_2)$, is coordinates with $x_1 :=$ longitude and $x_2 :=$ latitude.

Frontier conditions are chosen such that: $\frac{\partial A}{\partial t} \geq 0 \forall t$ (see appendix B)

Economies are characterized by their territory, a set of points $\mathbf{X}$, and connected through routes defined by other points $\mathbf{x}$. Define there exists a potential transfer of technologies between two economies if there exists a connected set of points with no empty intersection with the points of both economies (see appendix B).

Finally, there exists an accessible technological frontier, the economy with the highest level of technological progress achieved that is connected to economy $i$. The closer an economy is to the frontier or the better routes it has towards it, the fastest technology will flow into said economy. In the context of the Mongol Empire, the global technological frontier was in China and India (Broadberry & Gupta, 2006; Maddison, 2007). The restoration of the Silk Road under the Mongol rule connected the East and the West, allowing the Asian knowledge and technology to arrive into Western Europe (Christensen, 2014).

## 5.5 Technical Progress

Let us suppose there is not a Research and Development (R&D) sector in pre-modern times. However slow, humanity kept making progress in productive technologies (Mokyr, 1990). Inventions emerged from human ingenuity. I part from two insights: *learning by doing*, the more people in labour, the more likely it is some worker finds a new way to combine or alter the means of production as to make them more productive; *in the shoulders of giants*, ideas are produced with ideas, the more means of production different to labour there are, the more likely it is to come up with a new form of production good.

Let $\bar{B}_j$ is the higher achievable TFP at time $t$. To make it clear, this is not the world technical frontier, this is the better technology that a city's material conditions could achieve. Technology at time $t$ progresses towards this maximum at logistic rate $\gamma$. However, $\bar{B}_j$ can also progress if sector $j$ achieved an innovation. The technical progress is non-deterministic (Aghion & Howitt, 2009), every period there is a probability $\mu(K_i, L_{ij}; t)$ that sector $j \in \{A, M\}$ of economy $i$ achieves an improvement on its technology which increases its achievable productivity $\bar{B}_j(t)$ by a factor of $\bar{\gamma} > 1$ stochasticaly as:

$$E\{\dot{\bar{B}}_j(t)\} = \mu(\cdot)\bar{\gamma}\bar{B}_j$$

To capture the intuition that the more advanced the technology is, the harder is to make significant progress, I model the TFP dynamics logistically:

$$\dot{B}_j(t) = \gamma B_j \left(1 - \frac{B_j}{\bar{B}_j}\right) \tag{16}$$

With:

$$\frac{\partial \mu}{\partial K} > 0 \quad ; \quad \frac{\partial^2 \mu}{\partial K^2} < 0$$
$$\frac{\partial \mu}{\partial L_j} > 0 \quad ; \quad \frac{\partial^2 \mu}{\partial L_j^2} < 0$$

Accumulation of labour makes it more likely for a worker to come up with an idea; accumulation of capital implies more interactions with technology, thus, the probability to innovate.

## 5.6 Mongol Shocks

Let $\mathbf{R}_i$ be the distance vector from the political center of the Empire to its edge that is closest to economy $i$ in the direction of $i$ ($\hat{R}_i$): $\mathbf{R} = R_i(t)\hat{R}_i$

Such that:

$$\dot{R}_i(t) \begin{cases} > 0, & \text{implies expansion in direction of } \hat{R}_i \\ = 0, & \text{implies static frontier in direction of } \hat{R}_i \\ < 0, & \text{implies retreat in direction of } \hat{R}_i \end{cases}$$

Define the distance vector from the closest edge of the Empire to a particular point in $i$ as $\mathbf{D}_i := \mathbf{R}_i - \mathbf{x}_i$.

The origin of the coordinate system is taken on the political center of the Mongol Empire.

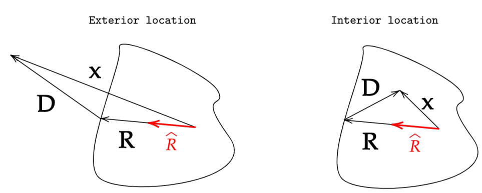



Figure 2: Illustration of the definition of $\mathbf{D}$, $\mathbf{R}$, $\mathbf{x}$ and $\hat{R}$

The Mongol Empire had a simply connected territory thus, there is a clear definition between its interior and its exterior. Define: $D := |\mathbf{x}| - |\mathbf{R}|$. If $D < 0$, the point being studied lies inside the Empire; whereas $D > 0$ implies that the point studied lies outside of it.

Under these definition, given $\hat{R}$:

$$\dot{\mathbf{D}} = \begin{cases} \dot{R}(t), & if \quad D < 0 \\ -\dot{R}(t), & if \quad D > 0 \end{cases}$$

When the Mongols conquered China, they were open to commerce with the West, and restored the Silk Road (Di Cosmo, 2010). Therefore, technology from the East would flow with less resistance into the West, as the Mongol Empire expanded towards Europe.

This can be rationalized as:

$$\frac{d\nu}{dD} \begin{cases} < 0, & if \quad D > 0 \\ = 0, & if \quad D < 0 \end{cases}$$

Moreover, as the Mongols grew their empire, more routes were integrated into world trade, as the Empire would protect traders from pillage and territorial disputes between conquered kingdoms and empires (Anderson et al., 2009; Di Cosmo, 2010). Thus, the best accessible technology for $i$, $\bar{A}_i$ is weakly increasing in the Mongol expansion $\dot{R}$:

$$\frac{d\bar{A}_i}{d\dot{R}} \geq 0$$

# 6 Equilibria

The ***general equilibrium*** of economy $i$ at time $t$ $GE_i^*(t)$ is a set of prices and quantities that empty the local markets:

$$GE_i^*(t) = \{Y_A^*, Y_M^*, L_A^*, L_M^*, L_D^*, L_O^*, q^*, C_A^{H*}, C_A^{R*}, C_M^{H*}, C_M^{R*}, P_A^*, w_A^*, w_D^*\}(t)$$

It satisfies:

$$\frac{d}{dt}\left(\frac{\partial \mathcal{L}^j}{\partial \dot{\chi}^j}\right) - \frac{\partial \mathcal{L}^{\mathcal{H}}}{\partial \chi^j} = 0$$

Where $j \in \{H, R\}$, $\chi^H \in \{L_M, L_O, C_A^H, C_M^H, S, K, \xi\}$, and $\chi^R \in \{L_D, L_A, C_A^R, C_M^R, q, \tau\}$

It is also worth defining the ***Malthusian Equilibrium***. While in Malthusian regime, this is, while there is not sustained stochastic technical progress in the technological frontier, nor in the economy $i$, the economy $i$ and the frontier will converge in long-run growth rates:

$$\lim_{t\to\infty}\frac{\dot{Y}}{Y}=\lim_{t\to\infty}\frac{\dot{L}}{L}=0$$

Finally, define the ***Solowian equilibrium*** as the situation in which: $\dot{K}>0$, $\frac{\dot{Y}}{Y}>0$ and:

$$\lim_{t\to\infty}\frac{\dot{K}/K}{\dot{Y}/Y}\in(0,\infty)$$

This is, when the economy achieves a Balanced Growth path, and growth depends only on capital accumulation.

# 7 Predictions

The existence of Malthusian Traps is fundamental to the model. Before the Industrial Revolution, and in particular during the Late Middle Ages, world population grew at a slow pace each century (Biraben, 1980; Durand, 1974; Haub, 1995; McEvedy & Jones, 1978). The world population and income were subject to the Malthusian regime: all gains in productivity that translated into increased per capita income would be compensated by a rise in population, thus keeping the living standard relatively stable (Ashraf & Galor, 2011).

This is, there was not a steady economic growth as in post-industrial times, but rather sporadic growth periods. Although the technical progress lead to different and evolving ways of production, economic structures, and division of labour, the living standards of the vast majority, those with no property or right over the means of production, would always tend to the subsistence level. Once the Malthusian regime is broken, namely after the Industrial Revolution, the living standards would rise along the population. It is precisely the emergence of sustained long run growth and rise in per capita income levels what this model aims to explain. Thus, it should have a situation in which the Malthusian Trap is not imminently broken.

Thus,

**Proposition 7.1.** *Under sufficiently weak seasonal cycles and with no stochastic progress in the achievable technological level in the technological frontier, there exists* $(K, A_A, B_A, A_M, B_M)$ *such that when* $\boldsymbol{L}\geq\boldsymbol{0}$ *there is a Malthusian Trap.*

Empirically, this proposition can be tested with the existence of sustained growth of income gaps in pre-industrial times. Under the Malthusian hypothesis, in the long run, economic growth per capita is null (Ashraf & Galor, 2011; Galor & Weil, 2000), thus the change in income gaps should have a diminishing trend. If said gaps are increasing in the long run before the Industrial Revolution, either a group of economies is contracting in income levels or a group of economies is increasing in income levels. As per the Malthusian hypothesis, the former is not possible—an economy cannot contract in the long run, as eventually, the per capita income would have to rise and population stabilize; otherwise, the population would starve to death. Thus, the latter is only possible: sustained divergence in pre-industrial times implies that a group of economies was able to hold sustained cycles of high per capita wealth (likely due to sustained high mortality rates (Voigtländer & Voth, 2009, 2013)), while the rest reached Malthusian equilibrium.

On the other hand, due to Engel's Law, rising household income implies the household dedicates a lower proportion of it to subsistence consumption (Clark, 2007). The rest of the purchasing power is dedicated either to saving or to non-essential consumption, here, manufactured goods. This creates market incentives to provide manufactured goods either by trade or by entrepreneurship. Thus, once agrarian productivity is sufficiently high, per capita income will be high too. Therefore, individuals will demand manufactured goods and will be able to save more to smooth consumption over time. If sufficiently high income and capital are accumulated as a consequence of high agrarian productivity, the economy will start its industrialization via manufacturing sectors (Ashraf & Galor, 2011; Galor & Weil, 2000; Voigtländer & Voth, 2009, 2013).

This is a key aspect of the Mongol Invasions and the Black Plague. The population shock increased the land-to-labour ratio, thus augmenting the per capita income, increasing the demand for manufactures, allowing households to accumulate capital, and setting the stage for proto-industrialization. Formally:

**Proposition 7.2.** *The agrarian wages are increasing in the land-to-labour ratio:*

$$\frac{\partial w_A}{\partial (Z_A/L_A)} > 0$$

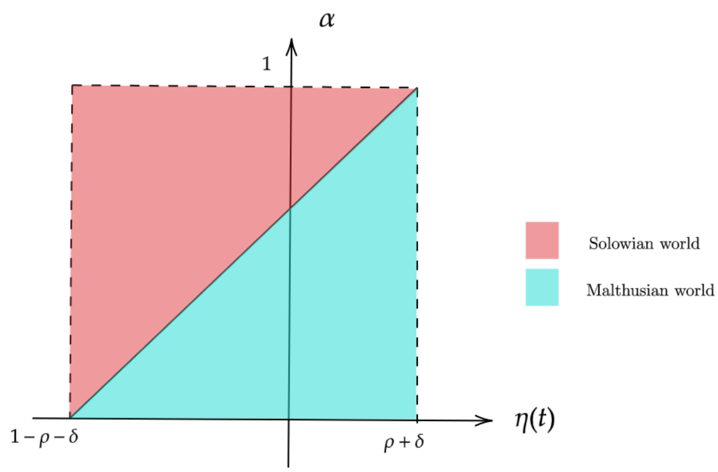
With:

**Corollary 7.2.1.** *For every $w^*$, there exists a land-to-labour ratio $\frac{\tilde{Z_A}}{\tilde{L_A}}$ such that for every $\frac{Z_A}{L_A} > \frac{\tilde{Z_A}}{\tilde{L_A}}$ it occurs $w_A\left(\frac{\tilde{Z_A}}{\tilde{L_A}}\right) > w^*$*

Which implies that the household begins to demand manufactures.

It is, then, a combination of economic structure and demographics that facilitates industrialization. A rise in per capita wealth due to an increase of the labour share in income at the expense of land income will only foster industrialization if the levels of wealth remain high for sufficiently long time. This is, in a Malthusian world, high mortality. Therefore, technical progress will lead to capital accumulation only in specific combinations of labour income and population growth rates. For this set up, consider the parameter space $(\alpha, \eta)$, labour share in agrarian income vs population growth, as depicted in figure 3. The Malthusian world will only transit into a "Solowian" world if technical progress can be absorbed into producing sustained growth. Either by a high share of labour income or high mortality, could productivity shocks produce the conditions to industrialization.

Figure 3: Space parameter $(\alpha, \eta)$ in which technical progress can foster industrialization.




Thus,

**Proposition 7.3.** *If in a Malthusian Trap, there exists a parameter space $(\alpha, \eta)$ such that increases in the agrarian TFP increase the storage stock. In said space, there exists a finite $\tilde{A}_A(t)^{\phi}\tilde{B}_A(t)^{1-\phi}$ such that for every $A_A(t)^{\phi}B_A(t)^{1-\phi} \geq \tilde{A}_A(t)^{\phi}\tilde{B}_A(t)^{1-\phi}$ it happens $\dot{K} > 0$.*

Empirically, population should grow richer when the land-to-labour ratio increases. This is, when the land share in income decreases relative to the share of labour income, societies should urbanize faster. Moreover, an assessment of the violence of the Mongol Empire could show a negative impact of violence on wealth growth. Although population contractions are predicted to favour economic growth in the short run, this model predicts that if violence also affects social division of labour and economic infrastructure (capital), the excess mortality may not translate in higher per capita wealth, but in a new (lower performance) equilibrium.

If it happens to be the case that violence is negative for per capita wealth growth in the "short" run, this would imply that the Malthusian Theory is incomplete. Not every population contraction will lead to higher wealth in the short run, nor the long run equilibrium will remain constant. This population contractions come along changes in the social division of labour and the economic structure, that ultimately dictate how technical progress is assimilated, and, thus, long run growth.

Now, the model produces both, a Malthusian Trap and sustained accumulation of capital. How can an economy in one of these scenarios end up in the other? Shocks. In particular, Mongol-like shocks. With these, I refer to at least one among: increased trade connectivity, destruction and misallocation of means of production, mass slaughter of population.

Take China, for instance. If Chinese states were the most technologically advanced, growing at a slow but steady rate, in the path of beginning sustained capital accumulation, the Mongols may have produced the conditions for these economies to fall into a Malthusian Trap, or to delay the sustained growth scenario. In contrast, for Western Europe, the increased commerce and technological transfer, plus the sustained cycle of high mortality after the Mongols and the Black Plague, could break the Malthusian regime (Voigtländer & Voth, 2009, 2013).

Formally,

**Proposition 7.4.** *If an economy is in a Malthusian Trap, then shocks at each among* $\{K, L, \nu, Q_0\}$ *can produce hysteresis into a long run growth path, and the converse.*

Empirically, some invaded wealthy societies could stagnate in the long run; some stagnated economies exposed to new trade opportunities could begin to grow, and exhibit a peak of growth. In further sections, an assessment to the effect of the Mongol shocks should show that the unconquered territories grew faster, improved their trade, and their land-to-labour ratio.

But the most important matter here is who benefited the most from and/or was affected the least by the Mongol Devastation? Arguably, regions close enough to the Mongol Empire as to benefit from commerce and technology transfer. But not that close as to being invaded or having to draw resources into preparing for an invasion.

Therefore, for this set up:

**Theorem 7.1.** ***The Goldilocks Zone:*** *There exists an interior distance* $D^*$ *that maximizes* $\frac{\dot{Y}}{Y}$.

Empirically, this means that somewhere outside the Mongol Empire, there exists a group of economies with the best growing rates per century, and are about the same distance from the Empire. Not to close, as to suffer an invasion attempt; not to far, as to not benefit from the new trade opportunities.

Wrapping up, this means that the Mongols affect growth through two main mechanisms: violence and trade. Violence contracts capital and population, demanding a new division of labour, which changes the per capita wealth, the demand for manufactures and the incentives to entrepreneurship. Trade allows cities to access better technology, but this increase in productivity will only become capital accumulation and industrialization depending on demography and the existing economic structure.

## Part III

# Data

This paper builds a novel dataset combining several data series and digitizing new information. I construct a city-century panel for 1,330 urban centers along Eurasia from year 0 CE to 1800 CE. The locations (latitude and longitude) of the Eurasian settlements are obtained from Reba, Reitsma, and Seto (2016). The main data comes from the History Database of the Global Environment (HYDE) (Klein Goldewijk, Beusen, Doelman, & Stehfest, 2016; Klein Goldewijk, Beusen, Van Drecht, & De Vos, 2011) from the PBL Netherlands Environmental Assessment Agency and Utrecht University. This data contains grid-level (up to 0.083 degrees) information on urban population, rural population, population density, and land use for the last 12,000 years, stored as rasters. Using the Geographic Information System (GIS) software ArcGIS, I obtain spatial statistics (mainly, sum or mean value raster) from the HYDE rasters around the Reba et al. (2016) settlement locations.

The availability of population density allows the study of the impact of the Mongol Empire on the Great Divergence. Taking into account that the context is set in the 13th century CE, Malthusian dynamics explain economic growth and development (Ashraf & Galor, 2011). Here, I use changes in (the natural logarithm of) population density as a measure of economic development. Because population density follows the dynamics of the Total Factor Productivity (TFP) in Malthusian scenarios, population density is a good proxy for development in pre-modern times (Ashraf & Galor, 2011; Voigtländer & Voth, 2009, 2013). Consider, then, that population density will be a good proxy only until 1800, as the Industrial Revolution of the 19th century broke the Malthusian trap. The validity of the empirical exercises rests on the assumption (and evidence) of Malthusian dynamics. Refer to tables 11-16 for descriptive statistics.

Geographical information for controls and trade route costs is obtained from the open datasets

Natural Earth (in partnership with the North American Cartographic Information Society) and EarthEnv (in partnership with NCEAS, NASA, NSF, and Yale University). From the Natural Earth data, I obtain distances to rivers and coastal lines, and sea floor bathymetry (from rasters). From the EarthEnv dataset, I get elevation, roughness, ruggedness, and slope from rasters at 1 km resolution. Refer to table 10 for descriptive statistics.

The Mongol Empire geographical limits were reconstructed following historical maps in Anderson et al. (2009); Che and Lan (2021); Ciociltan (2012); Craughwell (2008); Kennedy (2002); May (2018); McLynn (2015); Onon (2001); Pederson et al. (2014). From these, I get the administrative limits of the Empire and the geodesic distances from each city centroid to the Empire.

The medieval commercial network was built based on Anderson et al. (2009); Ciociltan (2012); McCormick (2007); Michalopoulos, Naghavi, and Prarolo (2018). The spatial connections with Reba et al. (2016) and HYDE (Klein Goldewijk et al., 2016, 2011) are explained in detail in appendix C. I build a cost-benefit index per route segment per century using the geographical data and the HYDE dataset. From this, a weighted adjacency matrix is built, and the trade relevance of each city per century is defined as the city Betweenness Centrality.

Finally, the violence dataset used the World History Battles Database by Kitamura (2022). I complemented the Kitamura (2022) dataset with historical evidence from Craughwell (2008); Giebfried (2013); Jaques (2007); Kennedy (2002); Madgerau (2016); May (2007); Onon (2001); Sophoulis (2015). With this data, I track the number of battles per century within 50 km of each city centroid (one-day horse-riding distance (Silverstein, 2007; Weatherford, 2004)). Refer to tables 17 to 19 for descriptive statistics.

## Part IV

# Global Effects

As to account for the Great Divergence, the effects of the Mongol Devastation should endure at least until the Discovery of the Americas. Because if the effect of the Mongol treatment goes in favor of Europe, any existing effect by then would begin to be amplified by the Colonialism Era. The effects of the Mongol Devastation could have persisted until 1500 CE or 1600 CE, because Asia would not recover from the Mongol Conquests, meaning it would not reach the level of development or growth relative to Western Europe of 1200 CE again. Simultaneously, Europe could develop the means to grow at higher rates due to increased commerce because of the reactivation of the Silk Road during the *Pax Mongolica* in the 14th century (Di Cosmo, 2010), and the technology transfer from Asia as a consequence of the Mongol invasions of Europe (Ronan & Needham, 1980). (Acemoglu et al., 2008) argue that between the 16th and 17th centuries, Western Europe was already more developed than the Asian civilizations, due in part to the emergence and development of Atlantic inter-oceanic commerce because of the Conquest and Colonization of the Americas. Furthermore, the precious metal flow from the Americas into East Asia and the incursion of European powers in the Indian Ocean deepened the economic decline of Asia (Broadberry & Gupta, 2006; Gunder Frank, 1998).

American gold and silver's final destination was India and China, as European powers imported manufactured goods, exotic fruits, and spices. The adoption of silver as the money standard in China led to inflation, while European empires made profits, and their economies became more dynamic, although they experienced strong inflation episodes themselves (Flynn & Giraldez, 1995). However, the economic structures and institutions that allowed this to happen were a legacy of the Mongol Empire. The rise of Eurasian commerce and the Mongol urge to extract rents from European merchants created a huge taxation system, supported by Chinese and Japanese silver mines, deriving silver as the standard measure unit. The silver boom lasted until the mid-14th century, near the fall of the last khanates. The Ming dynasty in China replaced the Yuan, from Kublai Khan's lineage, but was unable to switch to copper coin or paper money from silver, thus keeping silver as the standard. Then the silver flow from the Americas came (Kuroda, 2009).

Thus, if the Mongol Devastation effects persisted long enough, they could be accentuated by the Conquest of the Americas and therefore be a fundamental cause of the Great Divergence. The final blow to the Great Asian civilizations would be the Industrial Revolution, from which point all this added up and stretched differences in development would become the Great Divergence.

The Mongol Empire rose fast and violently, causing the deaths of tens of millions and the destruction of major cities, kingdoms, and empires. In a short time, it was able to radically transform the trade dynamics over Eurasia, notably the flow of knowledge and technology. Mongol institutions were imposed over nearly a fifth of Earth's surface, mixing local forms of governance with centralized tributary and trade systems (McLynn, 2015; Onon, 2001; White, 2011).

Clearly, several aspects of economic growth and development are being affected simultaneously. Moreover, within the Malthusian setup, population and productivity shocks are intimately related (Clark, 2007). Violence shrank population, a "positive" Malthusian shock, but also destroyed sources of income and production. Simultaneously, technology outflow from East Asia comparatively benefited the least developed societies that could access and adopt Asian technology, a laggers' advantage (Aghion & Howitt, 2009). Likely among others, these rapid changes in demography and technology transformed the economic structures of societies, creating the conditions for industrialization and prosperity in some places, while stagnating or sending others into low-performance equilibrium.

Thus, the Mongol Devastation constitutes a bundle treatment: a unique event causing several simultaneous shocks that merge into a single outcome. But then, what interesting historical event is not? In the spirit of (Acemoglu et al., 2011; Dell, Lane, & Querubin, 2018; Galán, 2021), I first approximate the causal *aggregated* effect of the Mongol Conquests on the levels of economic development and the century-long economic growth rates. In the following sections, I attempt to partial out the individual effect of the most relevant aspects: violence, trade, and structural transformation.

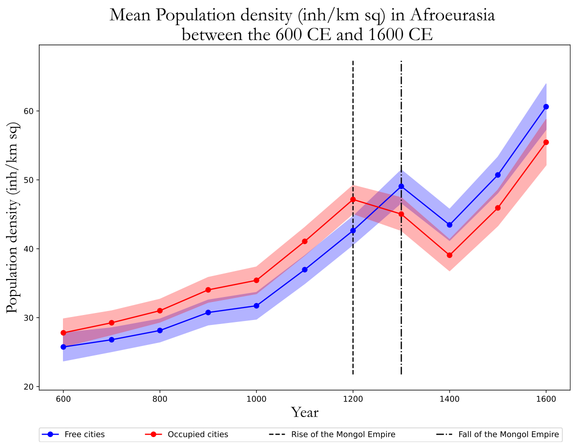
# 8 Long Run Effect on Development Levels and Persistence

The level effect of the Mongols on development will be assessed by a model of Differences-in-Differences (DID). Because the Mongol Empire rose and peaked within the same century, and the time frequency of the data is century level, every conquered territory was "treated" in the same period: the 13th century. Thus, the last pre-treatment period was the year 1200. The results will be then expressed relative to year 1200.

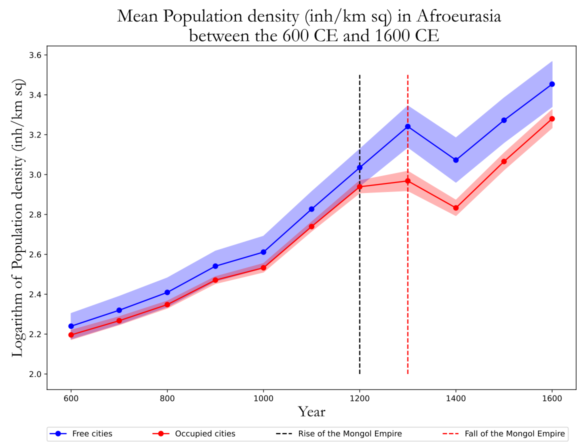
## Validity

The key assumption in DID is parallel trends: that the evolution of the treated and untreated is parallel before the moment of intervention. Century-level data makes it unclear as to how far in the past do we want the parallel trend assumption to hold. After controlling by linear trends, the evolution of population density between conquered and unconquered territories is parallel, as displayed in figure 4.

Figure 4: Trend evolution of population density (inh./sq km) among groups of Afroeurasian cities from 600 to 1600




((a)) Evolution of population density absolute levels




((b)) Evolution of the logarithms of population density

**Data:** Reba et al. (2016), Klein Goldewijk et al. (2016)

A point worth mentioning is that of non-anticipation, as technically, all the conquered cities were not invaded at the same time. If, for example, decade-level data were available, a Case Event Study would be more adequate. In this regard, although the Central Asian steppes had already pumped a major invasion into China, Persia, and Europe before, during the decline of the Roman Empire (the Hunic Conquests led by Attila in the 4th century CE), along the Middle Ages, no other warlord from the Steppe had come even close to conquering a Chinese state, let alone invading Europe (Anderson et al., 2009; H. J. Kim, 2013). The increased war capacity of the Mongol warlords, preceded by favorable climate change in the mid-12th century, was not deployed against major world powers until Genghis Khan rose to power in the early 13th century (Che & Lan, 2021; De Hartog, 2004; McLynn, 2015; Pederson et al., 2014; Putnam et al., 2016). Also, the last pre-treatment period in my sample is just six years before the beginning of the Mongol Conquests (1200 CE), and the Empire reached its peak and dissolved shortly before the next period available (1300 CE). Thus, it is reasonable to think that no city in my sample could anticipate the effects of the Mongol Devastation on itself.

Meaning, the exogeneity of the treatment relies on two dimensions: time, the moment of the Mongol Devastation is not anticipated; space, the extent of the Mongol Empire expansion, thus the treatment condition is also unknown *ex-ante*.

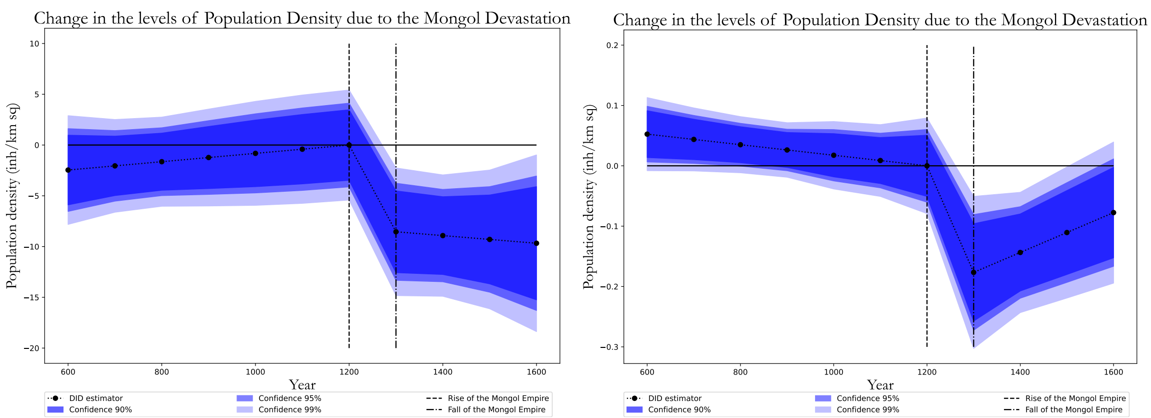
## Estimation

With all this in mind, let $Y_{it}$ be the population density of city $i$ at time $t$; $\theta_t$ and $\eta_i$ be century and city fixed effects; $\theta_{it}$ are the linear group trends; $\epsilon_i$ be errors clustered in the city level (Abadie, Athey, Imbens, & Wooldridge, 2017); $C_i$ be the indicator of having been conquered by the Mongol Empire by 1279 CE. I estimate the equation:

$$Y_{it} = \theta_t + \eta_i + \theta_{it} + \sum_{s=500, s\neq 1200}^{1700} \tau_s C_i \times I[s = t] + \epsilon_i \tag{17}$$

Results are shown in figure 5. No systematic differences are found between conquered and unconquered cities prior to the 13th century. However, by the year 1300 CE, a sharp decline in population density is observed in cities conquered by the Mongols during the previous century. Recall, under the Malthusian regime, this means a relative decline in development. Moreover, this fall in income levels in the Mongol Empire cities is persistent all the way through the 17th century.

Figure 5: Evolution in population density (inh./sq km) gap between conquered and unconquered cities from 600 to 1600



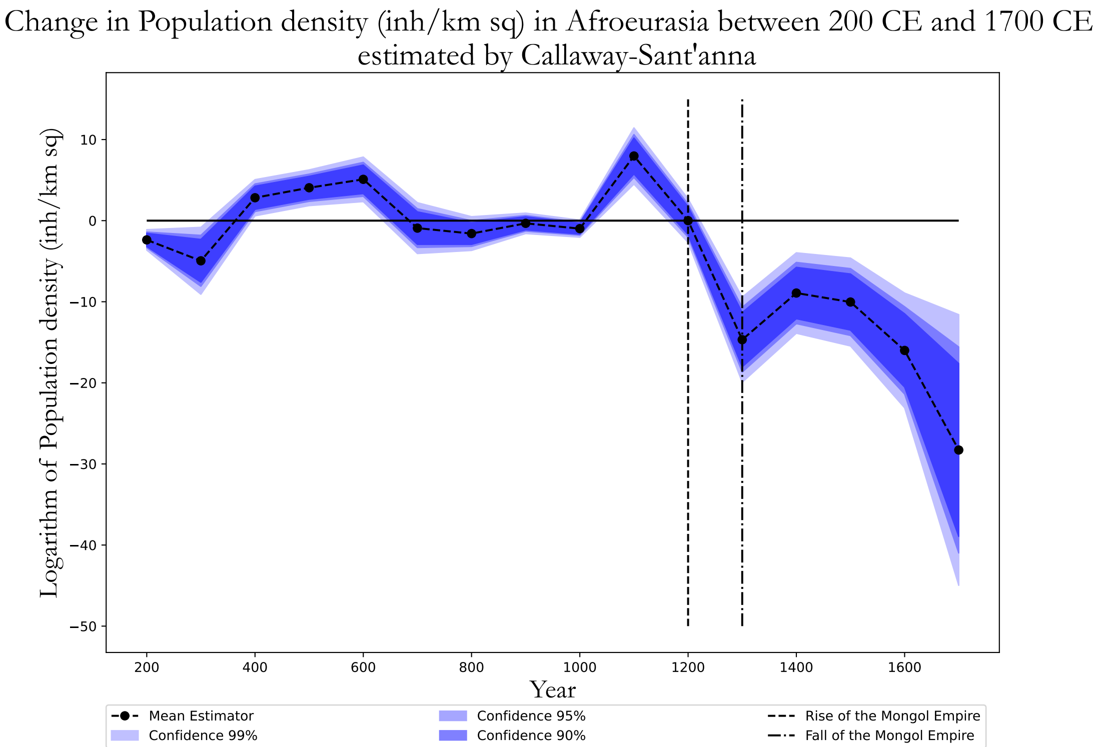

((a)) Level Effect

((b)) Effect on Growth

**Data:** Reba et al. (2016), Klein Goldewijk et al. (2016)

On a second specification, using Callaway and Sant'Anna (2021) two-way fixed effects I get very similar results, as displayed in figure 6.

Figure 6: Effect of the Mongol Devastation over Eurasia from 200 CE - 1700 CE using Callaway and Sant'Anna two-way fixed effects




**Data:** Reba et al. (2016), Klein Goldewijk et al. (2016)

These results suggest that not only did the Mongol Empire cause a decline in development indicators on their territories relative to the unconquered cities, this contraction persisted and accentuated for at least four centuries, at least until when my data stops working as valid proxy for economic development.

Thus, together with the RDD results, we have evidence that the overall effect of the Mongol Invasions of the 13th century was negative on the levels of economic development between conquered and unconquered territories. Coherent with the Mongol Empire historiography, the effects of the Mongol conquests were deep and persistent (Haw, 2013; McLynn, 2015). From the historical records, these effects come from both benefits for the unconquered and high costs for the conquered. That is, not only did the Mongols cause a decline in the territories they conquered, but the Empire also facilitated some of the unconquered territories to flourish, notably Western Europe.

Mass destruction of cities, salting of croplands, burning of libraries and hospitals, mass slaughter of populations, long-scale battles, among others, brought the decline of Chinese, Persian, Middle Eastern, and Eastern European economies. As sources of wealth, production, and technical progress were targeted by the Mongols during conquest (De Hartog, 2004; McLynn, 2015; Onon, 2001). When the time came to govern over the conquered, the cities and their economies had to be rebuilt and had to recover. However, economic recovery under the Mongols could not last long. The Empire collapsed in 1294 CE after Kublai Khan died, just 15 years after reaching its peak extension. The vacuum of power left by the Empire brought a new period of instability and conflict as new kingdoms and empires emerged (McLynn, 2015; Tilly, 1990; Turchin, 2007).

The 1300–1400 trend suggests that the invaded territories began to recover in the century after the collapse of the Empire. However, possibly due to the dynamics of the world economy following the Renaissance and the Conquest of the Americas, the gap created by the Mongols deepened.

Another plausible mechanism for the accentuation of the gap from 1400 CE to 1500 CE is the rise of the Ottoman Empire. If the Mongol violence effect over their territory was attenuated by Silk Road commerce, the Ottoman capture of Constantinople and harsh international trade policies would have turned off this source of economic recovery for Mongol-conquered lands (Finkel, 2007; Inalcik, 1997).

Moreover, the reactivation of silver flow into China (Kuroda, 2009) and the violent incursion of European trading companies in the Indian Ocean, given their military advantage relative to Asian powers (Broadberry & Gupta, 2006; Gunder Frank, 1998), led to the rise of Europe and pushed for the decline of Asia. This may explain the abrupt growth of the development gap between 1500 CE and 1700 CE.

Furthermore, the beginning of the Industrial Revolution pushed further the development gap created by the Mongol Devastation. This is a key result: not only did the development gap created by the Mongols last until the beginning of the Industrial Revolution, but it was also stretched by it.

Therefore, I have provided evidence that the Mongol Conquests are indeed a cause of the Great Divergence, as their effects can be quantitatively traced between the 13th and the 18th century.

# Part V

# Mechanisms

Now that I have shown that the Mongol Devastation caused a deep and persistent contraction in wealth levels and economic growth rates that extend towards the 18th century, it is left to assess the mechanisms of this effect and persistence.

The theoretical framework build in the model suggests that violence, technology transfer (through trade), and structural change are the key aspects the Mongol Invasions transformed radically and in short time. Through violence, the deaths of millions and the destruction of cities and wealth sources, the Malthusian Equilibrium is lower in population and, thus aggregated wealth. New trade opportunities when connecting the technological frontier in China and India, with Europe, asymmetrically benefited the economies that lagged behind in their technological progress. Technical progress is the only source of potentially sustained economic growth. It can only be achieved either when the accessible technical frontier is capable of endogenous sustained progress, or capital accumulation has lead to the emergence of sectors capable of endogenous technical progress within the city itself. The capacity to translate technical progress into capital accumulation depends on the economic structure and the growth rate of the population.

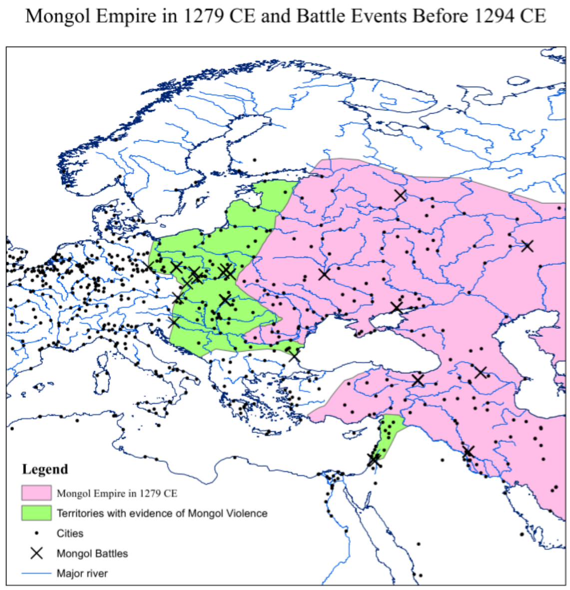
In the following sections, I show that the Mongol violence caused a contraction in economic growth; the relative relevance of unconquered territories in world trade grew faster than in the Mongol territories; the land-to-labour ratio increased in the unconquered cities, but decreased in the conquered territories.

## 9 Mongol Violence

The most direct effect of the expansion of the Mongol Empire is the long scale violence across Eurasia. In the Malthusian set-up, the Mongols attacked directly the population and the sources of wealth. Thus, it is unclear whether the per capita income increased or decreased in the short run, let alone the long-run dynamics.

In this section, I exploit the fact that the Mongol Empire was unable to control every territory they invaded. This means some invaded territories were not successfully conquered. As shown in figure 7, the Mongols invaded a large extent of Eastern and Central Europe before decisive defeats in German kingdoms, Bohemia-Moravia, and modern-day Croatia (Kitamura, 2022; McLynn, 2015; Nicolle, 1990; Onon, 2001). They also attempted a large-scale invasion of the Eastern Mediterranean

Figure 7: Extent of Mongol Empire and Occupation Attempts within the 13th Century




**Main Data:** Jaques (2007); Kitamura (2022); Reba et al. (2016)
**Complementary Data:** Craughwell (2008); Giebfried (2013); Kennedy (2002); Madgerau (2016); May (2007); Onon (2001); Sophoulis (2015)

into the Sinai Peninsula before suffering the famous decisive defeat in the Battle of Ain Jalut in 1260.

As suggested earlier, Mongol defeats and final limits are arguably (quasi-) random. The Ain Jalut defeat in 1260, for instance, was partially caused by the reallocation of a large portion of the Mongol army in the Middle East after the death of Mongke Khan, as a war for succession was set to begin (Nicolle, 1990). However, it can be argued that the alliances forged among European kingdoms to contain the expansion of the Empire into Western Europe are endogenous to development outcomes and explain why the Mongols could not attack cities past a certain point. The problem with this claim is the fact that other European kingdoms and alliances had already been successfully conquered, as was the case of Romania, portions of Poland-Lithuania, and Kievan Rus (De Hartog, 2004; McLynn, 2015; Nicolle, 1990; Onon, 2001). This is to say war is non-deterministic, and luck tends to play an important role in the outcomes.

With this in mind, cities fell nearly at random into one of three categories: conquered; invaded but unconquered; not invaded. I propose using these categories as part of a factorial design to partial out different aspects of the Mongol expansion.

Taking the not invaded cities as base category, let $I_i := I\{\text{Invaded but not conquered by Mongol Empire by 1279}$, $C_i = I\{\text{Conquered by Mongol Empire by 1279}\}$. Taking into account that every conquered territory was invaded (thus, no indicator of conquered but not invaded is not needed), I estimate the model:

$$g_i = \beta_0 + \tau_t C_i + \alpha_t I_i + \gamma X_i + \eta Z_{it} + \epsilon_{it} \tag{18}$$

Where $g_{it} := \frac{\Delta \ln(Y_{it})}{\Delta t}$ is the growth rate of economy $i$ between centuries $t$ and $t-1$. $X_i$ is a set of time invariant controls: elevation, roughness, rugedness, slope, distance to nearest major river, and distance to nearest coastal access. $Z_{it}$ is a set of time-varying controls: land-use variables and number of battles within 50km of the city. $\epsilon_{it}$ is the term of error. I run this estimation for periods 1200-1300, up to 1600-1700, as to show for persistence and evolution of the effects.

Here $\alpha_t$ estimates the effect of the Mongol Invasion, $\tau_t$ estimates the effect of the Mongol Conquest, and $\tau_t - \alpha_t$ estimates the effect of the Mongol Conquest without the invasion. This imperfectly captures in the $\alpha_t$ coefficient the effect of Mongol direct violence through invasions; arguably, most of this coefficient is just violence, the dynamics of war. In contrast, $\tau_t - \alpha_t$ is capturing every other aspect of Mongol governance, say: tributary institutions, trade policy, social division of labour, local governance, among others.

Results for the estimation of the model in equation 18 are displayed in table 1.

During the 13th century, the effect of violence was second to the effect of the rest of the Mongol shock. Less than a fifth of the effect on economic growth was could be attributed to the Mongol Invasions. In contrast, more than 80% of the effect on growth rates during the century of Mongol occupation could be attributed to Mongol governance dynamics.

The results get confusing by the 14th century. As the last khanates dissolved, the difference estimator shows that something in Mongol governance dragged the recovery of conquered territories. Or, it could be that as the Empire dissolved, the subsequent chaos left in the void of power affected the recovery potential of the cities once ruled by the Empire. Also, both invaded only and conquered cities caught up with the not invaded territories. Invaded only, recovered faster during this period. Invaded territories did not suffer the consequences of decisive defeat: few people other than the military perished in battle and sieges, relative to occupied cities; if the city could not be taken, its sources of wealth and infrastructure could not be destroyed by the Mongols. Therefore, as the Empire collapsed, the invaded only territories could enjoy some increased per capita wealth in the short run, and population density could increase faster relative to conquered cities and even unconquered cities. Another plausible explanation is the Black Plague. A more disperse population in Eastern Europe (which is over-represented in the invaded only group) made it difficult to the Plague to spread, while in Western Europe and China, the disease could spread faster among denser population (Voigtländer & Voth, 2013).

However, by the 15th century, the direct effect of the Mongol Invasions dominated: the invaded only cities were growing at 8 percentage points slower than the rest of the world. The direct effect of violence remained relevant up until the 17th century: not invaded cities grew faster than both, conquered and invaded territories.

Table 1: Effect of Mongol Violence: Factorial Design between Conquered, Invaded but Unconquered, and Non-Invaded Cities

*Violence*

| | ($\tau$) Conquered | ($\alpha$) Invaded Only | ($\tau - \alpha$) Estimate Difference | N. Obs | Geo. Control | Land Control | Viol. Control |
|---|---|---|---|---|---|---|---|
| Growth 1200-1300 | -0.2773*** (0.023) | -0.0645* (0.033) | -0.2128*** (0.0402) | 1125 | Yes | Yes | Yes |
| Cumulative Growth 1200-1400 | -0.1921*** (0.0161) | 0.1220*** (0.0258) | -0.3141*** (0.0503) | 1125 | Yes | Yes | Yes |
| Cumulative Growth 1200-1500 | -0.1796*** (0.0193) | -0.0412 (0.0337) | -0.2208*** (0.0558) | 1125 | Yes | Yes | Yes |
| Cumulative Growth 1200-1600 | -0.1952*** (0.0211) | -0.081 (0.0370) | -0.1872*** (0.0584) | 1125 | Yes | Yes | Yes |
| Cumulative Growth 1200-1700 | -0.3327*** (0.0254) | -0.1128*** (0.0390) | -0.2200*** (0.0614) | 1125 | Yes | Yes | Yes |

**Note:** Robust standard errors: *** p<0.01, ** p<0.05, * p<0.1
**Main Data:** Jaques (2007), Reba et al. (2016), Kitamura (2022)
**Complementary Data:** Onon (2001), Kennedy (2002), May (2007),Craughwell (2008), Giebfried (2013), Sophoulis (2015), and Madgerau (2016)

Rather puzzling in a Malthusian set-up, the contraction of population did not foster increased per capita wealth in the short run; nor did the growth rates converged in the span of five centuries. In one hand, the contraction of population came along the destruction of sources of wealth and misallocation of labour. On the other hand, hysteresis in the economic structures given the slow recovery of population after the Mongols and the Black Plague can explain differential technical progress and benefits from it.

This two aspects are studied in the next sections: the changes in trade patterns, associated with technology exchanges and the emergence of new technological frontiers; and the evolution of the economic structures in the centuries following the Rise of the Mongol Empire.

This results, however, rely under the assumption that belonging to either group is exogenous to development-related confounders, which is rather strong. Either the invaded but unconquered territories had certain characteristics that allowed them to repel the Mongol invaders; or could have happened that the Empire reached a limit in which its resources came insufficient to succeed at conquest. Historical evidence also implies that non-invaded cities and territories supported invaded cities against the Mongols, for instance, the definitive defeats of Mongol general Subotai in Bohemia were against a league of several Central European nations, cities, and kingdoms.

Therefore, I use Cattaneo, Frandsen, and Titiunik (2014) small-sample non-parametric RD estimation. The estimation is performed twice, one on each border: invaded but unconquered vs non-invaded; conquered vs invaded only. Results are displayed in table 2.

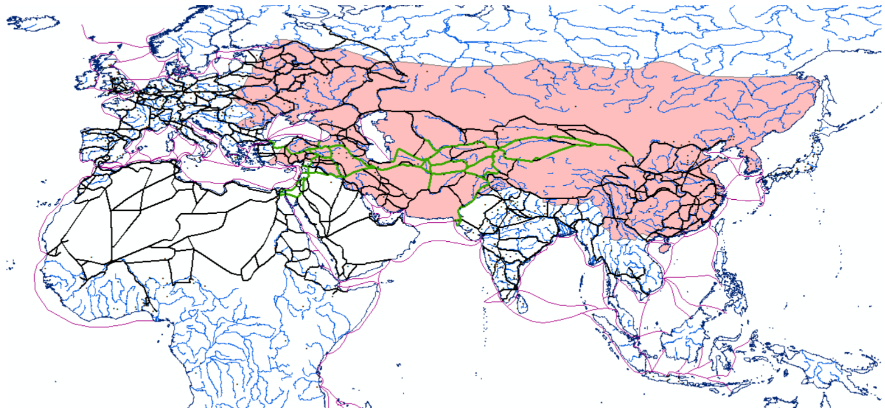
Table 2: Effect of Mongol Violence: Factorial Design between Conquered, Invaded but Unconquered, and Non-Invaded Cities. Estimated by Cattaneo et al. (2014) RD local randomization.

| *Violence* | | | |
|---|---|---|---|
| *Conquered vs Invaded Only* | | | |
| | Local Rand RD Estimate | BW (km) | Obs. |
| Growth 1200-1300 CE | -0,3 (0,19) | 240 | 97 |
| Growth 1300-1400 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1400-1500 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1500-1600 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1600-1700 CE | -0,15 (0,19) | 240 | 97 |
| *Invaded Only vs Free Cities* | | | |
| | Local Rand RD Estimate | BW (km) | Obs. |
| Growth 1200-1300 CE | -0,58*** (0,19) | 336 | 92 |
| Growth 1300-1400 CE | -0,63*** (0,2) | 336 | 92 |
| Growth 1400-1500 CE | -0,57*** (0,2) | 336 | 92 |
| Growth 1500-1600 CE | -0,52*** (0,19) | 336 | 92 |
| Growth 1600-1700 CE | -0,57*** (0,19) | 336 | 92 |

**Note:** Standard Errors: *** p<0.01, ** p<0.05, * p<0.1
**Main Data:** Jaques (2007), Reba et al. (2016), Kitamura (2022)
**Complementary Data:** Onon (2001), Kennedy (2002), May (2007),Craughwell (2008), Giebfried (2013), Sophoulis (2015), and Madgerau (2016)

These results suggest an stronger effect of violence than the parametric factorial design, plus a relevant negative, however, statistically non-significant effect of the conquests without the effect of the invasion. As invasion is not a perfect measure of violence, we must be careful when interpreting these coefficients. Nevertheless, the result is strong enough, as to suggest that the effect of Mongol

Figure 8: Main Medieval Trade Routes and the Mongol Empire at its Peak



Black: Main Trade Routes by Land
Green: Silk Road by Land
Purple: Sea Trade Routes
**Data:**
***Routes*:** (Anderson et al., 2009; Ciociltan, 2012; McCormick, 2007; Michalopoulos et al., 2018)
***Empire and Cities:*** (Anderson et al., 2009; Che & Lan, 2021; Ciociltan, 2012; Craughwell, 2008; Kennedy, 2002; May, 2018; McLynn, 2015; Onon, 2001; Pederson et al., 2014; Reba et al., 2016)

violence over development was deep and persistent, and shrunk the levels of development in the invaded cities.

## 10 Eurasian Trade

Between the Fall of the Western Roman Empire and the Rise of the Mongol Empire, the Silk Road was rendered nearly irrelevant in world trade (Anderson et al., 2009; Di Cosmo, 2010). The world trade center moved into the Indian Ocean for most of the Middle Ages (Gunder Frank, 1998). The fractured control of the Silk Road, the insecurity of long-scale trade between India and China, and Europe through it reduced the exchanges between Europe and Asia below the levels of trade achieved during the times of the Roman Empire.

When the Mongol Empire expanded through Eurasia, almost the entire Silk Road was located within its limits, as seen in figure 8. The Mongols opened to trade with nearly every neighboring kingdom, and with European merchants in particular. Commodities ranging from spices and fabrics to paper and gunpowder were imported into Europe through the Silk Road in exchange for tribute to the Mongols (H. Kim, 2009; Kuroda, 2009; Ronan & Needham, 1980). The reactivation of the Silk Road gave once again a living breath to trade between Europe and Asia and, as will be shown, led to the rise of Europe as a merchant power, setting the stage for the shift towards the Atlantic of world trade centuries before the Age of Exploration.

In the light of the model, the Mongols increased the trade connectivity $\frac{\partial A}{\partial t} = \nu \nabla^2 A$ and (weakly) opened cities to better frontier technology. In historical terms, they gave Europe access to Chinese technology (Andrade, 2016; Christensen, 2014; Haw, 2013). As the lagging economies, Europeans benefited the most from technology exchange and adoption (Aghion & Howitt, 2009). That is, the marginal effect of trade on TFP is higher in follower cities than at the frontier, everything else constant.

Thus, what follows is to test empirically whether the relevance of the unconquered cities in trade grew relative to the conquered cities.

## Measuring Trade Relevance in Pre-modern times

It would be a titanic task to track in time the trade routes by sea and land for the last millenium or so. Therefore, I propose the following procedure to approximate the evolution of trade dynamics in Eurasia in the Late Middle Ages. This procedure consists in creating a connected weighted graph between the cities, where the weights evolve in time and measure the costs and benefits of the routes.

The procedure described in appendix C creates a connected graph: every city is accessible from every other. To define the weight of each segment, first the network is split at its vertices. Second, I define the Thiessen Polygons[4] for the cities sample and split again the segments at the intersections of the network with the perimeter of the polygons. Then, each segment ($\cdot_{is}$) in polygon of city ($i$) is weighted as a geometric index of normalized elevation ($H_{is}$), ruggedness ($R_{is}$), roughness ($r_{is}$), and slope ($S_{is}$):

$$\omega_{is} = [(1 + H_{is})(1 + R_{is})(1 + r_{is})(1 + S_{is})]^{\frac{1}{4}}$$

This is a time invariant cost of mobilizing through segment $s$ when the closest city is $i$.

To capture time varying potential benefits of the route segment, I divide the weight by the urban area density of the closest city at each century $U_{it}$. Thus, the network segment weights are:

$$\omega_{ist} = \frac{\omega_{is}}{U_{it}}$$

[4]The Thiessen Polygon of city $i$ is the set of points on Earth which are closer to city $i$ than to any other city

For the network weights $W_{ijt}$ from city $i$ to city $j$ in century $t$:

$$W_{ijt} = \min_{P_{ij}} \sum_{s \in P_{ij}} \omega_{ist}$$

The weight $W_{ijt}$ is the sum of segments $s$ in path $P_{ij}$ from city $i$ to city $j$ such that this sum is minimum.

Finally, let $\delta_{ij}$ be an indicator equal to 1 if the Thiessen Polygons of cities $i$ and $j$ share a frontier.

With this, the adjacency matrix $M_{ijt}$ for century $t$ is:

$$M_{ijt} = [\delta_{ij} W_{ijt}]_{ij}$$

From the adjacency matrix, I calculate the betweenness centrality ($B_t(i)$) of each city $i$ at century $t$. Let $\mathcal{P}_t(k,l)$ be the weight of the shortest path from city $k$ to city $l$.

Let $\mathcal{P}_t(k,l|m) = 1\left\{m \in_{P_{ij}} \sum_{s \in P_{ij}} \omega_{ist}\right\} \mathcal{P}_t(k,l)$ be the same weight, but it is zero if city $m$ Thiessen Polygon is not visited.

Then:

$$B_t(i) = \sum_{k,l} \frac{\mathcal{P}_t(k,l|i)}{\mathcal{P}_t(k,l)}$$

## Results

For the causal effect of the Mongols in Eurasian commerce, I estimate the change in $B_t(i)$ per century in the RDD specification of Section 8. $\Delta B_t(i)$ measures the change in trade relevance, meaning more routes passed through the city as its trading potential (given by $U_{it}$) increased. The RDD in parametric form analogous is:

$$\Delta B_t(i) = \beta_0 + \gamma C_i + \epsilon_i : |D_i| \leq \eta$$

Results are displayed in table 3 and figure 9 (see figure 13 for the RD plot).

Table 3: Estimation of Non-Parametric RDD for the evolution of Trade Relevance between years 1000-1500

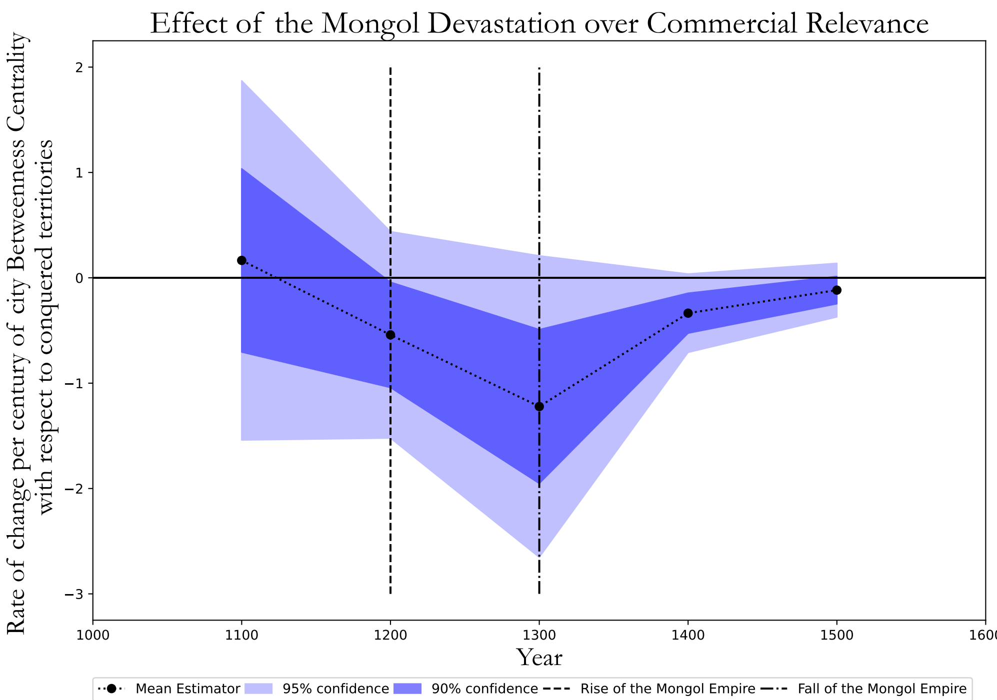
| *Change in Commerce Index* | | | | |
|---|---|---|---|---|
| | RD Estimate | BW (km) | N. Obs | Local Poly. Order |
| Change 1000-1100 | -0.05<br>(0.57) | 2017 | 697 | 1 |
| | 0.17<br>(0.87) | 2193 | 739 | 2 |
| Change 1100-1200 | -0.51**<br>(0.27) | 2429 | 772 | 1 |
| | -0.54<br>(0.5) | 2235 | 740 | 2 |
| Change 1200-1300 | -0.97**<br>(0.5) | 2599 | 775 | 1 |
| | -1.22*<br>(0.73) | 2482 | 767 | 2 |
| Change 1300-1400 | -0.04<br>(0.11) | 2844 | 799 | 1 |
| | -0.34*<br>(0.19) | 2339 | 758 | 2 |
| Change 1400-1500 | -0.01<br>(0.07) | 1712 | 539 | 1 |
| | -0.12<br>(0.13) | 2199 | 733 | 2 |

**Note:** Bias-corrected robust standard errors: *** p<0.01, ** p<0.05, * p<0.1
**Specification:** Non-parametric RDD (Calonico, Cattaneo, and Titiunik, 2014). Kernel: Epanechnikov. Local polynomials order: 1, 2.
**Main Data:** Natural Earth, EarthEnv, Klein Goldewijk et al. (2016)
**Complementary Data:** McCormick (2007), Anderson et al. (2009), Ciociltan (2012) and Michalopoulos et al. (2018); Reba et al. (2016)

The Mongol Empire did change the trade patterns over Eurasia. The unconquered cities grew more relevant in terms of trade in the following two centuries after the collapse of the Empire, relative to the conquered cities. Consistent with the historiography of the *Pax Mongolica*, the flows of commerce increased along the 13th and 14th centuries predominantly in Western Europe as a consequence of the renewed trade through the Silk Road (Di Cosmo, 2010; Franke, 1966; McLynn, 2015; Ronan & Needham, 1980). However, the Mongol influence on trade lasted only until 1500. Between 1400 and 1500, a century after the last remnants of the Empire were dissolved, the trade relevance differences reached a steady state. The 15th century witnessed the rise of the Ottoman Empire, which imposed harsh trade conditions on European merchants after the Fall of Constantinople (Anderson et al., 2009; Finkel, 2007; Inalcik, 1997). As a consequence, the Silk Road trade declined once again after two centuries of apogee under the Mongols, which pushed Western Europe into the Age of Exploration, leading to the Discovery and Conquest of the Americas in the 1600s.

The improvement of trading relevance in unconquered territories, which are predominantly Western European cities, shifted the world trade center towards the North Atlantic. This could set the stage for the Rise of Europe, as described in (Acemoglu et al., 2008). Although I do not test the impact of trade on any dimension of development, there is evidence that the steady increase in the trading relevance of Western European cities could lead to institutional changes, urbanization, and structural transformation (Acemoglu et al., 2008; Pirenne, 1977, 2014; Voigtländer & Voth, 2013).

Figure 9: Evolution of Betweenness Centrality of Eurasian Cities due to the Mongol Conquests




**Note:** Confidence intervals from bias-corrected robust standard errors: *** p<0.01, ** p<0.05, * p<0.1
**RD Plot:** see figure 13 in appendix F
**Specification:** Non-parametric RDD (Calonico et al., 2014). Kernel: Epanechnikov. Local polynomials order: 1, 2.

**Main Data:** Natural Earth, EarthEnv, Klein Goldewijk et al. (2016)
**Complementary Data:** McCormick (2007), Anderson et al. (2009), Ciociltan (2012) and Michalopoulos et al. (2018); Reba et al. (2016)

Thus, also through their effects on Eurasian trade, the Mongols set the stage for the Rise of

Europe. More trading relevance leads to urbanization (Pirenne, 1977, 2014; Voigtländer & Voth, 2013), which implies higher demand for capital-intensive commodities (Voigtländer & Voth, 2009, 2013). This demand presses towards the development of capital-intensive sectors, which foster capital accumulation and endogenous technical change (Aghion & Howitt, 2009; Voigtländer & Voth, 2013). It also fosters institutional change and constraints on the executive by creating a wealthy and powerful merchant class able to make demands to the ruling classes that benefit freer and more efficient economic activity (Acemoglu et al., 2008).

Perhaps one of the most relevant aspects of the increased flow of commerce through Western Europe was the arrival of gunpowder and the movable-type printing press (Andrade, 2016; Christensen, 2014; Haw, 2013). Gunpowder turned Europe into the world's military power, while the printing press favored the diffusion of the Renaissance and led to the Enlightenment and the Scientific Revolution from the 1600s onward (Christensen, 2014; Jara-Figueroa et al., 2019; Weinberg, 2015).

The seeds for the Rise of Europe through trade, and the Decline of Asia through violence, were brought by the Mongol Empire.

# 11 Structural Change

In this section, I provide evidence that the Mongol Devastation is closely related with the structural transformation of Eurasia. The economic structures can be affected by catastrophic events if the available labour and/or infrastructure endowment changes rapidly and abruptly. In the Malthusian set-up, the fundamental relation embedded in the progress, wealth and recovery potentials lies in the land-to-labour ratio (Voigtländer & Voth, 2009, 2013). I further propose, from the model set-up, that the levels of capital endowment complete the Malthusian mechanism that can prompt endogenous growth and the escape from the Malthusian Poverty Trap itself.

The land-to-labour ratio is in direct relation with individual income: more land to be worked per worker, means relatively scarce labour, thus, high wages (Voigtländer & Voth, 2009, 2013). The wealthier the representative individual, the more capital-intensive commodities will demand, therefore fostering the conditions for supply via commerce or endogenous provision. Capital intensive goods require better technology and skills, which create the conditions for creative destruction and learning by doing. Thus, human capital improves, and the rate of innovations increases. This implies, when the land-to-labour ratio increases, the conditions for the emergence of capital-intensive sectors that prompt endogenous and sustained growth appear. However, if with insufficient capital, the Malthusian mechanism of increased wealth in the short run will not trigger the emergence of the sectors where the endogenous growth potential exists.

In this sense, Mongol violence and the Black Plague augmented the land-to-labour in all of Eurasia. However, they also affected the endowment of non-labour and non-land factors: capital. Mostly in the Mongol conquered lands, the devastation included extensively the cities infrastructure itself.

## Economic Structure and Factor Shares in Pre-modern Times

Given the data availability, this section does not intend to identify a causal effect. Rather, this section intends to motivate further rigorous research on pre-modern factor shares and the evolution of economic structures, and provide suggestive evidence that the 13th century is a key moment in time to understand a radical shift in the Eurasian development trends. Thus, this section is more descriptive and observational in nature, than the previous.

Assume the aggregated output ($Y$) remunerates three factors: agrarian labour ($L_A$), land ($Z_A$), and capital ($K$). From the HYDE data-set, I proxy agrarian labour as the rural population count ($\tilde{L}_A$), land as area density of crops ($\tilde{Z}_A$), and capital as urban area density ($\tilde{K}$). I use the population density ($\tilde{Y}$) to proxy the aggregated output.

I first estimate the product elasticities $\beta^F_{Ts}$ of each factor $F \in \{L_A, Z_A, K\}$ in century $T$ for cities in group $s \in \{\text{Conquered}, \text{Unconquered}, \text{Afroeurasia}\}$:

$$\ln[\tilde{Y}_{it}] = \beta_0 + \beta^L_t \ln[\tilde{L}_{A_{it}}] + \beta^Z_t \ln[\tilde{Z}_{A_{it}}] + \beta^K_t \ln[\tilde{K}_{it}] + \epsilon_{it} \quad \text{Given: } t = T$$

For centuries 1st to 18th.

Then, I define the share ($\alpha^F_{Ts}$) of factor $F$ in century $T$, for sample $s$:

$$\alpha^F_{Ts} = \frac{\beta^F_{Ts}}{\sum_{f\in\{L_A,Z_A,K\}} \beta^f_{Ts}} \tag{19}$$

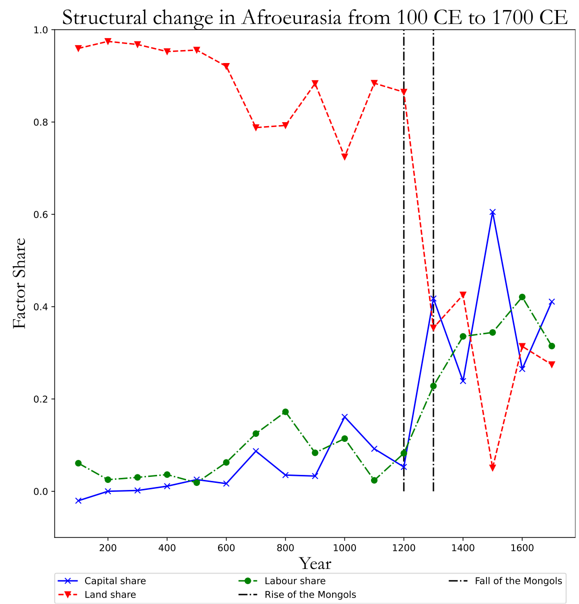
Note this guaranties: $\sum_{f\in\{L_A,Z_A,K\}} \alpha^f_{Ts} = 1$

So that I am defining the share of factor $F$ in income as the proportion of the total output-elasticity of these three inputs.

## Results

The evolution of factor shares as defined in equation 19 for Eurasian cities is displayed in figure 10.

Figure 10: Evolution of factor shares in Afroeurasian cities since year 100 to 1700




Note that the data depicts some expected regularities. First, the land share of income is nearly total during the Ancient Era and along the Middle Ages. Second, capital share and labour share are much lower in these epochs, but begin to dominate over land income from the Late Middle Ages.

What is perhaps odd, however, consistent with the story of this paper is the decline of land share between 1200 and 1300. Before the Black Plague and the Renaissance, the Afroeurasian economies experienced a sharp decline of the land share in income. Something happened in the 13th century that prompted a generalized decline in the land share, and a rise of labour and capital shares. Given the scale, reach and nature of the Mongol Invasions, against many other more local and less traumatic events of the 13th century, the Mongol Devastation is a likely explanation for this decline.

It is worth clarifying, that the rise of capital share does not necessarily imply capital accumulation, it means that capital became relatively more relevant in income, but does not say anything about the levels of capital and income themselves.

What this data can provide insights of is on the land-to-labour ratio. As land is remunerated relatively less, and labour is paid relatively more, more land is available per agrarian labourer, independently of the scale. Considering the model, this means, that the per capita agrarian income should have risen when the land share declines and the agrarian labour share increases. This is:

$$\frac{\alpha_T^Z}{\alpha_T^L} \propto \Phi\left(\frac{Z_A}{L_A}\right) \propto \Psi(w_A)$$

Where $\Phi(\cdot)$, $\Psi(\cdot)$ are increasing functions.

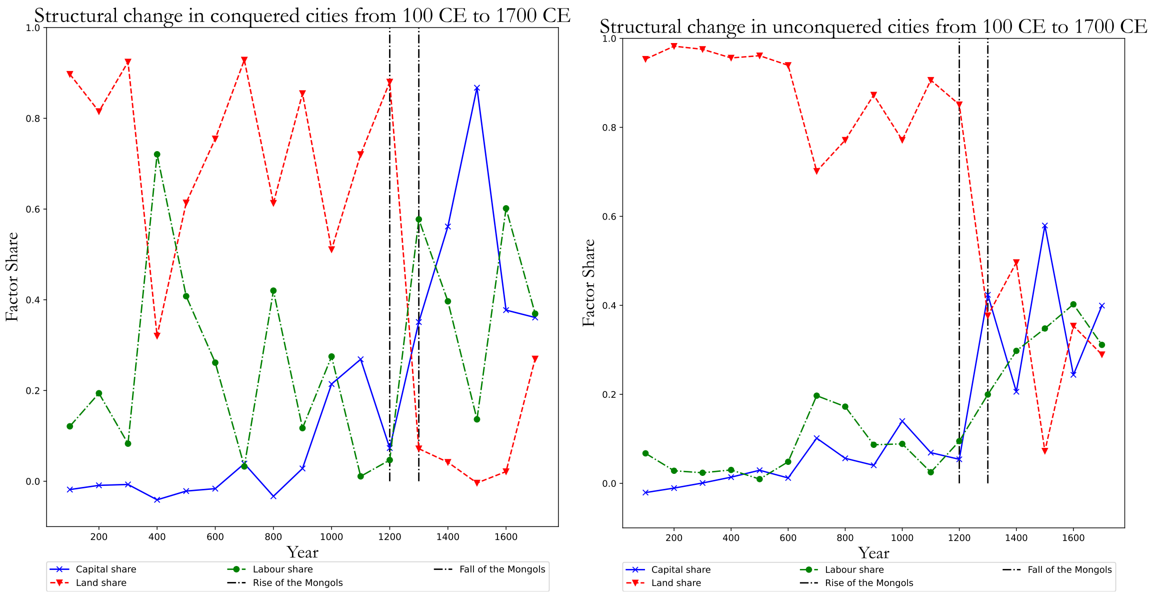
In this sense, I ask, where did the land-to-labour ratio increased the most? In the Mongol Empire, or elsewhere.

Figure 11 shows side by side the evolution of factor shares in what would be and was the Mongol Empire, and in the rest of Afroeurasia.

Clearly, the land-share of income declined faster in the Mongol Empire than in the rest of the world. Simultaneously, labour income increased faster in the Mongol Empire than outside of it. Therefore, the agrarian wages, relatively grew outside the Empire.This means, population in the conquered cities grew relatively poorer during the 13th century. This means, that the virtuous cycle of demand of manufactured, capital-intensive, goods could have been stronger outside the Empire than on it.

On a note on capital share, this increased strongly in the Mongol Empire than in the rest of Eurasia. However, it must be clear that this does not imply that capital was accumulated faster inside the Empire, as the share does not speak about the levels of capital, which is the relevant quantity in fostering the conditions for endogenous economic growth.

Figure 11: Evolution of factor shares in conquered and unconquered cities since year 100 to 1700




# Part VI

# Concluding Remarks and Discussion

This paper examined the escape from the Malthusian trap into a world of sustained creation of wealth and unequal growth, from a historical, theoretical, and empirical perspective. Its main contribution to economic history is to account for both the causes of the Rise of Europe and the Decline of Asia, which ultimately lead to the Industrial Revolution in Europe and to the Great Divergence. It also complements and extends the Unified Growth Theory and Malthusian models to explain necessary and sufficient conditions for escaping the Malthusian trap. It also implied the creation of a novel data-set accounting for the history of more than a thousand cities for nearly two millenia, and the use of modern econometric techniques to asses historical development.

I argued that a key event that explains several dimensions of the historical development of Eurasia are the Mongol Conquests of the 13th century. I found that the rise and fall of the Mongol Empire set the stage for the Rise of Europe and caused the Decline of Asia. The consequences and mechanisms of the Mongol Devastation are discussed theoretically and verified empirically. Moreover, the direct and indirect effects of the Mongol Invasions are predicted and shown to persist in time, long after the Empire collapsed and dissolved, up until at least the last period before the Industrial Revolution.

The model predicts four keys for the escape of the Malthusian trap: levels of capital accumulation, population growth, the land-to-labour ratio, and trade connectedness. All four, directly affected by the Mongol Empire. The destruction of cities, and the war effort lead to direct destruction of capital and inefficient allocation of capital and manpower. Population contracted abruptly as a result of the Mongol violence, and the subsequent introduction of the Black Plague. The population drop lead to a reorganization of the social division of labour and made agrarian labour relatively scarce with respect to land. Finally, the Mongols connected once again the East and the West through the Silk Road.

Empirically, I verify through a RDD that the economy of invaded territories grew slower or even contracted relative to unconquered territories. The DID model shows that the Mongols caused a persistent and growing gap of development between conquered and unconquered territories, favouring the former. This explains how Western Europe could catch up with and even surpass China and the Islamic World, and also contraction of these economies. I also show that the effect of violence was persistent, in agreement with the population hysteresis prediction of the model. In regard to trade, I show that the trade relevance of the unconquered territories increased, meaning that the flow of merchandise and technology into the West grew, which could set the stage for the shift towards the Atlantic of the world trade center from the Indian Ocean. Finally, I show suggestive evidence of a generalized shift on the land-to-labour ratio over Eurasia during the century of the Mongol Devastation.

All this results add up, first, to the Rise of Europe: the West grew faster than the East, thus, any development gap between Western Europe and Asia would be closed or even reversed. Second, the Decline of Asia: the Mongols contrasted directly the wealth levels of their invaded territories, and the legacy of their violence, their institutions and the void of power after their collapse, prevented and hampered the recovery of the conquered territories. The Mongol Devastation explains why Europe rose and Asia fell, but most importantly, it also explains why could Western Europe escape the Malthusian Trap. The ideal conditions of improved land-to-labour ratio, low population growth rates, allowed Western Europe to enter a virtuous cycle of relatively high sustained per capita wealth, while at the same time import, adapt and improve technology. The incentives for specializing in capital-intensive goods fostered the emergence of sectors capable of endogenous growth, incentive absent in the great Asian civilizations.

Why Europe rose? The adoption of fundamental technologies and increase in trade relevance due to the trade inflow from the East as a result of the restoration of the Silk Road. Why Asia declined, if population contractions are supposed to be beneficial in the short run in Malthusian set-ups? Mongol violence did not only kill millions, it also wiped out cities and sources of wealth; population declined, but also aggregated wealth. Why Western Europe diverged from Asia prior to the Industrial Revolution? The rise of Europe as a merchant power, and the structural transformation of their economies which lead to richer individuals in Europe than in Asia, which fostered the emergence of sectors capable of autonomous growth.

Why the Industrial Revolution took place in England, but did not in China? The Mongol Empire triggered a traceable domino effect in which the material conditions, say proto-capitalism, for the Industrial Revolution were ideal in England, while having wiped out the Chinese potential to an industrial revolution. Thus, the first and only case of sustained economic growth, the definitive take-off from the Malthusian regime, favoured Western Europe. The Great Divergence in favour of the North Atlantic and detriment of the rest of the world has some of its deepest seeds rooted in the Mongol Devastation.

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# Part VII

# Appendix

## Appendix A Robustness Checks

### A.1 Global Effect: Regression Discontinuity Design

#### Temporal Placebo

Table 4: Temporal Placebo for RDD robustness check

| VARIABLES | Growth<br>500 CE-600 CE | Growth<br>600 CE-700 CE | Growth<br>700 CE-800 CE | Growth<br>800 CE-900 CE |
|---|---|---|---|---|
| Conquered by 1279 | 0.0917 | 0.0129 | 0.0343 | -0.0747* |
| Robust s.e. | (0.0710) | (0.0636) | (0.0443) | (0.0400) |
| Eff. Obs. | 158 | 178 | 214 | 226 |
| BW in km | 704 | 750 | 846 | 868 |
| | Growth<br>500 CE-700 CE | Growth<br>600 CE-800 CE | Growth<br>600 CE-900 CE CE | Growth<br>700 CE-900 CE |
| Conquered by 1279 | 0.0503 | 0.0355 | -0.0581 | -0.0616 |
| Robust s.e. | (0.0431) | (0.115) | (0.141) | (0.0936) |
| Eff. Obs. | 235 | 178 | 166 | 136 |
| BW in km | 892 | 748 | 722 | 650 |

**Note:** Main RDD specification with order 1 local polynomial for changes in growth rates per century on the frontiers of the 1279 CE Mongol Empire on centuries 6th through 10th, around the Islam Golden Age. Treatment: conquered by the Mongol Empire at its peak (1279). Growth measured as change in the natural logarithm of population density (Aghion and Howitt, 2009; Ashraf and Galor, 2011). Bias-corrected standard errors significance: *** p<0.01, ** p<0.05, * p<0.1
**Data:** HYDE 3.2 (2017)

**Spatial Placebo**

Table 5: Spatial Placebo for RDD robustness check

| VARIABLES | Growth 1200 CE-1300 CE | | | | |
|---|---|---|---|---|---|
| Conquered by 1279 | 0.0727 | 0.124** | -0.0462 | 0.102 | -0.171** |
| Robust s.e. | (0.0611) | (0.0672) | (0.0542) | (0.111) | (0.0813) |
| Eff. Obs. | 569 | 309 | 479 | 152 | 135 |
| BW in km | 1706 | 1362 | 1980 | 832 | 810 |
| Km inside 1279 CE Frontier | 300 | 600 | 900 | 1200 | 1500 |
| VARIABLES | Growth 1200 CE-1400 CE | | | | |
| Conquered by 1279 | 0.0829* | 0.0719** | -0.0166 | 0.0900 | -0.109 |
| Robust s.e. | (0.0514) | (0.0380) | (0.0410) | (0.155) | (0.0891) |
| Eff. Obs. | 385 | 241 | 181 | 146 | 135 |
| BW in km | 1706 | 1362 | 1980 | 832 | 810 |
| Km inside 1279 CE Frontier | 300 | 600 | 900 | 1200 | 1500 |
| VARIABLES | Growth 1100 CE-1400 CE | | | | |
| Conquered by 1279 | 0.0710 | 0.0399 | 0.0546 | 0.171* | -0.122 |
| Robust s.e. | (0.0970) | (0.0537) | (0.0585) | (0.105) | (0.104) |
| Eff. Obs. | 684 | 191 | 181 | 161 | 158 |
| BW in km | 1930 | 1036 | 1080 | 876 | 904 |
| Km inside 1279 CE Frontier | 300 | 600 | 900 | 1200 | 1500 |

Bias-corrected standard errors

*** p<0.01, ** p<0.05, * p<0.1

**Note:** main specification with order 2 local polynomial for changes in growth rates per century on the period 1200 CE - 1300 CE for if the frontiers of the Mongol Empire in 1279 CE had been 250, 500, 750, 1000, 1250 and 1500 kilometers towards its interior. Treatment: conquered by the Mongol Empire at its peak (1279). Growth measured as change in the natural logarithm of population density (Aghion and Howitt, 2009; Ashraf and Galor, 2011).

**Kernel Sensitivity**

Table 6: Main RDD specification changing non-parametric estiamation kernels

| VARIABLES | Growth 1200 CE-1400 CE | | | | | |
|---|---|---|---|---|---|---|
| Conquered by 1279 | -0.210*** | -0.315*** | -0.204*** | -0.300*** | -0.279*** | -0.244*** |
| Robust s.e. | (0.0601) | (0.0734) | (0.0592) | (0.0758) | (0.0605) | (0.0610) |
| Eff. Obs. | 147 | 539 | 153 | 499 | 202 | 591 |
| BW in km | 682 | 1564 | 698 | 1470 | 812 | 1676 |
| Local Poly. Order | 1 | 2 | 1 | 2 | 1 | 2 |
| Kernel | epa | epa | tri | tri | uni | uni |
| VARIABLES | Growth 1200 CE-1400 CE | | | | | |
| Conquered by 1279 | -0.212*** | -0.226*** | -0.205*** | -0.188*** | -0.230** | -0.263*** |
| Robust s.e. | (0.0688) | (0.0828) | (0.0649) | (0.0783) | (0.104) | (0.0917) |
| Eff. Obs. | 86 | 335 | 99 | 331 | 63 | 358 |
| BW in km | 504 | 1094 | 536 | 1084 | 444 | 1148 |
| Local Poly. Order | 1 | 2 | 1 | 2 | 1 | 2 |
| Kernel | epa | epa | tri | tri | uni | uni |
| VARIABLES | Growth 1100 CE-1400 CE | | | | | |
| Conquered by 1279 | -0.159** | -0.326*** | -0.158*** | -0.302*** | -0.189** | -0.318*** |
| Robust s.e. | (0.0638) | (0.0837) | (0.0610) | (0.0791) | (0.0809) | (0.0893) |
| Eff. Obs. | 102 | 592 | 107 | 609 | 127 | 518 |
| BW in km | 546 | 1686 | 568 | 1736 | 630 | 1494 |
| Local Poly. Order | 1 | 2 | 1 | 2 | 1 | 2 |
| Kernel | epa | epa | tri | tri | uni | uni |

Bias-corrected standard errors

*** p<0.01, ** p<0.05, * p<0.1

**Note:** RDD main specification using triangular and uniform kernels. Epanechnikov kernel estimation for comparison. Treatment: conquered by the Mongol Empire at its peak (1279). Growth measured as change in the natural logarithm of population density (Aghion and Howitt, 2009; Ashraf and Galor, 2011). Treatment: conquered by the Mongol Empire at its peak (1279). Growth measured as change in the natural logarithm of population density (Aghion and Howitt, 2009; Ashraf and Galor, 2011).

**Variance-Covariance Matrix Sensitivity**

Table 7: Main RDD specification changing the variance-covariance matrix estimation procedure

| VARIABLES | Growth 1200 CE-1300 CE | | | | |
|---|---|---|---|---|---|
| Conquered by 1279 | -0.210*** | -0.209*** | -0.210*** | -0.220*** | -0.280*** |
| Bias-corrected s.e. | (0.0527) | (0.0533) | (0.0526) | (0.0510) | (0.0484) |
| Robust s.e. | (0.0601) | (0.0641) | (0.0635) | (0.0612) | (0.0588) |
| Eff. Obs. | 147 | 152 | 158 | 176 | 249 |
| BW in km | 682 | 696 | 708 | 744 | 928 |
| 504 | | | | | |
| VCE | nn | hc0' | hc1' | hc2' | hc3' |
| VARIABLES | Growth 1200 CE-1400 CE | | | | |
| Conquered by 1279 | -0.212*** | -0.213*** | -0.214*** | -0.214*** | -0.216*** |
| Robust s.e. | (0.0641) | (0.0642) | (0.0639) | (0.0657) | (0.0679) |
| Eff. Obs. | 86 | 89 | 92 | 92 | 92 |
| BW in km | 504 | 508 | 512 | 514 | 518 |
| VCE | nn | hc0' | hc1' | hc2' | hc3' |
| VARIABLES | Growth 1100 CE-1400 CE | | | | |
| Conquered by 1279 | -0.159** | -0.174*** | -0.165** | -0.162** | -0.148** |
| Robust s.e. | (0.0638) | (0.0764) | (0.0746) | (0.0768) | (0.0742) |
| Eff. Obs. | 102 | 97 | 99 | 99 | 109 |
| BW in km | 546 | 532 | 540 | 544 | 570 |
| VCE | nn | hc0' | hc1' | hc2' | hc3' |

Bias-corrected standard errors

*** p<0.01, ** p<0.05, * p<0.1

**Note:** RDD main specification using order 1 local polynomials for using different variance-covariance matrix estimation procedures.

## Not control for battles

Table 8: Local Effect of the Mongol Devastation on Economic Growth Rates per Century

| *Main Specification* | RD Estimate | BW (km) | N. Obs | Local Poly. Order | Sample Mean |
|---|---|---|---|---|---|
| Growth 1200-1300 | 0.36***<br>(0.1) | 1482 | 1485 | 1 | 0.23 |
| | -0.18<br>(0.14) | 1660 | 1751 | 2 | 0.24 |
| Growth 1200-1400 | 0.18***<br>(0.04) | 995 | 755 | 1 | -0.01 |
| | 0.37***<br>(0.13) | 1289 | 1059 | 2 | 0.00 |
| Growth 1100-1400 | 0.23***<br>(0.07) | 919 | 657 | 1 | 0.10 |
| | 0.45***<br>(0.11) | 1325 | 1147 | 2 | 0.12 |

**Note:** Bias-corrected robust standard errors: *** p<0.01, ** p<0.05, * p<0.1
**Specification:** Non-parametric RDD (Calonico et al., 2014). Kernel: Epanechnikov. Local polynomials order: 1, 2.
**Covariates:** latitude, longitude, elevation, (natural logarithm of) population density in year 1000.
**Data:** HYDE 3.2 2016, Reba et al. (2016)

## A.2 Violence Effect: Factorial Design

Table 9: Effect of Mongol Violence: Factorial Design between Conquered, Invaded but Unconquered, and Non-Invaded Cities. Estimated by Cattaneo et al. (2014) RD local randomization.

| *Violence* | | | |
|---|---|---|---|
| *Conquered vs Invaded Only* | | | |
| | Local Rand RD Estimate | BW (km) | Obs. |
| Growth 1200-1300 CE | -0,3 (0,19) | 240 | 97 |
| Growth 1300-1400 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1400-1500 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1500-1600 CE | -0,2 (0,19) | 240 | 97 |
| Growth 1600-1700 CE | -0,15 (0,19) | 240 | 97 |
| *Invaded Only vs Free Cities* | | | |
| | Local Rand RD Estimate | BW (km) | Obs. |
| Growth 1200-1300 CE | -0,58*** (0,19) | 336 | 92 |
| Growth 1300-1400 CE | -0,63*** (0,2) | 336 | 92 |
| Growth 1400-1500 CE | -0,57*** (0,2) | 336 | 92 |
| Growth 1500-1600 CE | -0,52*** (0,19) | 336 | 92 |
| Growth 1600-1700 CE | -0,57*** (0,19) | 336 | 92 |

**Note:** Standard Errors: *** p<0.01, ** p<0.05, * p<0.1
**Main Data:** Jaques (2007), Reba et al. (2016), Kitamura (2022)
**Complementary Data:** Onon (2001), Kennedy (2002), May (2007),Craughwell (2008), Giebfried (2013), Sophoulis (2015), and Madgerau (2016)

# Appendix B Proofs

Supplementary annex.

# Appendix C Data Description

## C.1 Trade Network

First, take the routes displayed in figure 8. In order to match the cities to the route and create a connected graph, use the following matching criteria in hierarchy[5]:

1. Match every city with the closest accesses to the main route layer within 50km
2. Match city to every coastal access within 50km
3. Match every city with any other within 50 km
4. Match every city that did not form a route in the previous step with any other within 100 km
5. Match every city that did not form a route in the previous step with any other within 200 km
6. Match every city with the closest accesses to the resulting layer in the previous step layer within 100km
7. Match every city that has not formed any route yet to the closest access to the layer in step 6)
8. Match every coastal access formed in step 2) with the sea routes of the base layer within 50km
9. Match every coastal access formed in step 2) that did not form a route with the sea routes of the base layer in the previous step with the resulting layer in 8) sea routes within 100km
10. Match every coastal access formed in step 2) that did not form a route with the sea routes of the base layer in the previous step with the closest point of the resulting layer in 9) sea routes

[5] Here "match" means: "create a route segment between ..."

# Appendix D Complementary Tables

## D.1 Descriptives

Table 10: Phyisical Geography Descriptive Statistics

| *Physical Geography* | Whole Sample | Conquered by 1279 | Not Conquered | Mean Difference |
|---|---|---|---|---|
| Elevation (m) | 252.04 | 444.16 | 190.54 | -253.62*** |
| | (413.54) | (624.51) | (292.62) | (25.56) |
| Roughness | 1.61 | 1.76 | 1.57 | -0.19 |
| | (1.87) | (2.38) | (1.68) | (0.12) |
| Ruggedness | 6.19 | 6.72 | 6.02 | -0.7 |
| | (6.94) | (8.82) | (6.22) | (0.44) |
| Slope | 19.12 | 20.84 | 18.57 | -2.27 |
| | (21.79) | (27.85) | (19.45) | (1.39) |
| Dist. to | 81.27 | 54.96 | 89.71 | 34.74*** |
| Major River (km) | (125.22) | (81.92) | (135.18) | (7.95) |
| Dist. to | 260.36 | 503.93 | 182.24 | -321.69*** |
| Coast (km) | (353.09) | (500.76) | (243.48) | (20.79) |
| Latitude | 36.12 | 40.25 | 34.79 | -5.46*** |
| | (15.66) | (8.95) | (17.07) | (0.99) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.
**Data:** Natural Earth; EarthEnv

Table 11: Land Use Variables Descriptive Statistics: Centuries I-VI

| *Land* | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| **Crop area density** | | | | | | |
| Whole Sample | 9.63 | 9.81 | 9.8 | 9.0 | 9.08 | 8.69 |
| | (15.85) | (15.66) | (15.4) | (14.27) | (14.24) | (13.58) |
| Conq. by 1279 | 12.14 | 11.72 | 11.07 | 8.45 | 9.44 | 10.15 |
| | (19.56) | (18.87) | (17.87) | (14.7) | (15.95) | (16.87) |
| Not Conq. | 8.83 | 9.2 | 9.39 | 9.17 | 8.97 | 8.22 |
| | (14.38) | (14.44) | (14.51) | (14.14) | (13.65) | (12.32) |
| Mean Diff | -3.3*** | -2.52** | -1.68 | 0.73 | -0.47 | -1.93** |
| | (1.07) | (1.06) | (1.04) | (0.97) | (0.96) | (0.92) |
| **Irrigated area density** | | | | | | |
| Whole Sample | 0.21 | 0.22 | 0.32 | 0.37 | 0.42 | 0.45 |
| | (2.66) | (2.65) | (3.61) | (3.92) | (4.63) | (4.69) |
| Conq. by 1279 | 0.22 | 0.22 | 0.21 | 0.21 | 0.19 | 0.22 |
| | (3.23) | (3.23) | (3.22) | (2.08) | (2.71) | (3.23) |
| Not Conq. | 0.21 | 0.22 | 0.35 | 0.42 | 0.49 | 0.52 |
| | (2.45) | (2.44) | (3.73) | (4.35) | (5.09) | (5.06) |
| Mean Diff | -0.0 | 0.0 | 0.13 | 0.21 | 0.3 | 0.31 |
| | (0.18) | (0.18) | (0.24) | (0.27) | (0.31) | (0.32) |
| **Grazing area density** | | | | | | |
| Whole Sample | 0.68 | 0.73 | 0.8 | 0.85 | 0.81 | 0.81 |
| | (1.42) | (1.49) | (1.84) | (2.64) | (1.71) | (1.7) |
| Conq. by 1279 | 0.69 | 0.69 | 0.69 | 0.64 | 0.7 | 0.78 |
| | (1.25) | (1.29) | (1.33) | (1.35) | (1.42) | (1.6) |
| Not Conq. | 0.68 | 0.74 | 0.83 | 0.91 | 0.85 | 0.82 |
| | (1.47) | (1.56) | (1.98) | (2.94) | (1.79) | (1.73) |
| Mean Diff | -0.01 | 0.04 | 0.14 | 0.27 | 0.15 | 0.04 |
| | (0.1) | (0.1) | (0.12) | (0.18) | (0.12) | (0.11) |
| **Urban area density** | | | | | | |
| Whole Sample | 0.11 | 0.12 | 0.12 | 0.12 | 0.13 | 0.12 |
| | (0.48) | (0.51) | (0.53) | (0.55) | (0.56) | (0.45) |
| Conq. by 1279 | 0.06 | 0.06 | 0.06 | 0.04 | 0.05 | 0.06 |
| | (0.21) | (0.23) | (0.2) | (0.13) | (0.16) | (0.18) |
| Not Conq. | 0.12 | 0.13 | 0.14 | 0.15 | 0.16 | 0.15 |
| | (0.53) | (0.57) | (0.6) | (0.62) | (0.64) | (0.51) |
| Mean Diff | 0.07** | 0.07** | 0.08** | 0.11*** | 0.11*** | 0.09*** |
| | (0.03) | (0.03) | (0.04) | (0.04) | (0.04) | (0.03) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.

**Data:** HYDE 3.2 2016

Table 12: Land Use Variables Descriptive Statistics: Centuries VII-XII

| *Land* | | | | | | |
|---|---|---|---|---|---|---|
| | VII | VIII | IX | X | XI | XII |
| **Crop area density** | | | | | | |
| Whole Sample | 8.4 | 8.73 | 9.16 | 10.18 | 10.65 | 12.79 |
| | (13.57) | (13.46) | (13.5) | (14.19) | (14.26) | (16.51) |
| Conq. by 1279 | 11.42 | 10.8 | 10.12 | 10.82 | 10.54 | 14.77 |
| | (18.7) | (17.55) | (16.69) | (17.35) | (16.85) | (21.78) |
| Not Conq. | 7.44 | 8.07 | 8.86 | 9.97 | 10.68 | 12.15 |
| | (11.3) | (11.79) | (12.3) | (13.02) | (13.34) | (14.39) |
| Mean Diff | -3.98*** | -2.72*** | -1.26 | -0.85 | 0.13 | -2.62** |
| | (0.91) | (0.91) | (0.91) | (0.96) | (0.97) | (1.12) |
| **Irrigated area density** | | | | | | |
| Whole Sample | 0.42 | 0.49 | 0.53 | 0.6 | 0.63 | 0.6 |
| | (4.15) | (4.52) | (4.79) | (5.13) | (5.4) | (5.27) |
| Conq. by 1279 | 0.22 | 0.35 | 0.39 | 0.39 | 0.35 | 0.32 |
| | (3.23) | (3.92) | (4.23) | (4.25) | (3.78) | (3.54) |
| Not Conq. | 0.49 | 0.53 | 0.57 | 0.67 | 0.71 | 0.69 |
| | (4.41) | (4.7) | (4.95) | (5.38) | (5.82) | (5.71) |
| Mean Diff | 0.27 | 0.18 | 0.19 | 0.28 | 0.36 | 0.37 |
| | (0.28) | (0.31) | (0.32) | (0.35) | (0.37) | (0.36) |
| **Grazing area density** | | | | | | |
| Whole Sample | 0.83 | 1.01 | 1.27 | 1.56 | 1.7 | 2.23 |
| | (2.03) | (2.26) | (2.7) | (3.24) | (3.61) | (5.01) |
| Conq. by 1279 | 0.83 | 0.84 | 0.85 | 0.9 | 0.9 | 1.15 |
| | (1.65) | (1.67) | (1.74) | (1.78) | (1.81) | (2.15) |
| Not Conq. | 0.83 | 1.07 | 1.41 | 1.77 | 1.96 | 2.57 |
| | (2.14) | (2.42) | (2.92) | (3.56) | (3.99) | (5.58) |
| Mean Diff | -0.0 | 0.23 | 0.56*** | 0.87*** | 1.06*** | 1.42*** |
| | (0.14) | (0.15) | (0.18) | (0.22) | (0.24) | (0.34) |
| **Urban area density** | | | | | | |
| Whole Sample | 0.12 | 0.13 | 0.14 | 0.17 | 0.19 | 0.24 |
| | (0.37) | (0.42) | (0.47) | (0.54) | (0.59) | (0.72) |
| Conq. by 1279 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.14 |
| | (0.23) | (0.2) | (0.17) | (0.2) | (0.2) | (0.43) |
| Not Conq. | 0.14 | 0.15 | 0.17 | 0.2 | 0.23 | 0.27 |
| | (0.41) | (0.46) | (0.53) | (0.6) | (0.67) | (0.78) |
| Mean Diff | 0.07*** | 0.08*** | 0.11*** | 0.14*** | 0.16*** | 0.12** |
| | (0.03) | (0.03) | (0.03) | (0.04) | (0.04) | (0.05) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.
**Data:** HYDE 3.2 2016

Table 13: Land Use Variables Descriptive Statistics: Centuries XIII-XVIII

| *Land* | | | | | | |
|---|---|---|---|---|---|---|
| | XIII | XIV | XV | XVI | XVII | XVIII |
| **Crop area density** | | | | | | |
| Whole Sample | 14.82 | 16.02 | 13.2 | 14.89 | 14.67 | 13.62 |
| | (17.87) | (18.58) | (16.56) | (18.14) | (16.22) | (13.63) |
| Conq. by 1279 | 15.91 | 14.38 | 13.48 | 15.39 | 14.9 | 13.05 |
| | (22.48) | (20.72) | (19.74) | (21.77) | (18.53) | (15.18) |
| Not Conq. | 14.47 | 16.54 | 13.11 | 14.74 | 14.6 | 13.81 |
| | (16.12) | (17.83) | (15.42) | (16.82) | (15.42) | (13.1) |
| Mean Diff | -1.45 | 2.16* | -0.36 | -0.65 | -0.31 | 0.75 |
| | (1.21) | (1.26) | (1.12) | (1.23) | (1.1) | (0.92) |
| **Irrigated area density** | | | | | | |
| Whole Sample | 0.54 | 0.57 | 0.47 | 0.47 | 0.5 | 0.41 |
| | (4.9) | (4.97) | (4.12) | (4.0) | (4.05) | (3.17) |
| Conq. by 1279 | 0.23 | 0.24 | 0.25 | 0.27 | 0.3 | 0.23 |
| | (3.19) | (3.21) | (3.25) | (3.29) | (3.04) | (2.48) |
| Not Conq. | 0.63 | 0.67 | 0.54 | 0.53 | 0.57 | 0.47 |
| | (5.33) | (5.42) | (4.37) | (4.2) | (4.33) | (3.36) |
| Mean Diff | 0.4 | 0.44 | 0.29 | 0.26 | 0.26 | 0.25 |
| | (0.33) | (0.34) | (0.28) | (0.27) | (0.27) | (0.21) |
| **Grazing area density** | | | | | | |
| Whole Sample | 2.61 | 2.8 | 2.21 | 2.34 | 2.69 | 3.26 |
| | (6.06) | (6.64) | (4.88) | (5.03) | (5.52) | (6.89) |
| Conq. by 1279 | 1.24 | 1.16 | 1.04 | 1.18 | 1.38 | 1.41 |
| | (2.45) | (2.5) | (2.03) | (2.26) | (2.46) | (2.52) |
| Not Conq. | 3.04 | 3.32 | 2.58 | 2.71 | 3.11 | 3.85 |
| | (6.77) | (7.42) | (5.43) | (5.58) | (6.13) | (7.69) |
| Mean Diff | 1.8*** | 2.17*** | 1.54*** | 1.54*** | 1.73*** | 2.44*** |
| | (0.41) | (0.45) | (0.33) | (0.34) | (0.37) | (0.46) |
| **Urban area density** | | | | | | |
| Whole Sample | 0.3 | 0.37 | 0.32 | 0.38 | 0.47 | 0.52 |
| | (0.88) | (1.18) | (0.87) | (1.0) | (1.35) | (1.43) |
| Conq. by 1279 | 0.17 | 0.15 | 0.14 | 0.18 | 0.21 | 0.22 |
| | (0.5) | (0.39) | (0.35) | (0.44) | (0.49) | (0.51) |
| Not Conq. | 0.34 | 0.44 | 0.37 | 0.44 | 0.55 | 0.61 |
| | (0.97) | (1.33) | (0.98) | (1.11) | (1.52) | (1.61) |
| Mean Diff | 0.16*** | 0.28*** | 0.23*** | 0.26*** | 0.35*** | 0.39*** |
| | (0.06) | (0.08) | (0.06) | (0.07) | (0.09) | (0.1) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.

**Data:** HYDE 3.2 2016

Table 14: Demographic Variables Descriptive Statistics: Centuries I-VI

| *Population* | | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| **Population Density (inh/km sq)** | | | | | | |
| Whole Sample | 1559.37 | 1659.45 | 1763.63 | 1807.02 | 1792.1 | 1747.64 |
| | (3606.01) | (4311.89) | (5311.56) | (6807.16) | (5624.05) | (4746.82) |
| Conq. by 1279 | 987.96 | 936.64 | 868.78 | 633.18 | 757.25 | 877.8 |
| | (1416.48) | (1296.81) | (1170.54) | (917.96) | (1097.18) | (1331.54) |
| Not Conq. | 1742.21 | 1890.75 | 2049.99 | 2182.65 | 2123.25 | 2026.0 |
| | (4048.5) | (4877.58) | (6039.43) | (7767.25) | (6397.31) | (5372.59) |
| Mean Diff | 754.25*** | 954.11*** | 1181.21*** | 1549.47*** | 1366.01*** | 1148.2*** |
| | (243.25) | (290.72) | (358.11) | (458.84) | (378.84) | (319.76) |
| **Rural pop.** | | | | | | |
| Whole Sample | 1559.64 | 1668.01 | 1791.42 | 1863.6 | 1771.94 | 1682.86 |
| | (5498.95) | (6818.92) | (8606.28) | (11284.03) | (9120.97) | (7527.78) |
| Conq. by 1279 | 1031.62 | 947.76 | 874.32 | 667.53 | 783.87 | 896.97 |
| | (1845.75) | (1701.08) | (1612.27) | (1428.88) | (1583.63) | (1785.87) |
| Not Conq. | 1728.61 | 1898.49 | 2084.9 | 2246.34 | 2088.12 | 1934.35 |
| | (6222.54) | (7762.11) | (9829.08) | (12917.55) | (10422.56) | (8575.65) |
| Mean Diff | 696.99* | 950.72** | 1210.58** | 1578.81** | 1304.26** | 1037.38** |
| | (371.89) | (461.01) | (581.83) | (762.88) | (616.59) | (508.96) |
| **Urban pop.** | | | | | | |
| Whole Sample | 456.99 | 498.48 | 530.31 | 539.95 | 576.66 | 578.28 |
| | (1786.5) | (1904.03) | (2003.68) | (2061.9) | (2114.99) | (2081.23) |
| Conq. by 1279 | 208.61 | 234.16 | 228.98 | 153.74 | 185.68 | 214.26 |
| | (799.8) | (837.41) | (753.26) | (490.65) | (588.78) | (684.49) |
| Not Conq. | 536.48 | 583.06 | 626.74 | 663.53 | 701.78 | 694.77 |
| | (1995.93) | (2129.16) | (2254.18) | (2339.54) | (2393.93) | (2348.09) |
| Mean Diff | 327.87*** | 348.91*** | 397.76*** | 509.79*** | 516.1*** | 480.51*** |
| | (120.62) | (128.56) | (135.21) | (138.86) | (142.46) | (140.27) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.
**Data:** HYDE 3.2 2016

Table 15: Demographic Variables Descriptive Statistics: Centuries VII-XII

| *Population* | | | | | | |
|---|---|---|---|---|---|---|
| | VII | VIII | IX | X | XI | XII |
| **Population Density (inh/km sq)** | | | | | | |
| Whole Sample | 1731.83 | 1808.53 | 1902.64 | 2078.35 | 2139.95 | 2460.04 |
| | (4167.99) | (3879.62) | (3832.95) | (4306.41) | (4070.69) | (4348.18) |
| Conq. by 1279 | 1078.97 | 1060.82 | 1060.45 | 1193.68 | 1209.91 | 1959.22 |
| | (1722.34) | (1962.85) | (2463.34) | (2765.96) | (3026.13) | (3969.46) |
| Not Conq. | 1940.75 | 2047.79 | 2172.14 | 2361.45 | 2437.56 | 2620.31 |
| | (4670.14) | (4290.32) | (4142.57) | (4659.71) | (4311.58) | (4452.79) |
| Mean Diff | 861.78*** | 986.97*** | 1111.69*** | 1167.77*** | 1227.65*** | 661.09** |
| | (281.18) | (261.19) | (257.59) | (289.69) | (273.39) | (293.87) |
| **Rural pop.** | | | | | | |
| Whole Sample | 1624.47 | 1675.09 | 1730.88 | 1847.77 | 1863.36 | 2096.07 |
| | (6393.59) | (5680.34) | (5351.11) | (5630.04) | (5393.86) | (5616.86) |
| Conq. by 1279 | 1081.99 | 1074.99 | 1085.32 | 1206.61 | 1224.64 | 1816.33 |
| | (2133.5) | (2293.44) | (2708.12) | (3007.47) | (3258.07) | (4227.58) |
| Not Conq. | 1798.06 | 1867.12 | 1937.45 | 2052.94 | 2067.75 | 2185.58 |
| | (7238.5) | (6385.26) | (5940.55) | (6228.19) | (5903.62) | (5993.1) |
| Mean Diff | 716.08* | 792.13** | 852.13** | 846.34** | 843.11** | 369.25 |
| | (432.53) | (384.03) | (361.58) | (380.52) | (364.5) | (380.27) |
| **Urban pop.** | | | | | | |
| Whole Sample | 586.1 | 611.74 | 660.32 | 753.8 | 820.21 | 980.4 |
| | (2097.94) | (2185.63) | (2290.63) | (2420.29) | (2564.62) | (2800.87) |
| Conq. by 1279 | 265.67 | 238.69 | 211.91 | 246.95 | 244.93 | 558.9 |
| | (867.22) | (748.55) | (641.91) | (746.49) | (724.86) | (1706.18) |
| Not Conq. | 688.64 | 731.11 | 803.81 | 915.99 | 1004.3 | 1115.28 |
| | (2351.14) | (2463.65) | (2590.62) | (2729.08) | (2894.25) | (3058.35) |
| Mean Diff | 422.97*** | 492.42*** | 591.9*** | 669.04*** | 759.37*** | 556.38*** |
| | (141.56) | (147.34) | (154.19) | (162.77) | (172.29) | (189.01) |

**Note:** Mean difference t-test between treated cities and control cities: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
**Data:** HYDE 3.2 2016

Table 16: Demographic Variables Descriptive Statistics: Centuries XIII-XVIII

| *Population* | XIII | XIV | XV | XVI | XVII | XVIII |
|---|---|---|---|---|---|---|
| **Population Density (inh/km sq)** | | | | | | |
| Whole Sample | 2793.36 | 3071.59 | 2796.35 | 3229.98 | 3819.09 | 4640.17 |
| | (4783.03) | (5156.11) | (5125.02) | (5695.28) | (6658.57) | (9813.0) |
| Conq. by 1279 | 2329.12 | 1886.74 | 1841.61 | 2237.01 | 2584.94 | 2879.37 |
| | (5110.24) | (3871.7) | (4314.24) | (5008.02) | (6139.9) | (7533.88) |
| Not Conq. | 2941.91 | 3450.74 | 3101.86 | 3547.73 | 4214.02 | 5203.62 |
| | (4666.72) | (5451.89) | (5324.73) | (5865.46) | (6772.07) | (10378.47) |
| Mean Diff | 612.79* | 1564.0*** | 1260.26*** | 1310.72*** | 1629.07*** | 2324.25*** |
| | (323.46) | (346.25) | (345.18) | (383.85) | (448.49) | (661.19) |
| **Rural pop.** | | | | | | |
| Whole Sample | 2326.28 | 2538.82 | 2259.39 | 2596.74 | 3019.99 | 3688.37 |
| | (6030.55) | (6931.05) | (6681.68) | (7389.13) | (8430.77) | (13517.93) |
| Conq. by 1279 | 2155.5 | 1736.06 | 1698.14 | 2044.63 | 2364.13 | 2652.59 |
| | (5387.44) | (4164.02) | (4520.71) | (5267.97) | (6428.88) | (7838.48) |
| Not Conq. | 2380.93 | 2795.71 | 2438.99 | 2773.42 | 3229.86 | 4019.82 |
| | (6224.14) | (7590.86) | (7231.15) | (7943.68) | (8970.6) | (14873.0) |
| Mean Diff | 225.43 | 1059.65** | 740.85 | 728.79 | 865.73 | 1367.23 |
| | (408.39) | (468.42) | (452.03) | (500.01) | (570.45) | (914.69) |
| **Urban pop.** | | | | | | |
| Whole Sample | 1182.75 | 1378.64 | 1243.46 | 1472.97 | 1807.65 | 2182.45 |
| | (3085.19) | (3449.41) | (3175.44) | (3503.69) | (4139.55) | (5333.06) |
| Conq. by 1279 | 663.35 | 566.28 | 535.92 | 674.04 | 779.74 | 835.8 |
| | (1939.33) | (1470.64) | (1334.71) | (1700.27) | (1908.64) | (2018.95) |
| Not Conq. | 1348.96 | 1638.59 | 1469.88 | 1728.62 | 2136.58 | 2613.38 |
| | (3354.53) | (3839.36) | (3540.24) | (3875.01) | (4584.28) | (5956.91) |
| Mean Diff | 685.62*** | 1072.31*** | 933.96*** | 1054.59*** | 1356.84*** | 1777.57*** |
| | (208.01) | (231.54) | (213.35) | (235.32) | (277.58) | (357.49) |

**Note:** Mean difference t-test between treated cities and control cities: *** p<0.01, ** p<0.05, * p<0.1.
**Data:** HYDE 3.2 2016

Table 17: Violence Variables Descriptive Statistics: Centuries I-VI

| *Violence* | | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| **Number of Battles** | | | | | | |
| Whole Sample | 0.12 | 0.05 | 0.11 | 0.07 | 0.19 | 0.12 |
| | (0.8) | (0.46) | (0.7) | (0.47) | (1.01) | (0.72) |
| Conq. by 1279 | 0.0 | 0.09 | 0.2 | 0.09 | 0.01 | 0.07 |
| | (0.0) | (0.57) | (1.09) | (0.49) | (0.12) | (0.54) |
| Not Conq. | 0.15 | 0.04 | 0.07 | 0.05 | 0.23 | 0.13 |
| | (0.91) | (0.4) | (0.45) | (0.42) | (1.12) | (0.77) |
| Mean Diff | 0.15*** | -0.05* | -0.13*** | -0.04 | 0.22*** | 0.06 |
| | (0.05) | (0.03) | (0.04) | (0.03) | (0.07) | (0.05) |

**Note:** Mean difference t-test between treated cities and control cities:
*** p<0.01, ** p<0.05, * p<0.1.
**Data:** Kitamura (2022)

Table 18: Violence Variables Descriptive Statistics: Centuries VII-XII

| *Violence* | | | | | | |
|---|---|---|---|---|---|---|
| | VII | VIII | IX | X | XI | XII |
| **Number of Battles** | | | | | | |
| Whole Sample | 0.32 | 0.16 | 0.19 | 0.23 | 0.33 | 0.5 |
| | (1.28) | (0.73) | (0.83) | (1.03) | (1.32) | (2.32) |
| Conq. by 1279 | 0.16 | 0.06 | 0.04 | 0.08 | 0.15 | 0.15 |
| | (0.7) | (0.48) | (0.33) | (0.5) | (0.95) | (0.95) |
| Not Conq. | 0.33 | 0.17 | 0.22 | 0.24 | 0.36 | 0.55 |
| | (1.31) | (0.78) | (0.91) | (1.04) | (1.36) | (2.36) |
| Mean Diff | 0.16** | 0.11** | 0.18*** | 0.16** | 0.21** | 0.4*** |
| | (0.08) | (0.05) | (0.05) | (0.06) | (0.09) | (0.14) |

**Note:** Mean difference t-test between treated cities and control cities:
*** p<0.01, ** p<0.05, * p<0.1.
**Data:** Kitamura (2022)

Table 19: Violence Variables Descriptive Statistics: Centuries XIII-XVIII

| *Violence* | | | | | | |
|---|---|---|---|---|---|---|
| | XIII | XIV | XV | XVI | XVII | XVIII |
| **Number of Battles** | | | | | | |
| Whole Sample | 0.88 | 0.76 | 0.79 | 1.03 | 2.08 | 2.29 |
| | (2.73) | (2.52) | (2.36) | (2.95) | (4.4) | (6.47) |
| Conq. by 1279 | 0.2 | 0.1 | 0.11 | 0.23 | 0.68 | 0.26 |
| | (0.85) | (0.82) | (0.59) | (1.02) | (2.48) | (0.98) |
| Not Conq. | 1.03 | 0.91 | 0.97 | 1.22 | 2.43 | 2.74 |
| | (3.03) | (2.73) | (2.63) | (3.26) | (4.73) | (6.97) |
| Mean Diff | 0.83*** | 0.81*** | 0.85*** | 0.98*** | 1.74*** | 2.48*** |
| | (0.18) | (0.16) | (0.16) | (0.2) | (0.29) | (0.41) |

**Note:** Mean difference t-test between treated cities and control cities: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
**Data:** Kitamura (2022)

## D.2 Balances

Table 20: Phyisical Geography RDD Balance

| *Physical Geography* | RD Estimate | BW (km) | N. Obs. Not Conquered | N. Obs. Conquered |
|---|---|---|---|---|
| Elevation (m) | 186.88<br>(155.46) | 839.84 | 377 | 207 |
| Roughness | 0.94<br>(0.63) | 909.95 | 407 | 217 |
| Ruggedness | 3.32<br>(2.29) | 923.71 | 411 | 217 |
| Slope | 10.78<br>(7.26) | 923.08 | 411 | 217 |
| Dist. to<br>Major River (km) | -16.19<br>(10.32) | 928.14 | 414 | 220 |
| Dist. to<br>Coast (km) | 247.17<br>(104.27) | 796.07 | 365 | 198 |
| Latitude | -1.52<br>(2.98) | 711.26 | 322 | 178 |

**Note:** Mean difference test between treated cities and control cities. Non-parametric RDD estimation, Epanechnikov kernel, degree 1 local polynomial. Significance of Bias-corrected robust standard errors: *** p<0.01, ** p<0.05, * p<0.1
**Data:** Natural Earth; EarthEnv

Table 21: Pre-treatment RDD Balance of Time-Varying Varibles

| *Pre-treatment RD Balance* | | | | |
|---|---|---|---|---|
| | RD Estimate | BW (km) | N. Obs. Not Conquered | N. Obs. Not Conquered |
| Crop area density | -5.94 (4.51) | 1097.97 | 437 | 213 |
| Irrigated area density | -3.2 (2.42) | 925.8 | 365 | 194 |
| Grazing area density | -2.24 (1.42) | 979.77 | 385 | 198 |
| Urban area density | -0.1 (0.08) | 842.31 | 333 | 184 |
| Population Density (inh/km sq) | 157.37 (552.9) | 928.8 | 367 | 195 |
| Rural pop. | 788.05 (805.93) | 984.13 | 386 | 198 |
| Urban pop. | -419.54 (332.43) | 865.5 | 340 | 188 |
| Number of Battles | 0.96* (0.56) | 850.49 | 335 | 185 |

**Note:** Bias-corrected robust standard errors: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

**Baseline year:** 1200. Mean difference test between treated cities and control cities. **Specification:** Non-parametric RDD estimation, Epanechnikov kernel, degree 1 local polynomial.

**Data:** HYDE 3.2 2016

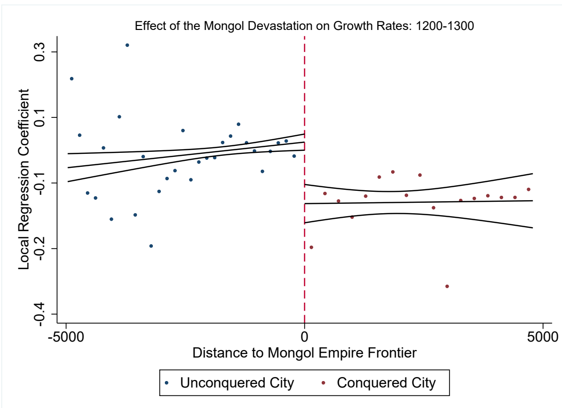
## Appendix E Comparison of Pre-Modern Empires

| | *Extension* | *Duration* | *Violence in Expansion* | *Contact* | *Effect on inter-regional interactions* |
|---|---|---|---|---|---|
| **Mongols** | **Huge** | **Shortlived** | **Very High** | **High** | **High** |
| *Romans* | Large | Longlived | Low-Moderate | High | High |
| *Persians* | Large | Longlived | Moderate | High | Moderate |
| *Macedonians* | Large | Shortlived | Low | Isolated | Moderate |
| *Ottomans* | Large | Longlived | Moderate | High | High |
| *Aztecs* | Small | Shortlived | High | Isolated | Low |
| *Incas* | Medium | Shortlived | Low | Isolated | Low |
| *Umayyad* | Very Large | Shortlived | Moderate-High | High | High |
| *Mughal* | Medium | Longlived | Moderate | Moderate | Low |
| *Mayans* | Small | Longlived | Low | Isolated | Low |

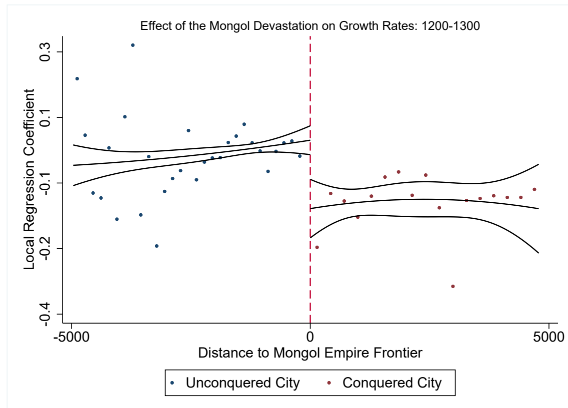
Table 22: Comparison in relevant aspects of some pre-modern empires with the Mongols. Extension: small, less than 500.000 sq. km; medium, until 4 million sq. km; large, until 10 million sq. km.; very large, until 20 million sq. km; huge, larger than 20 million sq. km. Duration: shortlived, until 100 years; long lived, more than 300 years.

# Appendix F RD Plots

Figure 12: RD plot for the Effect of the Mongol Devastation on Afroeurasian growth rates per century between 1200-1300

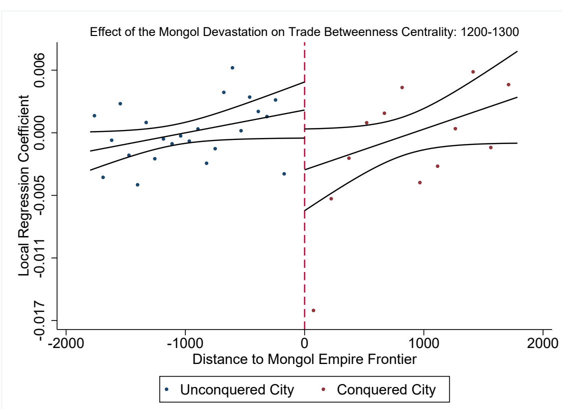



((a)) Linear Local Polynomial

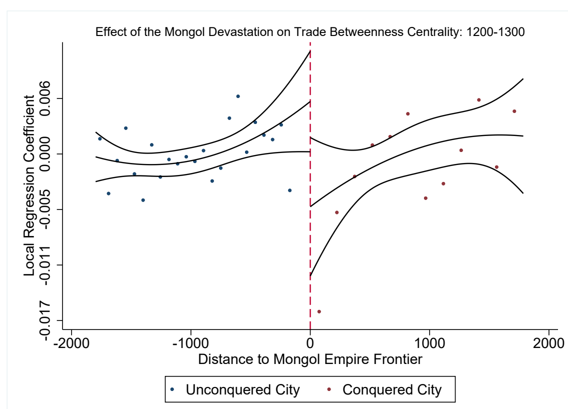



((b)) Quadratic Local Polynomial

Figure 13: RD plot for the Effect of the Mongol Devastation on the change per century in trade relevance of Afroeurasian cities between 1200-1300




((a)) Linear Local Polynomial




((b)) Quadratic Local Polynomial

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