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Beasts of Burden, Trade, and Hierarchy: The Long Shadow of Domestication

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Abstract

This paper studies how the prehistoric geographic distribution of domesticable transport animal species has contributed to shaping differences in development. I identify the historical ranges of the ten animal species that are (1) suitable for domestication and (2) suitable for carrying loads. Based on these ranges, I create a measure of the prehistoric presence of domesticable transport animals around the world. The empirical analysis reveals a strong relationship between the historical presence of domesticable transport animals and the emergence of ancient long-distance trade routes and early forms of hierarchy. Historical access to domesticable transport animals also continued to matter in the long run: Pre-industrial ethnic groups living in regions historically home to domesticable transport animals were more involved in trade and had built more complex hierarchical structures. Moreover, these groups developed greater numerical skills, larger levels of labor specialization, and higher levels of class stratification, thus underscoring the broad cultural and developmental impacts exerted by historical access to domesticable transport animals.

Keywords: Domestication, hierarchy, long-distance trade, persistence, transport animals

JEL: F10, N30, N70, O10, Z10

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1 Introduction

The unequal distribution of wealth has been a persistent aspect of human history, at least since the end of the last Ice Age (e.g. Scheidel, 2017). Today, geographic disparities, notably between the neighboring continents Europe and Africa, are particularly striking. In recent years, scholars have identified a range of historical aspects that have contributed to these large wealth differences, including factors that favored European development (Acemoglu et al., 2005; Dittmar, 2011; Wahl, 2017) and factors that hampered African development (Nunn, 2008; Michalopoulos and Papaioannou, 2016). Moreover, as other recent work has documented, the foundations of such regional differences in development were already set in prehistory (Olsson and Hibbs, 2005; Ashraf and Galor, 2013; Arbath et al., 2020; Mayshar et al., 2022). One largely unexplored factor, however, is the historical geographic distribution of large mammal species that are suitable for domestication. Indeed, Diamond (1997) suggests the unequal historical distribution of such species as a potential main determinant of regional differences in long-run development.

This paper advances the hypothesis and establishes empirically that the prehistoric distribution of a specific subset of domesticable animal species – species that are suitable for carrying heavy loads and can thus be used to transport goods and people, or wage war – has greatly mattered for various aspects of human development throughout history. First, I identify the historical ranges of the ten species that are (1) suitable for domestication and (2) suitable for carrying loads. Based on these ranges, I create a measure of the historical presence of domesticable transport animals around the world. The empirical analysis reveals that the prevalence of domesticable *transport* animals, but not the presence of other domesticable animals, was an important determinant of the emergence of ancient long-distance trade routes as well as early forms of hierarchy. Historical access to domesticable transport animals also continued to matter in the long-run: Pre-industrial ethnic groups living in regions historically home to domesticable transport animals were more involved in trade and had built more complex hierarchical structures than other groups.

The first part of the analysis draws on geocoded data at the 1x1 degree grid cell level and examines (1) the relationship between domesticable transport animals and the emergence of long-distance trade routes and (2) the relationship between domesticable transport animals and early forms of hierarchy, which I proxy with the presence of ancient cities. The results show that the geographic distribution of domesticable transport animals is an important determinant of the emergence of ancient long-distance trade routes as well as the locations of cities founded before 400 AD. More specifically, conditional on geographic controls and country fixed effects, distance to the closest ancient trade route is 31.5% lower for grid cells where domesticable transport animals were present. For distance to the closest ancient city the relative effect size is very similar at 32.1%.

These results are robust to many changes in the baseline specifications. Furthermore, the results show that there is no statistically significant relationship between the presence of domesticable *non-transport* animals and the emergence of long-distance trade routes or early forms of hierarchy. The absence of such relationships addresses the potential concern that the effects might be a function of domestication in general. To further rule out that the results are driven by unobserved geographic or climatic conditions, I conduct a large number of placebo regressions with measures built on random combinations of the historical ranges of megafauna species that are closely related to at least one of the species included in my main measure. The results show that the strong relationship between the presence of domesticable transport animals and the emergence of long-distance trade routes and early forms of hierarchy can be observed only for this specific combination of species. Hence, unobserved geographic or climatic factors that are conducive to these types of animals in general are unlikely to bias the results. Moreover, a measure of geographic suitability for domesticable transport animal species is only related to the emergence of trade routes and hierarchy in regions where domesticable transport animal species were present, further addressing the issue of omitted variable bias. It is also implausible that the results are driven by reverse causality, as the historical ranges of the animals by far predate the trade routes. However, to further rule out the possibility that the ranges of these species formed where the first long-distance trade routes had previously been built, I conduct an analysis with a measure built on the current ranges of these species. The results suggest that there is no significant relationship between the current ranges of these species and historical long-distance trade routes or ancient cities, further alleviating the potential concern of reverse causality.

The second part of the analysis examines a potential persistence in these patterns. By drawing on data from Michalopoulos and Xue (2021) the analysis shows that pre-industrial ethnic groups living in regions historically home to domesticable transport animals were more involved in trade. Conditional on ethnicity specific controls and country fixed effects, these groups reach a 48.7% higher value of a folklore based proxy variable for pre-industrial trade involvement. Additionally, by drawing on data from the Ethnographic Atlas (Murdock, 1967), the results show that these groups have built more complex hierarchical structures. Finally, the analysis suggests that these groups have developed greater numerical skills, higher levels of labor specialization, and higher levels of class stratification, thus underscoring the broad cultural and developmental impacts exerted by historical access to domesticable transport animals.

Together, these results emphasize the importance of the access to domesticable transport animals for the emergence of ancient long-distance trade routes as well as early forms of hierarchy. More broadly, such access appears to have shaped the cultural and institutional characteristics of ethnic groups over the long term, with persistent effects observable up to the modern era. Overall, these results show that prehistoric access to domesticable transport animals exerted major long-term impacts on regional developmental trends.

This paper relates to several strands of the literature. First, it connects to the literature exploring the ancient origins of trade (e.g. Özak, 2018; Barjamovic et al., 2019; Bakker et al., 2021; Bertinelli and Litina, 2021; Flückiger et al., 2022). Bakker et al. (2021) find that regions with beneficial geographic conditions for connectedness, such that they could benefit from the emerging sea trade, began to develop faster in the Iron Age compared to other regions. Barjamovic et al. (2019) examine the Assyrian trade network, which is one of the oldest trade networks in the world, and demonstrate that cities with a central position in the network gained a growth advantage in the Bronze Age. Flückiger et al. (2022) show how the Roman transport network influenced economic integration within Europe over nearly two thousand years. Bertinelli and Litina (2021) link the origins of intra-regional trade to differences in land productivity within regions.

So far, little is known about the geographic determinants of the emergence of ancient long-distance trade routes. Özak (2018) takes a first step in this direction, relating beneficial geographic conditions for traveling to the locations of trade routes established between 500 BC and 1820 AD. This paper focuses exclusively on ancient long-distance trade routes and shows that the prehistoric distribution of domesticable transport animals played an important role for the emergence of such routes.

Moreover, this paper is related to the literature examining the prehistoric origins of differences in development. Olsson and Hibbs (2005) highlight the importance of favorable bio-geographic conditions for the transition from hunter-gathering to agriculture and show that regions with such conditions in prehistory have higher levels of development today. In a similar vein, Olsson and Paik (2016) relate the Neolithic Revolution to present day cultural norms. More specifically, they show that individuals in regions that adopted agriculture relatively early value obedience more and feel less in control of their lives. Michalopoulos et al. (2018b) also focus on individual outcomes and demonstrate that when an individual's ancestors obtained a higher share of calories from agriculture, the higher are their education and wealth levels today in Sub-Saharan Africa. Michalopoulos (2012) finds that the extent of ethnic diversity within countries can be traced back to prehistoric geographical conditions. Moving away from geographical characteristics, Ashraf and Galor (2013) demonstrate that genetics determined tens of thousands of years ago still matters for present day economic development. Closely related, Arbath et al. (2020) find a strong relationship between genetic diversity and conflict within countries.

Within this broader body of literature, recent work has specifically focused on the factors influencing the emergence of early forms of hierarchy (e.g. Turchin, 2009; Dow and Reed, 2013; Fenske, 2014; Schönholzer, 2020; Bertinelli and Litina, 2021; Dal Bo et al., 2022; Mayshar et al., 2022; Mayoral and Olsson, 2022). Turchin (2009) highlights the importance of antagonistic interactions between nomadic pastoralists and settled agriculturalists for the development of state structures. Dow and Reed (2013) develop a theoretical model that links differences in land quality to the evolution of hierarchy. Schönholzer (2020) and Mayoral and Olsson (2022) find empirical evidence for Carneiro's circumscription hypothesis (Carneiro, 1970), by showing that land quality only matters for the development of early states in areas that are circumscribed by lower-quality land. Dal Bo et al. (2022) theoretically link increased insecurity to the emergence of hierarchy structures. In recent work, Mayshar et al. (2022) demonstrate that the development of hierarchy strongly depends on the types of crops that are available within a region. More specifically, they show that hierarchical structures emerged predominantly in regions in which cereals were available to facilitate taxation, while regions where roots and tubers were available mostly did not experience such a development. Closely related to this paper is previous work linking geographic diversity to the development of state structures, thanks to greater (intra-regional) trade (Fenske, 2014; Bertinelli and Litina, 2021). Fenske (2014) shows that African ethnic groups developed more centralized states if their environment was ecologically more diverse. Similarly, Bertinelli and Litina (2021) argue that regions with a high degree of geographic diversity – and thus a particularly large potential for gains from trade – developed state structures at an early point in time.

This paper argues that a complementary factor for the emergence of hierarchy structures was the historical presence of domesticable species of transport animals. First, the presence of domesticable transport animals might have generated beneficial conditions for the development of hierarchy structures by increasing the probability of the emergence of long-distance trade routes. Long-distance trade routes raised the need for security arrangements to protect the merchants and their goods and increased the incentives to set up such systems, as they enabled the extraction of rents from the traded goods. Such a process would be similar to the mechanisms described by Fenske (2014) and Bertinelli and Litina (2021), yet this paper highlights the role of long-distance trade. Second, the access to domesticable transport animal species and thus, to potentially fast moving animals, could have been beneficial for the development of hierarchy by facilitating communication over larger distances. Third, conflict also might play a role, as access to domesticable transport animal species makes it easier to conquer neighboring regions.

Finally, this paper connects to the literature focusing on the persistence of institutions and cultural traits, as well as the long-run impacts of variation in these factors (e.g. Acemoglu et al., 2001; Borcan et al., 2018; Enke, 2019; Becker, 2022; Michalopoulos and Xue, 2021; Bahrami-Rad et al., 2022). Acemoglu et al. (2001) show that the forms of colonial institutions set up by the Europeans persist to the present, while Borcan et al. (2018) find a hump-shaped relationship between historical state formation and current GDP per capita. Moving to cultural traits, Enke (2019) demonstrates that the historical kinship system determines the present-day moral systems of ethnic groups. Relatedly, Bahrami-Rad et al. (2022) show that historical kinship intensity is associated with lower present-day economic development. Becker (2022) examines how male absence in historically more pastoral groups affects norms regarding female promiscuity and restrictions of freedom in mobility within these groups over the long-run. More generally, Michalopoulos and Xue (2021) show that cultural traits among ethnic groups are highly persistent and are often greatly influenced by geographic and climatic conditions. This paper provides evidence on the long-run persistence of hierarchical structures as well as trading culture, by first showing that in antiquity long-distance trade routes and hierarchy structures were more likely to emerge in regions historically home to domesticable transport animal species, and, second, by documenting that pre-industrial ethnic groups living in these regions were more involved in trade and have built more complex hierarchy systems. Furthermore, I find more general impacts to culture, as such groups have also developed greater numerical skills, larger levels of labor specialization, and larger levels of class stratification.

The remainder of this paper is structured as follows. Section 2 first gives a brief overview on the theory of animal domestication, before discussing the historical evidence linking transport animals to the emergence of long-distance trade routes. The last part of Section 2 discusses the mechanisms through which the historical presence of domesticable transport animal species might be linked to the emergence of early forms of hierarchy. Section 3 provides information about the main data sources used in the empirical analysis. Section 4 presents and discusses the results on the grid cell level. Section 5 explores the implications of historical access to domesticable transport animals species over the very long term. Section 6 concludes.

2 Theoretical Considerations and Historical Background

This section first discusses the process of animal domestication, with an emphasis on the question why no further large mammal species could be domesticated, besides the ones that were successfully domesticated. Section 2.2 briefly summarizes the development of ancient trade routes and the role domesticable transport animals played in this process. Section 2.3 then discusses a potential relationship between the historical presence of domesticable transport animal species and the evolution of early forms of hierarchy.

2.1 Theoretical Background on Animal Domestication

An important assumption of this research is that the large mammal species that were domesticated between 10,000 and 5,000 years ago are the only large mammal species suitable for domestication. If this assumption were violated, the empirical analysis might suffer from endogeneity. For example, the successful domestication of a species then might have partially depended on the cooperation skills of human groups, while these in turn also might be decisive for the evolution of hierarchy and trade. This section summarizes why the successful domestication of further large mammal species in antiquity probably was not possible.

Generally, animal domestication describes an evolutionary process by which animals are artificially selected and undergo huge phenotypic behavioral and physiological alterations (Trut et al., 2009). Zeder (2012) categorizes three different (ancient) pathways to domestication – namely, the commensal pathway, the prey pathway, and the directed pathway. The commensal pathway describes when animal species come into closer contact of human settlements by themselves, e.g. in search for food. Animals that were domesticated through the commensal pathway include dogs, cats, and pigs. None of the animals classified by this research as "domesticable transport animal species" were domesticated through this pathway. The prey pathway describes the domestication process for species that humans usually hunted for their meat. Over time humans developed strategies to increase prey availability, which under certain circumstances could develop into actual herd management, including the controlled breeding of animals. Animals classified by this research as "domesticable transport animal species" that were probably domesticated by the prey pathway are the five different forms of oxen as well as the llama. The directed pathway describes a fast-track domestication process where humans use knowledge gained from previous domestications to domesticate further species that possess desirable resources. Zeder (2012) speculates that the horse, the donkey, the dromedary, and the

Bactrian camel were domesticated this way.

But what decided which large mammal species were suitable for domestication by humans? An animal species must fulfill a range of conditions to be suitable for domestication (Diamond, 1997, 2002; Zeder, 2012). Diamond (1997, 2002) specifies six criteria large mammals need to fulfill. First, the species must to be able to be fed on a diet that can be supplied by humans. Second, the growth rate of the animals needs to be sufficiently fast. Third, the animal may not be overly aggressive. Fourth, the species must be able to breed in captivity. Fifth, a follow-the-leader hierarchy is important. Sixth, the animal may not be overly susceptible to panic (Diamond, 1997, 2002).

Most animal species fail to meet at least one of these conditions. As sometimes slight issues can decide if a species is suitable for domestication or not it can occur that among two closely related species, one may be suitable for domestication, while the other is not. For example, Ovis orientalis (the ancestor of the sheep) was domesticated, while its close relative Ovis canadensis was not suitable for domestication, as it to some extent lacks of follow-the-leader dominance hierarchies (Diamond, 2002). Another example comes from the family of Equidae: Equus africanus (the ancestor of the donkey) and Equus ferus (the ancestor of the horse) were domesticated, while the three forms of zebras (Equus grevyi, Equus zebra, and Equus quagga) were not. Zebras are slightly more aggressive than donkeys; moreover they have a better peripheral vision than horses, which makes them very difficult to capture, and these characteristics prevented their domestication (Diamond, 2002). In this way, each of the around 150 mammal species that remain undomesticated possess traits that have prevented their domestication. Diamond (1997) provides additional arguments as to why it is highly unlikely that a successful domestication of further species could have been possible in antiquity. First, peoples without access to domesticable animal species very rapidly accepted introduced domesticates when they came into contact with Europeans. Second, the 14 species suitable for domestication were all domesticated at least 5,000 years ago, and most of them have been independently domesticated from several distinct groups. Third, there have been a range of modern attempts to domesticate further large species, none of which were successful. Overall, the arguments in this section suggest that successful domestication of further species was prevented by imperfect conditions among the animal species, not because of limited skills among local human groups.

2.2 Transport Animals and Long-Distance Trade

The exact date when humans started to employ animals for transportation tasks is unknown. Yet it is well documented that as early as 4,000 BC domesticated transport animals played an important role in the growing long-distance trade in the Middle East. Scarce commodities such as obsidian, metals, textiles, and jewelry now were extensively transported between distant places using donkeys, oxen, horses, and mules (McNeill, 2000). Domesticated transport animals also played an important role in the evolution of the first more standardized trade routes (e.g. Amin, 1970; Scheck, 1995; Miller and Burger, 1995; Burger et al., 2010; Frankopan, 2015).

An important and well-known ancient long-distance trade route was the Incense Route, ranging from the South of the Arabian peninsula to Gaza and Damascus, both on the Mediterranean coast. The Incense Road formed around 3,000 years ago, and the domestication of Camelus dromedarius played a crucial role in the evolution of this route (Kaster, 1986). In antiquity, the desert climate in wide parts of the Arabian peninsula made traveling larger distances there a serious challenge. However, the dromedary combines a range of characteristics that makes it perfectly suitable as a pack animal in this kind of climate, including the ability to go without water for more than two weeks. More than 100,000 dromedaries wandered the Incense Route each year in its peak (Scheck, 1995).

The Silk Road was another important long-distance trade route that linked China, Central Asia, Europe, and the Middle East for more than 4,000 years (Northrup, 2015). The merchants that conducted trade on the Silk Road often organized themselves into caravans (Liu, 2010). While other domesticated animals, such as the horse or the donkey, also played a role on the Silk Road, the Bactrian camel was the most important transport animal. The Silk Road often went through regions with extreme temperatures – conditions that the Bactrian Camel, similar to its relative, the dromedary, can manage extraordinarily well (Frankopan, 2015). Recent work by Frachetti et al. (2017) shows that in higher regions, the Silk road often developed along pre-existing nomad paths, which depended on the provision of good conditions for their animals (e.g. pasture), further highlighting the important role of domesticable transport animals for the early development of the Silk Road paths.

In the north-eastern part of Africa, trade between Egypt and Nubia (roughly today's Sudan) emerged as early as 4,000 BC. The Egyptians imported, among other goods, oils, certain kinds of grain, incense, and myrrh from Nubia, while they exported faience and alabaster objects, ointment, honey, and potentially copper (Vercoutter, 1959; Amin, 1970). Here it was at first the donkey that played an important role in the emerging trade. In ancient caravans hundreds of donkeys wandered between the two regions. The camel became an important transport animal on the route a bit later, probably sometime in the first millennium BC (Amin, 1970; Phillips, 1997).

In the Americas, by contrast, the most important historical trade route presumably was the network of Inca Roads, connecting many places within and around the Andes. While the Inca Empire did not rise before the early 13th century, the foundations of their road network had been established much earlier. The northern part of the Inca Empire had been home to the Wari Culture. In this area, the Inca Roads often coincide with earlier sites of the Wari People, suggesting a Wari origin (McEwan, 2005). In the south of the area later occupied by the Incas, among others, the Tiwanaku, were involved in long-distance trade during a much earlier era (Stanish et al., 2010). Already as early as 1,000 BC, long-distance trade in the Andes was conducted using llamas as pack animals (Miller and Burger, 1995; Burger et al., 2010).

This paper's focus on standardized trade routes does not mean that in other world regions, there was no long-distance trade ongoing in antiquity. For example, there is evidence of trade on land over longer distances from the Aztecs, various peoples in North America, and the Aborigines in Australia (e.g. Smith, 1990, 2010; Kampanelis and Elizalde, 2022). However, the total weight of transported goods is not comparable between these regions and the regions along the previously discussed trade routes. For example, McLaughlin (2016) reports an incident from the first century AD on the Silk Road, where a Chinese caravan was raided. This single caravan – using oxen – transported goods with a total weight of around 500 tons. Such a trade volume can hardly be reached in a region without paved trade routes and without transport animals. Estimating humans can transport a weight of 25 kilograms for 25 kilometers a day (roughly what Roman legionnaires were capable of), it would take 20,000 men to transport these goods over 350 kilometers in two weeks, underlining the different possibilities in long-distance trade between such regions. Together, the previous examples suggest that, independent of the region or the specific species, domesticable transport animals played an important role in the evolution of long-distance trade in various parts of the world.

These trade structures, which were mostly set up very early in the development process of modern human cultures, might have tended to create persistent patterns. For example, the horse plays an extremely important role in the culture and daily life of the Kalmyks, a Mongolian subgroup living within the historical range of the wild ancestor of the horse (Equus ferus); the Kalmyks have a long history of trading with neighboring sedentary peoples (Khodarkovsky, 1992). As the data by Michalopoulos and Xue (2021) show, some 3.2% of motifs in the oral folklore of the Kalmyks are about trade – while among pre-industrial ethnic groups, this value is around 1%. The Somalis, who reside in the heart-land of Equus africanus, the ancestor of the donkey, played a central role in trade in eastern Africa for hundreds of years (Gonzalez-Ruibal et al., 2017). Trade also plays an important role in the folklore of the Somalis. By contrast, the Acholi people, who live further west, in the region bordering Sudan and Uganda, most likely did not have access to Equus africanus, as the species was not endemic to their home territory. Accordingly, the Acholi hunt and farm (see e.g. Atkinson, 1994), but trade never seems to have played a large role in their culture. While their folklore spans 45 different motifs in total, none of them are about trade. Overall, ethnic groups living in a region historically home to domesticable transport animals have on average 2.61 trade-related motifs in their folklore, while other groups have on average 0.70 motifs.

2.3 Transport Animals and the Evolution of Hierarchy

Scholars have developed a range of theories about the emergence of early hierarchical structures. While many of these theories are based on agricultural developments (for a recent summary see Mayshar et al., 2022), some of the mechanisms said to have fostered the evolution of hierarchy could have been influenced or driven by the presence of domesticable transport animals (see also Turchin, 2011).

One theory argues that the emergence of long-distance trade routes favored the development of early hierarchical structures. Throughout history, merchants have been a rewarding target for predation. Merchants are an especially easy target if the routes on which they travel are not secured. Thus, in regions where such routes emerge there is a need for some form of security force that is centrally administered (similar to the mechanism linking farmers' insecurity to the development of defense capacities described by Dal Bo et al., 2022). Also, providing such security enables to extract rents from the traded goods, further augmenting the incentives to develop security structures (McNeill, 2000; Stearns, 2001). Consequently, regions through which long-distance trade routes passed appear to have had more favorable conditions for the development of organizational structures, compared to other regions.

Usually, written records from these periods, thousands of years ago, are sparse, so that in many cases it is difficult to assess if structures related to trade were established early on in the development process of hierarchy. However, in Anatolia many written records date as far back as 2,000 BC. These records suggest that organizational structures related to trade were established very early in the development process of the large-scale empires emerging around 3,800 years ago. These structures, for example, included arrangements for the standardized packaging of commodities, insurance against losses, and frameworks for the negotiation of protection rents with local rulers (McNeill, 2000). Similarly, Parkinson and Galaty (2007) suggest that political centralization in ancient Greece might have been caused by increasing inter-regional trade. Rodgers (2007) hypothesizes that luxury goods imported from China may have contributed to the emergence of hierarchy structures in parts of Inner Asia. Possibly, the emergence of long-distance trade favored the development of hierarchical structures in other regions as well. As argued in Section 2.2, the presence of domesticable transport animals might have increased the probability for the emergence of long-distance trade routes. Thus, in light of the hypothesized relationship between trade and more complex organizational structures, the presence of domesticable transport animals may have been a crucially important enabling factor for the emergence of hierarchy structures.

A second mechanism through which the presence of domesticable transport animals could have contributed to the development of hierarchy is by facilitating communication over longer distances. When an empire grows, administration becomes significantly more crucial. Fast lines of communications between the regions of an empire are essential. Regions that can draw on fast moving animals seem to have a natural advantage in communication speed, compared to other regions (e.g. Turchin, 2011). Indeed, such animals played an important role in facilitating communications in the first larger-scale empires, such as the Persian Empire and the first united Chinese empires (Colburn, 2013; Li et al., 2020).

Finally, access to domesticable transport animal species might have contributed to the emergence of hierarchy structures by facilitating warfare. While transport animal species such as the donkey and the llama are not suitable to be used in combat, they were used for transport by military logistics of the Romans (donkey) and the Inca (llama) (Mitchell, 2018; Cowie, 2017). Other transport animal species can be also of great value in direct combat. Especially the horse and the camel have been used in warfare for thousands of years, often making it easier for groups to conquer larger regions (see e.g. Köhler-Rollefson, 1993; Sidnell, 2006; Turchin, 2011; Turchin et al., 2013; Kitchell, 2014; Turchin et al., 2016, 2021; Kumagai, 2022a). Turchin (2011), Turchin et al. (2013), and Scheidel (2019) argue that such cavalry played an important role in empire building in some parts of the world.

Overall, facilitating long-distance trade, communication, and warfare represent three different mechanisms through which the presence of domesticable transport animal species in a region may have contributed to the emergence of hierarchy structures.

3 Data

This section describes how the main variables used in the empirical analysis are constructed. I will first describe the variables used at the grid cell level (the underlying grid has a size of 1x1 degrees, which is equal to around 100x100 kilometers at the equator). Second, I will outline the main variables employed at the ethnic group level. Summary statistics for the main variables at the grid cell level are presented in Appendix Table C1. Summary statistics for the main variables at the ethnic group level are presented in Appendix Table C2.

3.1 Grid Cell Level

3.1.1 Domesticable Transport Animals

The variable this study uses to measure the historical presence of domesticable transport animals is primary based on data from the Phylogenetic Atlas of Mammal Macroecology (Faurby et al., 2018, 2020). This dataset includes the historical (natural) and current ranges for all known 5,831 mammal species that have lived during the last interglacial era (around 130,000 years ago until present).[1] The historical ranges depict a situation before humanity began to alter the landscape, thus before the beginning of the neolithic period. I identify the historical ranges of the species that fulfill two criteria: (1) they must be suitable for domestication and (2) they must be suitable for transportation tasks. In total, there are only 14 large mammal species on earth that are suited for domestication (Diamond, 1997). Appendix Table C3 gives an overview of these animals.[2]

I then define a species as suitable for transportation if it can be used as a pack animal, which means that it can carry heavy loads on its back without the need for further technology such as a sledge. Section 2.2 provided evidence for the importance of the domesticated forms of Camelus dromedarius (dromedary), Camelus ferus (camel), Equus africanus (donkey), Equus ferus (horse), and Lama guanicoe (lama) for the emergence of long distance trade routes. All of these species were extremely well suited for transportation tasks. In addition to these species, the domesticated species of Bovidae have been used for transportation (see e.g. Kaster, 1986; McNeill, 2000; Sturgis, 2015; McLaughlin, 2016). These species include Bos gaurus (gaur), Bos javanivus (banteng), Bos mutus (yak), Bos primigenius (aurochs), and Bubalus arnee (water buffalo).

The remaining species – namely, Caepra aegrarus (the ancestor of the goat), Canis lupus (the ancestor of the dog), Ovis Orientalis (the ancestor of sheep), and Sus Scrofa (the ancestor of the pig) – are defined as not suitable for transportation. While in rare instances, these species may have been used as pack animals (e.g. there are reports by Spaniards in the 16th century suggesting than Native Americans used dogs as pack animals; see Sturgis, 2015), evidence for such usage is sparse, and their primary benefit to humans clearly does not lie in carrying loads. By contrast, species such as the

[1]In other recent work, Kumagai (2021) uses this dataset to create a measure of megaherbivore biomass, while Kumagai (2022b) draws on the data to create a measure of lost biomass due to megaherbivore extinction.

[2]I exclude Rangifer tarandus (reindeer) from this list. To what extent Rangifer tarandus is domesticable is disputed. To date, it is not fully domesticated and is rather seen as a semi-domesticated species (Takakura, 2020) (for a general discussion about domestication and semi-domestication see Mysterud, 2010).

camel, donkey, horse, or yak are capable of carrying loads in excess of 100 kg over long distances. (see e.g. Smith, 1898; Clutton-Brock, 1981; Gauthier-Pilters and Dagg, 1981; Sturgis, 2015). The carrying of such loads is completely beyond the capacities of the remaining domesticable species, not least due to their smaller size and weight. The species classified as suitable for transportation by far outdo human capabilities in carrying loads, an attribute that does not apply to the remaining species. Thus, these species can be reasonably defined as not suitable for transportation.

I then combine the historical ranges of the 10 species classified as suitable for transportation (see Appendix Figures B1 and B2), to create a measure of the historical presence of domesticable transport animals, granular to the grid cell level; see Figure 1.[3] For the main measure, I categorize a grid cell as historically having included domesticable transport animals if the cell overlaps the historical range of one of the species by at least 100 km^2.

3.1.2 Ancient Trade Routes

To measure the spread of ancient trade routes, the ideal solution would be to create a measure that illustrates the evolution of trade routes over time. Yet in the case of most routes, the exact date when they began to be used is unknown. Thus, for trade routes of the old world I follow Michalopoulos et al. (2018a) and draw on data from Brice and Kennedy (2001). These trade routes depict the situation for Europe, Asia, and Africa in late antiquity. I complement these routes by geocoding data from Hyslop (1984) for the Inca Roads. While the Inca Empire first developed in the early 13th century, their road system was based on earlier routes (as discussed in Section 2.2). Thus, it can be assumed that most parts of the road network were already in use in late antiquity. Figure 1 shows the course of these roads around the world. For the robustness analysis, I additionally draw on data from McCormick et al. (2013) for Roman roads.

Based on the geocoded trade routes data I then create two measures. First, I follow Michalopoulos et al. (2018a) and create a variable that measures, for each grid cell, the log of 1 + distance to the closest trade route (measured in 100 km units), which I use as my main dependent variable. Second, I construct a dummy variable that takes a value of 1 if a trade route is present in a grid cell, and 0 if otherwise.

[3] Note that Equus ferus underwent extinction in wide parts of its natural range, e.g. in the Americas, during the transition from Pleistocene to Holocene, before humans developed skills to domesticate animals. Thus, for the range of Equus ferus I draw on alternative data from Naundrup and Svenning (2015) that refers to a later point in time (around 3,500 BC). The results are qualitatively and quantitatively similar when using the historical range of Equus ferus from Faurby et al. (2018, 2020) and only accounting for its extinction in the Americas.

3.1.3 Ancient Cities

To measure hierarchical complexity in antiquity, I follow Mayshar et al. (2022) by drawing on data on the locations of ancient cities from Reba et al. (2016) as well as from DeGroff (2009). The dataset of Reba et al. (2016) is based on population data from Chandler (1987) and Modelski (2003). It includes the locations of urban settlements from 3,700 BC until 2,000 AD. I follow Mayshar et al. (2022) and construct ancient settlements for two points in time: 500 BC and 450 AD. The data from DeGroff (2009) refers to 400 AD. This dataset is more detailed and includes considerably more cities. Thus, in the main analysis I use the data from DeGroff (2009), which is shown in Figure 2. The cities depicted in Reba et al. (2016) referring to year 450 AD and year 500 BC are shown in Appendix Figures B3 and B4.

Analogous to the trade routes data, I create two measures. First, I create a variable that measures, for each grid cell, the log of 1 + distance to the closest ancient city (measured in 100 km units). Second, I construct a dummy variable that takes a value of 1 if an ancient city is present in a grid cell, and 0 if otherwise.

3.1.4 Further Variables

To measure caloric suitability, I draw on the Caloric Suitability Index by Galor and Özak (2016). Furthermore, I construct a measure on historical biodiversity, which counts the number of large mammal species per grid cell, by drawing on data from the Phylogenetic Atlas of Mammal Macroecology (Faurby et al., 2018, 2020). I further use this dataset to construct a measure of the presence of domesticable non-transport animal species. From the United States Geological Survey I take data on mineral deposits around the world (Schulz and Briskey, 2005). Distance to the coast is constructed measuring each grid cells distance to the nearest coastline. Further geographic and climatic variables are taken from Mayshar et al. (2022).

3.2 Ethnic Group Level

3.2.1 Domesticable Transport Animals

The variable measuring the historical presence of domesticable transport animal species within the region of an ethnic group is constructed similarly to the measure at the grid cell level. I first define a 25 km radius around the geographic centroid of an ethnic group, according to the Ethnographic Atlas (Murdock, 1967). An ethnic group then is categorized as living in a region where historically domesticable transport animal species were present when this area of 2500 km^2 overlaps with at least 25 km^2 of the historical range of one of the species.

3.2.2 Ethnographic Atlas

The Ethnographic Atlas is a dataset documenting various socioeconomic and cultural aspects of 1,267 ethnic groups around the world (Murdock, 1967). The characteristics of the groups are measured for the earliest period for which satisfactory ethnographic data were available and always refer to pre-industrial times. To measure the levels of hierarchy among these groups I draw on variable "v33" (jurisdictional hierarchy beyond local community). To measure class stratification within the groups I use variables "v66" (class stratification) and "v68" (class stratification in endogamy). To be more precise, I create a measure that takes a value of 1 if any form of class stratification is present within the group, and 0 otherwise. To measure the level of pre-industrial labor specialization, I follow Depetris-Chauvin and Özak (2020), who construct various measures based on 11 variables from the Ethnographic Atlas. These 11 variables measure the existence of "age or occupational specification" for metal working (v55), leather working (v56), pottery making (v57), boat building (v59), house construction (v60), gathering (v61), hunting (v62), fishing (v63), animal husbandry (v64), and agriculture (v65). I draw on the main measure of Depetris-Chauvin and Özak (2020), which counts the number of specialized activities per group. I further use variable "date", referring to the respective year in which the ethnographic data was recorded, as well as Longitude and Latitude of the groups' centroids. Furthermore, I follow Becker (2022) and construct a measure of historical dependence on pastoralism. More precisely, this measure combines the degree to which a society depended on animal husbandry with information on which animal was the predominant type in this society (for further details see Becker, 2022).

3.2.3 Folklore Data

To measure the pre-industrial level of involvement in trade, I draw on data from Michalopoulos and Xue (2021) based on the dataset of Berezkin (2015). The dataset of Berezkin (2015) includes the oral folklore of 958 language groups around the world. In total, there are 2,564 various motifs categorized in the data. Each motif reflects a combination of images, episodes, or structural elements that are found at least in two texts (Berezkin, 2015; Michalopoulos and Xue, 2021). Michalopoulos and Xue (2021) demonstrate that the frequency of motifs across ethnic groups strongly reflects the geography as well as norms, values, and habits of groups. Furthermore, they show how this data can be useful when traditional ethnographic data are not available. As there is no pre-industrial measure of trade for ethnic groups around the world, I draw on the motifs-based trade measure created by Michalopoulos and Xue (2021). Second, I use the folklore motifs to create a variable measuring numerical skills among ethnic groups. Therefore, for each group I construct the share of motifs that include the number of three or higher among all motifs. The folklore data are then merged with the groups from the Ethnographic Atlas. I also draw on the log number of publications Berezkin consulted per group as well as the log year of the first publication from Michalopoulos and Xue (2021). Following Michalopoulos and Xue (2021) I include these variables as baseline controls in each specification, when the dependent variable is folklore based.

3.2.4 Further Variables

To construct a measure of caloric suitability for each ethnic group around the world, I draw a 25 km radius around the groups' centroid and then calculate the mean of the Caloric Suitability Index proposed by Galor and Özak (2016). Distance to the coast is calculated by measuring the distance from the groups' centroid to the nearest coastline. Furthermore, I follow Becker (2022) and construct a variable of land suitability for pastoralism relative to agriculture, which is based on data from Beck and Sieber (2010). The data to construct this variable is not available for the Americas.

4 Domesticable Transport Animals, Ancient Long-Distance Trade Routes, and Early Forms of Hierarchy

In this section, I turn to empirically investigating (1) the relationship between domesticable transport animals and the emergence of ancient long-distance trade routes and (2) the relationship between domesticable transport animals and early forms of hierarchy. As discussed in Section 2.2, domesticated transport animals played an important role in the history of many ancient trade routes, such as the Incense Road, the Silk Road, and the Inca Roads. Thus, I hypothesize that the prehistoric presence of domesticable transport animals within a region increases the probability of long-distance trade routes emerging within that region. In Section 2.3, I discuss how the presence of domesticable transport animals might also have contributed to generating beneficial conditions for the development of hierarchy. Thus, second, I hypothesize that the prehistoric presence of domesticable transport animals within a region increases the probability that hierarchical structures emerge within that region. To test these hypotheses, I run variants of the following specification:

$$y_i = \alpha + \beta \text{DomesticableTransportAnimals}_i + \delta_{c(i)} + \gamma x_i' + \varepsilon_i, \tag{1}$$

where y_i is the outcome of interest (one of the trade and hierarchy measures described in Section 3.1), at the 1x1 degree grid cell level (roughly 100 x 100 kilometers at the equator).[4] In the main analysis, the presence of ancient trade routes and ancient cities is measured by the log of 1 + a grid cell's distance to the nearest trade route or ancient city. Given that the historical ranges of the domesticable animals species and the trade routes and hierarchy data are based on archaeological data, it may be that they are imprecisely measured. A potential concern that this inaccuracy biases the results can be alleviated by drawing on the distances to trade routes and ancient cities, as minor inaccuracies will not weigh heavily in such a setting. $\text{DomesticableTransportAnimals}_i$ is a dummy variable denoting the historical prevalence of domesticable transport animals in i. $\delta_{c(i)}$ are country or continent fixed effects and x_i' is a vector of control variables.

4.1 Domesticable Transport Animals and Ancient Long-Distance Trade Routes

Table 1 reports the results of specification (1) with the log distance to an ancient trade route as the dependent variable. Column (1) shows the raw correlation between the dummy variable denoting the historical presence of domesticable transport animals and the distance to a trade route. The coefficient is negative and statistically significant, suggesting that grid cells where domesticable transport animals were historically present are on average located 82.8% closer to a trade route, compared to other grid cells.[5] In column (2) continent fixed effects are introduced into the model, which reduces the coefficient slightly.

In column (3) three additional control variables are added that might be decisive for the emergence of early human structures. First, ancient mines might have affected the probability of the emergence of long-distance trade. Thus, distance to a mineral deposit is added as a control variable. Second, certain geographic variables could equally influence the conditions for the development of domesticable transport animals as well as for the emergence of long-distance trade routes. As an example, in far northern regions, the conditions are generally unfavorable both for such animals and for long-distance trade routes. To address the concern that the coefficient on domesticable transport animals captures advantageous conditions for the development of animals and humans in general, as

[4] Note that not all grid cells have the full size, e.g. because they are bordering the sea. In the main analysis, I exclude grid cells with an area less than 50% of a full grid cell.

[5] The percentage impacts in the regressions with a log variable as the dependent variable and a dummy variable as the main independent variable are calculated using 100 * [exp(β) - 1], as proposed by Halvorsen and Palmquist (1980).

a proxy for the general biodiversity in a grid cell I control for the number of prehistoric megafauna species there. Third, the conditions to engage in agriculture might have influenced the emergence of ancient long-distance trade routes. Thus, I also control for the caloric suitability within grid cells.

Column (4) introduces additional controls to further account for varying geographic and climatic conditions that might be related to the diffusion of domesticable transport animals as well as the spread of ancient trade routes. These controls include latitude, longitude, an interaction term between latitude and longitude, distance to the coast, elevation, ruggedness, temperature, and precipitation. Adding the controls reduces the coefficient by around 30%, while it remains negative and statistically significant.

In column (5) I replace the continent fixed effects with a set of country fixed effects. The coefficient is reduced by around half. However, it remains significant at the 1% level. The magnitude of the coefficient in column (5) implies that, within a country, moving from a grid cell where no domesticable transport animals were present to a grid cell where domesticable transport animals were present reduces the average distance to the next trade route by 31.5%. This is a quantitatively remarkable effect size, suggesting that domesticable transport animals were an important determinant for the development of ancient long-distance trade routes.

4.2 Domesticable Transport Animals and Early Hierarchy

Table 2 reports the results of specification (1) with the distance to the closest ancient city as the dependent variable. More specifically, I draw on the data from DeGroff (2009), which depict cities founded before 400 AD. The table has the exact same structure as Table 1. Throughout all columns, the dummy variable denoting the presence of domesticable transport animals is negative and significantly related to the distance to an ancient city. The coefficient in column (5) suggests that grid cells where domesticable transport animals were present are on average 32.1% closer to an ancient city, compared to other grid cells.

4.3 Threats to Identification and Robustness

The previous results presented in Sections 4.1 and 4.2 documented a strong statistical relationship between the prehistoric presence of domesticable transport animals and (1) the emergence of long-distance trade routes, as well as (2) the emergence of early forms of hierarchy, proxied by the presence of ancient cities. This section first addresses two salient challenges to a causal interpretation of the results. First, the effects could reflect a relationship between domestication in general and the emergence of hierarchy. Second, the effects could be driven by unobserved geographic or climatic conditions I was not able to capture with the controls included in the main specifications. Finally, this section examines the general robustness of the results by applying various changes to the data and the baseline specifications.

4.3.1 Domestication in General

This section addresses the concern that the observed relationships reflect a mechanism originating in domestication in general. There are at least two plausible mechanisms through which the domestication of animals in general could have led to an early development of hierarchy. First, groups that are involved in the domestication process early on could initially be adversely affected by diseases transmitted by the animals. Yet, later on these groups might have developed immunity against such diseases, so that they might gain an advantage in their development potential compared to other groups (see e.g. Galor and Moav, 2007; Scheidel, 2017).

Second, domestication generally enables more complex forms of subsistence. Domestication enables animal husbandry as well as the use of animals in agriculture. Insofar as these subsistence forms represent a relative advantage, they could also abet the rise of more complex social hierarchies. In both cases, the coefficients on the domesticable transport animals dummy in Table 2 could reflect a positive relationship between domestication in general and the probability for the development of hierarchy. The coefficients on the domesticable transport animals dummy in Table 1 could then reflect a larger probability for the emergence of trade routes in regions where hierarchy was already developing.

Section 2.1 outlined why the domestication of further species was not possible such that unobserved cooperation skills of human groups are unlikely to be driving the results. This section additionally further addresses this concern. If such unobserved cooperation skills would increase the probability of a successful domestication, such that the presence of domesticable species would be influenced by them, as well as the emergence of trade and hierarchy, a similar relationship should be found when using a variable measuring the presence of domesticable non-transport animal species. Moreover, if I were capturing a mechanism related to disease immunity or agriculture, then this mechanism should also be captured by a variable measuring the presence of domesticable non-transport animals. Thus, to address these concerns, I construct such a measure, based on the historical ranges of Ovis orientalis (the ancestor of the sheep), Sus scrofa (the ancestor of the pig), Capra aegagrus (the ancestor of the goat), and Canis lupus (the ancestor of the dog). Appendix Figure B5 shows the geographic distribution of these species.

Panel A of Table 3 explores the relationship between the historical presence of domesticable non-transport animals and the distance to a trade route. Columns (1) and (4) repeat the analysis undertaken in columns (4) and (5) of Table 1. In columns (2) and (5) I replace the measure of the presence of domesticable transport animals with the measure of the presence of domesticable non-transport animals. In columns (3) and (6) both variables are included. In column (2) the coefficient on the dummy variable implies a negative but insignificant relationship between the presence of domesticable non-transport animals and the distance to a trade route. When both measures are included in column (3) the coefficient becomes smaller. In columns (5) and (6), when country fixed effects are included, the coefficients are again insignificant and close to zero. In column (3) as well as in column (6) the coefficient on the presence of domesticable transport animals hardly reacts to the inclusion of the measure for the presence of domesticable non-transport animals. Panel B of 3 shows the results when using the distance to an ancient city as the dependent variable. Again, the results suggest no statistically significant relationship between the historical presence of domesticable non-transport animals and the outcome of interest.

Overall, the results of this exercise suggest that there is no significant relationship between the presence of domesticable non-transport animals and the emergence of trade routes or ancient cities. Thus, the effects of the previous Sections 4.1 and 4.2 are unlikely to be driven by some mechanism related to domestication in general. By revealing that there is no relationship between the historical presence of domesticable non-transport animal species and early human development these results also address the concern that the results are driven by unobserved cooperation skills of groups that increase the probability of successful domestication as well as the development of long-distance trade and early forms of hierarchy. If such cooperation skills were the cause of the results in Sections 4.1 and 4.2, a similar relationship should have been revealed when drawing on the domesticable non-transport animal species measure.

4.3.2 Unobserved Geographic and Climatic Variables

This section addresses the concern that the results are driven by unobserved geographic or climatic conditions that are related to the geographic distribution of the species suitable for domestication and transportation as well as early human development. The species suitable for domestication and transportation are all included in the families of Bovidae, Camelidae, or Equidae. In total, there are 47 other species included in these families that did not go extinct until the neolithic revolution and that are not suitable for domestication. Note that these species should not be systematically different to the species included in my main measure, except for their suitability for domestication. Successful domestication requires that a species must fulfill a wide range of criteria (see Section 2.1). Slight differences can determine if a species is domesticable or not. For example, Equus hemionus (the onager) and Equus grevyi, Equus zebra, and Equus quagga (various forms of zebras), are slightly more aggressive than Equus ferus (the ancestor of the horse) or Equus africanus (the ancestor of the donkey), which prevented their domestication. Equus ferus and Equus africanus are the only Equidae species that are suited for domestication. Except for their ability to be domesticated, the various species of equids are genetically so close that they even regularly interbred, underlining the similarity of species within these families (see e.g. Orlando, 2015). Thus, if the results from Sections 4.1 and 4.2 would be driven by unobserved geographic or climatic conditions that are related to the presence of Bovidae, Camelidae, or Equidae species, such a mechanism should also be captured by other combinations of the historical ranges of these species. I test this by drawing 1,000 random combinations of the historical ranges of ten species included in the families of Bovidae, Camelidae, and Equidae (excluding the species included in my main measure). I then re-estimate specification (1) and include these placebo variables instead of the variable measuring the historical presence of domesticable transport animal species.

Figure 3 shows the distribution of t-values for the placebo variables when distance to a trade route is the dependent variable. The underlying specification is equivalent to column (5) from Table 1 with country fixed effects and a full set of controls. The red line denotes the size of the t-value from the estimate on the historical presence of domesticable transport animal species based on column (5) of Table 1. The t-values from the placebo variables more or less follow a normal distribution around zero, while none of them reaches the size of the t-value of the variable measuring the historical presence of domesticable transport animal species. Figure 4 shows the distribution of t-values for the placebo variables when distance to an ancient city is the dependent variable. The results are very similar, while the difference between the placebo variables and the domesticable transport animals measure is a bit less pronounced.

To further address the concern that the results are driven by unobserved geographic or climatic conditions that are related to the geographic distribution of the species suitable for domestication and transportation as well as early human development, I conduct a second exercise. I follow Naundrup and Svenning (2015), who construct a measure on geographic suitability for Equus ferus by employing the model of Phillips et al. (2017) as well as the range of Equus ferus and the WorldClim data from Fick and

Hijmans (2017), and construct such a measure of geographic suitability for each of the ten domesticable transport animal species. I then construct a variable measuring suitability for domesticable transport animal species by aggregating these variables. On the continents where domesticable transport animal species were present there is a large correlation between this measure and the dummy denoting their presence (50–70%).

If the relationship between the historical presence of domesticable transport animal species and early human development would be driven by unobserved conditions that are conducive for the development of these animals as well as early human development, then it should also be captured by this variable – independently from the presence of these animals in a region. Thus, I split the sample of grid cells into two groups. The first group consists of grid cells in countries where no domesticable transport animal species were present historically. The second group consists of grid cells in countries, where at least in one of these cells domesticable transport animal species were present. I then regress the dependent variables from Section 4.1 and Section 4.2 on the measure of domesticable transport animals suitability in both of these groups. If the main results were capturing a mechanism originating in beneficial conditions for these types of animals instead of reflecting the presence of these animals, then this measure should be similarly related to the dependent variables in both groups. Panel A of Table 4 shows that there is no significant relationship between the suitability measure and log distance to a trade route when considering only regions where no domesticable transport animal species were present historically in columns (1) and (2). On the contrary, the coefficient is negatively and significantly related to the dependent variable in columns (3) and (4), when regions are considered where such animals were present. The results are similar in Panel B, when the log distance to an ancient city is the dependent variable.

Overall, these results suggest that the relationships between the presence of domesticable transport animals and the distance to a trade route as well as the distance to an ancient city are not driven by unobserved geographic or climatic conditions that are generally favorable to these species. Thus, I conclude from these exercises that the relationships between the historical presence of domesticable transport animals and the distance to a trade route as well as the distance to an ancient city indeed originate in the suitability of these animals for domestication, and thus in the possibility for humans to use them for transportation tasks. In combination with the results of the previous sections, these results thus support a causal interpretation of these relationships.

4.3.3 Further Robustness Tests

This section presents the results of further robustness analyses. A potential concern could be that the results only hold for a specific region, e.g. Europe or Asia. To rule out that the effects are driven by only one of these regions, I re-run column (5) from Tables 1 and 2 and exclude one of the continents in each case. The results are shown in Appendix Table D1. Again, the results are qualitatively and quantitatively similar to the baseline results.

Another concern could be that the results are largely driven by a single one of the ten transport animal species. For example, the horse began to play a particularly important role in various domains of human life starting in the Bronze Age. To address this concern, I re-run column (5) from Tables 1 and 2 and each exclude one of the species. The results are presented in Appendix Table D2. Throughout all columns, the coefficients are qualitatively and quantitatively similar to the coefficients of the main regressions and thus confirm that the effects are not driven by only one of the species.

Another issue might be that the results of Section 4.1 depend on the specific trade route data I draw on. While it is likely that the Inca Roads were predominantly in use in antiquity (see Section 2.2), this cannot be verified. Thus, in Panel A of Appendix Table D3 I re-run the specifications from Table 1 and exclude the Inca Roads. The results are again similar to the baseline results. Next, I draw on additional trade routes data. McCormick et al. (2013) provides detailed data on Roman roads. I did not include these roads in the main analysis for two reasons. First, the network of Roman roads was mostly built at a later point in time than the roads depicted by Brice and Kennedy (2001). Second, the level of detail varies strongly between the two datasets. While Brice and Kennedy (2001) focus on long-distance trade routes, the Roman road network includes many rather minor roads, so that the focus shifts away from long-distance trade. Yet, to address concerns about a potential selection issue, I include the Roman roads in Panel B of Appendix Table D3. The results are again quantitatively and qualitatively similar to the baseline results.

Mayshar et al. (2022) have shown that hierarchy first primary developed in regions where cereals, but not roots or tubers, were cultivated. As good climatic and geographic conditions for cereals could also to some extent reflect good conditions for specific types of animals, geographic overlap between domesticable transport animals and cereals is potentially a concern. To address this possibility, I draw on the data of Mayshar et al. (2022) and include three variables in the analysis. First, I include a dummy variable indicating if domesticable cereals but not domesticable roots and tubers were available in a grid cell. Second, I include a dummy variable indicating if domesticable roots and tubers but not domesticable cereals were available in a grid cell. Third, I include a variable taking a value of 1 if there are domesticable cereals as well as roots and tubers available in a grid cell, and 0 if otherwise. Panel A of Appendix Table D4 shows the results of this exercise. Similar to the results of Mayshar et al. (2022), the presence of domesticable cereals is significantly related to the emergence of early forms of hierarchy, which I again measure with the distance to an ancient city. Moreover, the coefficient on the dummy measuring the historical presence of domesticable transport animal species hardly changes when including these additional variables. Thus, the relationship between cereals and hierarchy is not driving the results.

In other recent work, Schönholzer (2020) shows that higher levels of environmental circumscription increased the probability for state emergence. To rule out that the results are caused by larger levels of circumscription in regions where domesticable transport animal species were present, in Panel B of Appendix Table D4 I control for a measure of circumscription constructed following Schönholzer (2020). The results do not change when this variable is included, while circumscription itself is negatively related to the distance to a trade route as well as the distance to an ancient city.

As the data on the historical ranges of the domesticable transport animal species refers to an earlier point in time than the trade routes data, reverse causality is unlikely to be the cause of the results. However, to further address this issue, I additionally include a variable measuring today's geographic presence of domesticable transport animal species in the analysis, which is based on the current ranges of these species. If the relationship were reversed, such that humans started to keep these types of animals close to trade routes, then it should be captured in particular by a geographic measure based on the current ranges of these species. Appendix Table D5 shows the results when this additional measure is included. In columns (1) and (4) of Panel A I replicate columns (4) and (5) from Table 1, with full controls and continent or country fixed effects. In columns (2) and (5) I replace the measure built on the historical ranges with a measure built on the current ranges. In columns (3) and (6) I include both measures in the regressions. The results suggest no significant relationship between the current presence of domesticable transport animal species and distance to an ancient trade route, while the coefficient on the historical presence of domesticable transport animal species remains negative and statistically significant. Panel B of Appendix Table D5 shows the corresponding results when considering a grid cell's distance to an ancient city. The results are very similar compared to Panel A, again suggesting no significant relationship between the current presence of domesticable transport animal species and the dependent variable. Overall, these results show that reverse causality does not play a role.

In the main analysis, the presence of ancient trade routes and ancient cities are measured by a grid cell's distance to the nearest trade route or ancient city. Given that the historical ranges of the domesticable animals species and to some extent also the trade routes and hierarchy data are based on archaeological data, it may be that they are imprecisely measured. A potential concern that this biases the results can be alleviated by using the distances, as minor inaccuracies will not weigh heavily in such a setting. Yet there may be the concern that this introduces other bias, as beyond a certain threshold increasing distance is no longer relevant. To address this issue Appendix Table D6 replicates Tables 1 and 2 but replaces the dependent variables with dummy variables to measure the presence of ancient long-distance trade routes and ancient cities. The coefficient on the domesticable transport animals dummy is positive and significantly related to the dependent variables throughout all columns, in Panel A (ancient trade routes) as well as in Panel B (ancient cities). The effect size again is remarkable, suggesting that grid cells where domesticable transport animal species were present have on average a 3.9 percentage point larger probability to include an ancient trade route, and a 2.2 percentage point larger probability to include an ancient city, while the unconditional means of including an ancient trade route or an ancient city both are around 5%. However, the standard error goes up, so that the coefficients in column (5) only remain significant at the 10% level.

The main analysis draws on continent fixed effects and country fixed effects. The idea of using country fixed effects is twofold. First, when country fixed effects are included, the variation comes from units that are relatively homogeneous inside. Second, the historical ranges of the domesticable animals species as well as the trade routes and hierarchy data are based on archaeological data. The density as well as the accuracy of archaeological excavations might differ drastically between modern countries. In the main analysis I draw on country fixed effects to further account for such potential heterogeneities. Yet, there might be the concern that country fixed effects only imperfectly account for regional heterogeneities. To address the concern that this might affect the results, in Appendix Table D7 I use different versions of grid cell fixed effects instead of country fixed effects. The results are once again similar compared to the main results, while the effect size naturally varies depending on the size of the grid cell fixed effects.

Many grid cells are located at the coast, such that they do not reach the full grid cell size. In the main analysis, I included all cells that are at least 50% the size of a full cell. To rule out that this decision affects the results in Appendix Table D8 I use different grid cell size cut-offs, going from including all grid cells to including only grid cells with the full size. The results are similar for each of these specifications.

While domesticable animals were present on all continents but Australia, the largest numbers of animals suitable for domestication were native to Europe and Asia. Thus, a further interesting question to explore is if the results still hold when only exploiting variation from within Europe and Asia. Appendix Table D9 shows the results when the sample is restricted to these continents. Overall, the results of this exercise are remarkable similar to the baseline results.

Furthermore, Appendix Table D10 uses different versions of Conley standard errors to account for spatial auto-correlation, while Appendix Table D11 only exploits variation in grid cells where domesticable non-transport animal species where present, to further rule out potential selection issues. Appendix Table D12 additionally controls for the presence of large rivers, while Appendix Table D13 controls for the human mobility index from Özak (2018). In Appendix Table D14 the domesticable transport animal species dummy is replaced with a variable measuring the log of 1 + the number of domesticable transport animal species historically present in a grid cell. Appendix Table D15 shows the results for the relationship between the historical presence of domesticable transport animal species and early forms of hierarchy when the data on the locations of ancient cities is taken from Reba et al. (2016). The coefficients again reveal a negative and significant relationship between the historical presence of domesticable transport animal species and the distance to an ancient city.

Overall, the analyses in this section demonstrate that the documented relationship between the historical presence of domesticable transport animals and the emergence of long-distance trade routes, as well as the relationship between the historical presence of domesticable transport animals and the emergence of hierarchy, hold for various specifications and are robust to a wide range of modifications.

5 Trade and Hierarchy among Pre-industrial Ethnic Groups

This section examines the potential long-run implications of the relationships described in Section 4. Note that the historical ranges of the domesticable transport animal species should not have a continuous direct effect on the trade and hierarchy measures used in the empirical analysis of Section 5. These variables are drawn from the Ethnographic Atlas (Murdock, 1967) as well as from the folklore data of Michalopoulos and Xue (2021). The average observation date in the Ethnographic Atlas is 1894, and the key publications for the folklore data are on average from the early 20th century. By contrast, the domestication of large mammal species usually was completed thousands of years ago, and the ranges of the domesticable transport animal species, which are the wild ancestors of the domesticates, changed drastically during the Holocene. Only in 13% of their historical ranges are these species still present today. Thus, I expect the historical presence of domesticable transport animal species to primary affect pre-industrial trade involvement and hierarchy structures by affecting their emergence in antiquity. Being involved in long-distance trade early on could result in larger involvement in trade in the long-run. Such a pattern would be in line with the anecdotal evidence provided in Section 2 as well as previous work that has demonstrated the long-run persistence of trading structures (e.g. Wahl, 2017; Flückiger et al., 2022). Similarly, developing hierarchical structures early on could translate into more complex levels of hierarchy in the long-run. I now turn to investigating these hypotheses by switching to the ethnic group level. To this end, I employ data from Murdock (1967) and Michalopoulos and Xue (2021) (see Section 3.2 for details). I then estimate variants of the following specification:

$$y_i = \alpha + \beta \text{DomesticableTransportAnimals}_i + \delta_{c(i)} + \gamma x_i' + \varepsilon_i, \quad (2)$$

where y_i is the outcome of interest (the trade and hierarchy measures described in Section 3.2) of ethnic group i and $\text{DomesticableTransportAnimals}_i$ denotes the historical prevalence of domesticable transport animals within 50 square kilometers of the centroid of group i. $\delta_{c(i)}$ are country or continent fixed effects and x_i is a vector of control variables at the ethnic group level.

5.1 Trade

Table 5 shows the results based on specification (2), when the share of trade-related motifs in a group's oral tradition is the dependent variable. I follow Michalopoulos and Xue (2021) by including two baseline folklore controls in all columns. These folklore controls include the number of publications Berezkin has consulted per group as well as the year of the earliest publication per group. In column (1), where no further controls or fixed effects are included, the coefficient on the dummy variable measuring the historical presence of domesticable transport animals implies that ethnic groups living in regions historically home to domesticable transport animals have on average a 0.355 log points or 42.6% larger share of trade-related motifs in their oral folklore, compared to other groups. In column (2) continent fixed effects are introduced, which slightly reduces the coefficient. In column (3) I add a range of control variables. These controls include land suitability for agriculture, distance to the coast, latitude, longitude, an interaction term between latitude and longitude, and a variable that reports the date of description of the groups in the Ethnographic Atlas. While the coefficient is reduced by around a third, it remains positive and significantly related to the dependent variable at the 1% level. In column (4) I replace the continent fixed effects with a set of country fixed effects. The coefficient remains significant at the 1% level and suggests that ethnic groups living in regions historically home to domesticable transport animals have on average a 48.7% larger share of trade-related motifs in their folklore, compared to other groups. Overall, the results in Table 5 suggest that trade plays a considerably larger role among pre-industrial ethnic groups living in regions historically home to domesticable transport animals, compared to other groups.

5.2 Hierarchy

Table 6 shows the results based on specification (2), when the hierarchy measure described in Section 3.2 is used as the dependent variable. As I do not draw on the folklore data throughout Table 6, the baseline folklore controls from Table 5 are not included here. Apart from that, the table has the exact same structure as Table 5. In column (1), the coefficient on the historical transport animals dummy equals 1.11, suggesting that groups living in regions historically home to domesticable transport animals reach on average roughly one more level of hierarchical complexity, compared to other groups. Including continent fixed effects in column (2) and the set of control variables in column (3) reduces the effect by around 40%, while it remains significant at the 1% level. In column (4) I again replace the continent fixed effects with a set of country fixed effects. The coefficient now implies that groups living in regions historically home to domesticable transport animals have on average 0.503 more levels of hierarchical complexity. Given that the unconditional mean of hierarchical complexity within my sample is equal to 0.893, this is a remarkable effect size.

Together, the results suggest that prehistoric exposure to domesticable transport animals has a large influence on the culture and on the institutions of ethnic groups in the long run: These groups were not only more involved in trade but also had built more complex hierarchical structures at the outset of the industrial era.

5.3 Robustness

This section assesses the robustness of the long-run results presented in Section 5.1 and Section 5.2. One concern might be that the long-run results reflect characteristics of involvement in animal husbandry. Recent work has demonstrated that groups that extraordinarily rely on animal husbandry for their subsistence differ in certain respects to other groups. Becker (2022) has shown that pastoral societies have special gender norms. Cao et al. (2021) find that the descendants of pastoralists are more involved in conflict. Potentially, these propensities for patriarchy and violence could have impacted trade involvement and the development of social hierarchies. As ethnic groups living in regions historically home to domesticable transport animals are frequently engaged in animal husbandry, the results in Table 5 and Table 6 potentially could be driven by such factors.

To address this concern, Appendix Table E1 examines whether the results hold when controlling for an ethnic group's engagement in animal husbandry. Columns (1) and (2) of Panel A replicate columns (4) and (5) from Table 5, while additionally controlling for historical dependence on pastoralism, constructed following Becker (2022) by drawing on data from the Ethnographic Atlas (Murdock, 1967). More precisely, this measure combines the degree to which a society depended on animal husbandry with information on which animal was the predominant type in this society (for details see Becker, 2022). The coefficient on the dummy measuring the historical presence of domesticable transport animal species within a region of an ethnic group becomes a bit smaller, while maintaining significantly related to the trade measure at the 1% level. Historical dependence on pastoralism itself is positively and significantly related to the dependent variable. As the domesticable transport animals dummy and the measure of historical dependence on pastoralism are correlated to a high degree (49.38%), it is difficult to disentangle the effects. Therefore in columns (3) and (4) of Panel A I control for another variable. To allow for causal inference, Becker (2022) uses a measure on land suitability for pastoralism relative to agriculture based on data from Beck and Sieber (2010). This measure is highly correlated to the variable measuring historical dependence on pastoralism, while it is only weakly correlated to the measure on the historical presence of domesticable transport animals, such that it might be better suited for distinguishing between effects driven from the availability of transport animals and pastoralism in general. The underlying data for the construction of this variable is not available for the Americas; thus, the number of observations drops from 951 to 505, equal to a sample size reduction of around 47%. While the coefficients on the dummy measuring the historical presence of domesticable transport animals are still positive and significantly related to the dependent variable, land suitability for pastoralism relative to agriculture is not significantly related to the extent groups are involved in trade, once country fixed effects are included. Panel B of Appendix Table E1 repeats the analysis with the hierarchy measure as the dependent variable. The results are very similar. Thus, it seems unlikely that the long-run effects are driven by behavior or norms specific to pastoralist groups.

To further assess the robustness of the main results, I conduct a large number of modifications to the main analyses, similar to the modifications in Section 4. Similarly to the results of Section 4, the results are not driven by just a single region (see Appendix Table E2). The results also do not depend on a single one of the ten species (see Appendix Table E3). The results are also comparable when using different specifications, such as using a log version of the domesticable animals measure (see Appendix Table E4), only including Europe and Asia (see Appendix Table E5), using Conley Standard Errors to account for spatial auto-correlation (see Appendix Table E6), or using grid cell fixed effects (see Appendix Table E7). The results are also similar when using only variation of groups living in regions historically home to domesticable non-transport animals (see Appendix Table E8).

Given the total number of 9,005 concepts in the dataset of Michalopoulos and Xue (2021), for many characteristics there are different terms describing similar issues. If the relationship between the historical presence of domesticable transport animals and the number of trade-related motifs in the folklore of groups indeed reflects a larger involvement in trade, there should be positive associations with trade-related terms such as 'sell', 'sale', or 'market' as well. Appendix Table E9 relates the historical presence of domesticable transport animals with such terms. Using https://relatedwords.io, a website showing related words for any given term, I depict the top six terms that are closest to 'trade'. These terms are 'sell', 'sale', 'commerce', 'exchange', 'market', and 'merchandise'. As can be seen in Panel A of Appendix Table E9, the historical presence of domesticable transport animals is positive and significantly related to each of these terms. Overall, the analysis suggests that these trade-related terms play a larger role among ethnic groups who live in a region where domesticable transport animals were present, compared to other groups, supporting the hypothesized persistence in trade involvement.

A similar analysis is conducted in Panel B of Appendix Table E9. Here the top six terms that are closest related to 'hierarchy' are depicted.[6] These terms are 'authority', 'power', 'status', 'order', 'administration', and 'monarchy'.[7] The coefficient on the historical presence of domesticable transport animals is positive in each column and significantly related to the dependent variable in columns (2) to (4) and (6). Overall, the analysis suggests that these hierarchy-related terms play a larger role among ethnic groups who live in a region where historically domesticable transport animals were present, compared to other groups, supporting the hypothesized persistence in hierarchical structures.

While the Ethnographic Atlas does not include a direct measure of trade, the more detailed Standard Cross-cultural Sample from Murdock and White (1969) includes several variables related to trade. However, all of these variables are only available for a very limited number of ethnic groups. However, in Appendix Table E10 I employ a measure of trade importance from the Standard Cross-cultural Sample as the dependent variable, based on variable "SCCSv819". The number of observations

[6]Note that https://relatedwords.io enables to select another term with which the depicted terms should be related. As hierarchy has different meanings, the additional term 'state' is selected.

[7]For 'administration', the variable is built on the motifs 'administrative', 'administration', and 'administrator'.

is therefore reduced by around 82%. The coefficient is positive throughout all columns, while only reaching statistical significance in columns (1) and (4). Overall, the results confirm the robustness of the main results.

5.4 Further Characteristics of Ethnic Groups

Given the extent to which the historical presence of domesticable transport animals is associated with marked differences between ethnic groups in terms of trade involvement and hierarchical structures, we might ask whether there are additional points of divergence between groups in terms of aspects that are associated with trade or hierarchy. Section 5.4 explores such potential differences.

An interesting characteristic to explore in this context is numeracy. Numeracy itself is an important personal ability and related to economic development through various mechanisms (Crayen and Baten, 2010). The how and when of the origins of numeracy in human development are unclear. As early as 25,000 to 35,000 years ago notched bones were used for counting purposes. Some scholars argue that trade played an important role in the development of numeracy (Menninger, 1969). For the earliest form of trade – barter – some degree of numeracy is essential. Thus, it is plausible to assume that ethnic groups living in regions historically home to domesticable transport animals and that consequently were more involved in trade would have developed greater numeracy skills. To examine this potential relationship, I construct a new measure of numeracy among pre-industrial ethnic groups, based on data from Berezkin (2015) and Michalopoulos and Xue (2021), which are based on numbers present in a groups' folklore (for details see Section 3.2).

Another characteristic that might be more prevalent among these groups is the extent of labor specialization. Depetris-Chauvin and Özak (2016) have highlighted the importance of pre-industrial labor specialization, by linking it to higher present-day nighttime light luminosity, a common proxy for economic development. Depetris-Chauvin and Özak (2016) and Depetris-Chauvin and Özak (2020) provide first evidence of an important determinant of pre-industrial labor specialization, which is the genetic diversity of ethnic groups. To explore a potential relationship between the historical presence of domesticable transport animals and labor specialization I follow Depetris-Chauvin and Özak (2020) and construct a measure for the extent of labor specialization among pre-industrial ethnic groups based on the Ethnographic Atlas (for details see Section 3.2).

Furthermore, larger involvement in trade as well as more pronounced hierarchical structures could both be related to higher levels of class stratification, which might be seen as a proxy for within-group inequality. While trade is usually beneficial for a community, it also has been shown to increase inequalities (see e.g. Helpman et al., 2017). More pronounced hierarchical structures, by creating elites, also naturally increase inequality. To examine a possible relationship between the historical presence of domesticable transport animals and class stratification, I create a measure of class stratification based on data from the Ethnographic Atlas (for details see Section 3.2).

Table 7 explores these potential relationships between prehistoric exposure to domesticable transport animals and numeracy, labor specialization, and class stratification. Panel A shows the results of specification (2), when the measure of numeracy is employed as dependent variable. Panel B shows the results of specification (2), when the measure of labor specialization is used as the dependent variable. Panel C shows the results of specification (2), when the measure of class stratification is employed as the dependent variable. The table has the same structure as Table 6.

In Panel A, the coefficient on the dummy measuring the historical presence of domesticable transport animals is positive and significantly related to the numeracy measure throughout all columns. In column (4), the coefficient suggests that groups living in regions historically home to species of domesticable transport animals reach a 0.19 log points larger value in the measure of pre-industrial numeracy, compared to other groups. This corresponds to 20.6% percentage points and is a considerable difference. In Panel B, the coefficient on the dummy measuring the historical presence of domesticable transport animals is positive and significantly related to the measure of labor specialization throughout all columns. In column (4) the coefficient suggests that groups living in regions historically home to domesticable transport animals have on average 0.540 more levels of labor specialization. Given that the unconditional mean of labor specialization within my sample is equal to 0.661, this again is a remarkable effect size. In Panel C, the coefficient on the historical presence of domesticable transport animals is also positive and significantly related to the dependent variable, which is the measure of class stratification described in Section 3.2. In column (4), the coefficient implies that groups living in regions historically home to domesticable transport animals have on average a 0.168 log points or 18.3 percentage points larger probability of being a society in which inequality in terms of class stratification is present. Given that class stratification is present in 53.7% of groups, this again is a considerable effect size.

Overall, the results in this section underscore the fact that ethnic groups with access to domesticable transport animals diverge culturally from other groups, by demonstrating higher levels of numeracy, greater labor specialization, and higher levels of class stratification.

6 Conclusions

This paper studied the developmental impacts of historical access to domesticable transport animals. The first part of the analysis showed that the historical presence of domesticable transport animal species was an important determinant of the emergence of ancient long-distance trade routes as well as early forms of hierarchy. These results are robust to a many changes in the baseline data and are not driven by domestication in general, unobserved geographic and climatic conditions, or reverse causality. The second part of the analysis examined the potential persistence of these patterns. The results show that pre-industrial ethnic groups living in regions historically home to domesticable transport animals were more involved in trade and had built more complex social hierarchies, compared to other groups. Furthermore, these groups developed greater numerical skills, larger levels of labor specialization, and higher levels of class stratification, thus underscoring the broader cultural differences that emerged between groups as a function of their access to domesticable transport animals.

As domesticable transport animal species were overwhelmingly concentrated in parts of Europe and Asia, this research also sheds more light on why Europe developed at a more rapid pace than other parts of the world (see e.g. McNeill, 1990; Mokyr, 2005; Acemoglu et al., 2005; Voigtländer and Voth, 2013; Stasavage, 2016; de la Croix et al., 2018; Schulz, 2022). More generally, these results highlight the great relevance of historical access to domesticable transport animals species for the development path of peoples. In particular, this paper shows how bio-geographic factors have conditioned the development of human culture.

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Figures

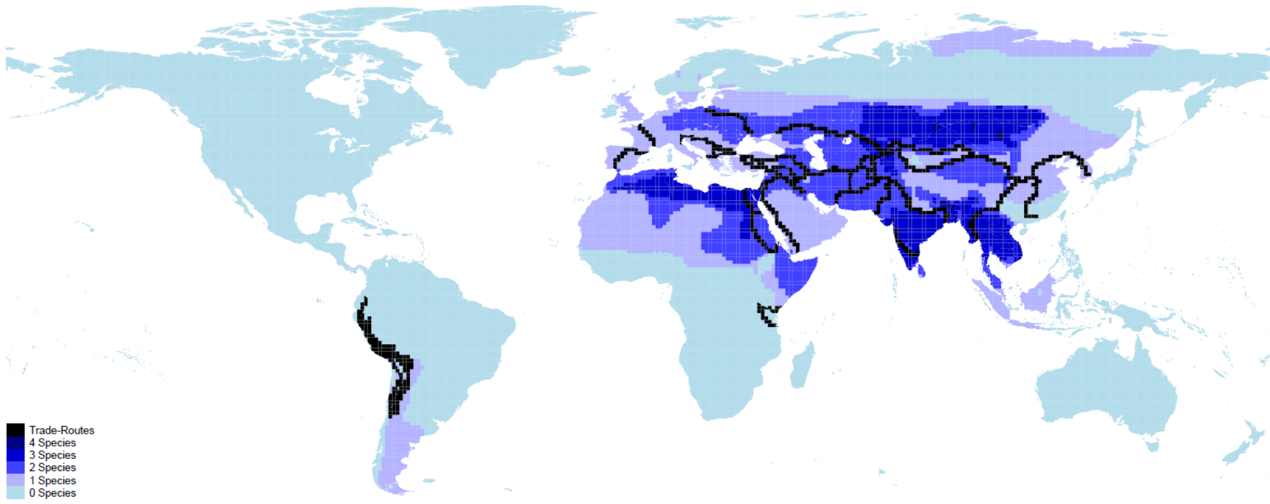

Figure 1 Domesticable Transport Animals and Ancient Trade Routes Around the World

Notes: This figure shows the historical prevalence of domesticable transport animal species and the courses of ancient trade routes. Species of domesticable transport animals include Bubalus arnee, Bos gaurus, Bos javanivus, Bos mutus, Bos primigenius, Camelus dromedarius, Camelus ferus, Equus africanus, Equus ferus, and Lama guanicoe. Data on the historical ranges of these species come from Faurby et al. (2018, 2020) and Naundrup and Svenning (2015). Data on the courses of ancient trade routes is from Brice and Kennedy (2001) and Hyslop (1984).

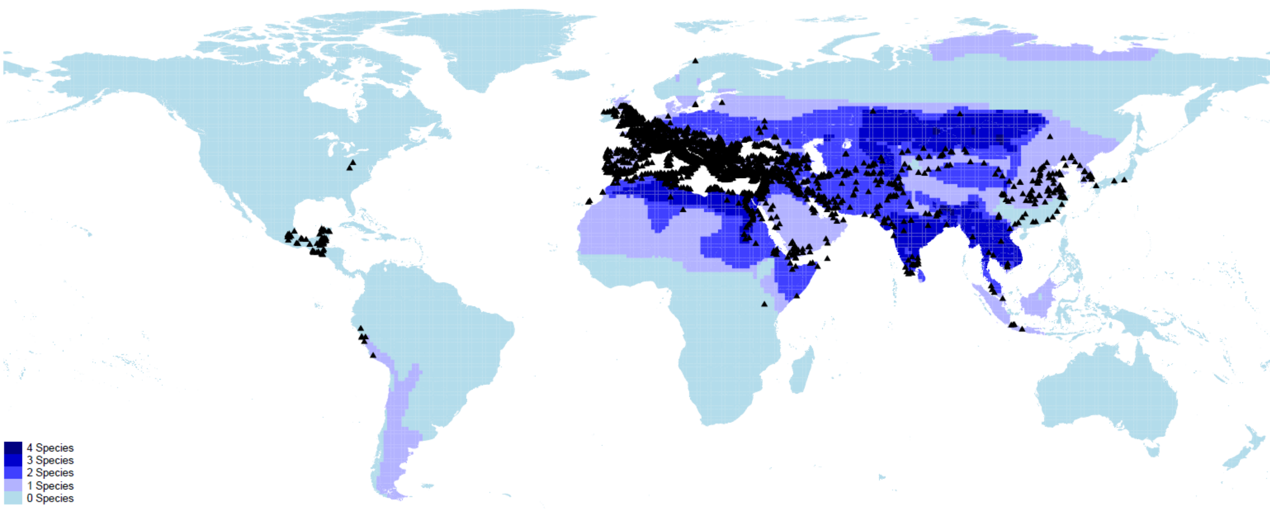

Figure 2 Domesticable Transport Animals and Ancient Cities Around the World

Notes: This figure shows the historical prevalence of domesticable transport animal species and the locations of ancient cities. Species of domesticable transport animals include Bubalus arnee, Bos gaurus, Bos javanivus, Bos mutus, Bos primigenius, Camelus dromedarius, Camelus ferus, Equus africanus, Equus ferus, and Lama guanicoe. Data on the historical ranges of these species come from Faurby et al. (2018, 2020) and Naundrup and Svenning (2015). Data on the locations of ancient cities is from DeGroff (2009).

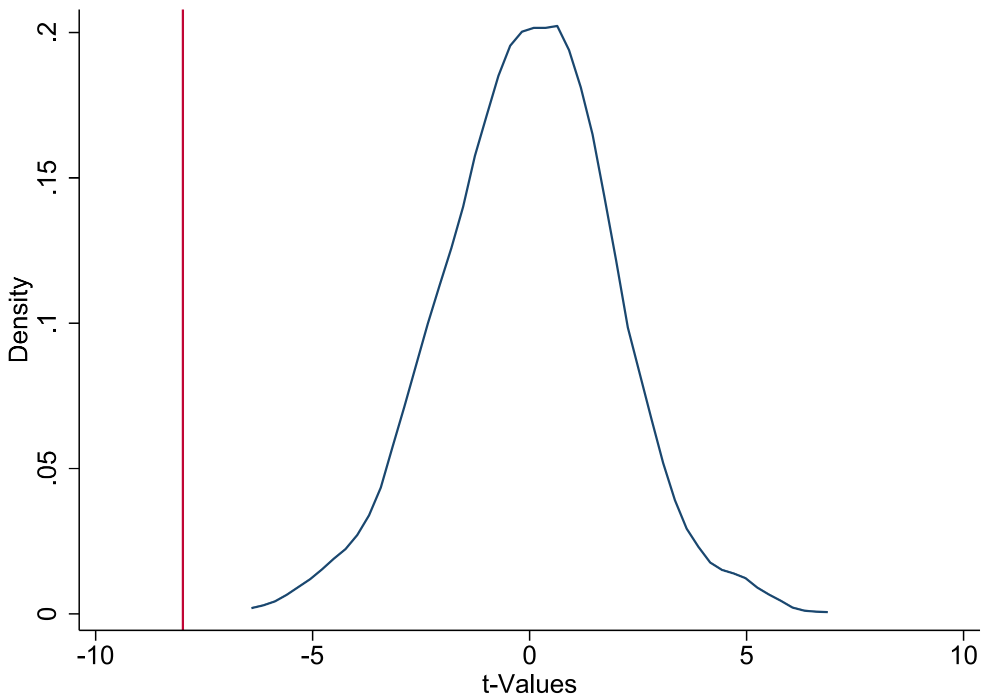

Figure 3 Placebo Regressions With Random Combinations of Similar Species: Log Distance to a Trade Route

Notes: This figure shows the distribution of the t-values of 1,000 placebo variables constructed using animal species that are similar to the 10 domesticable transport animal species. The underlying regressions are equivalent to column (5) from Table 1 with country fixed effects and full controls. The red line denotes the t-value of the domesticable transport animals measure from the respective specification in Table 1.

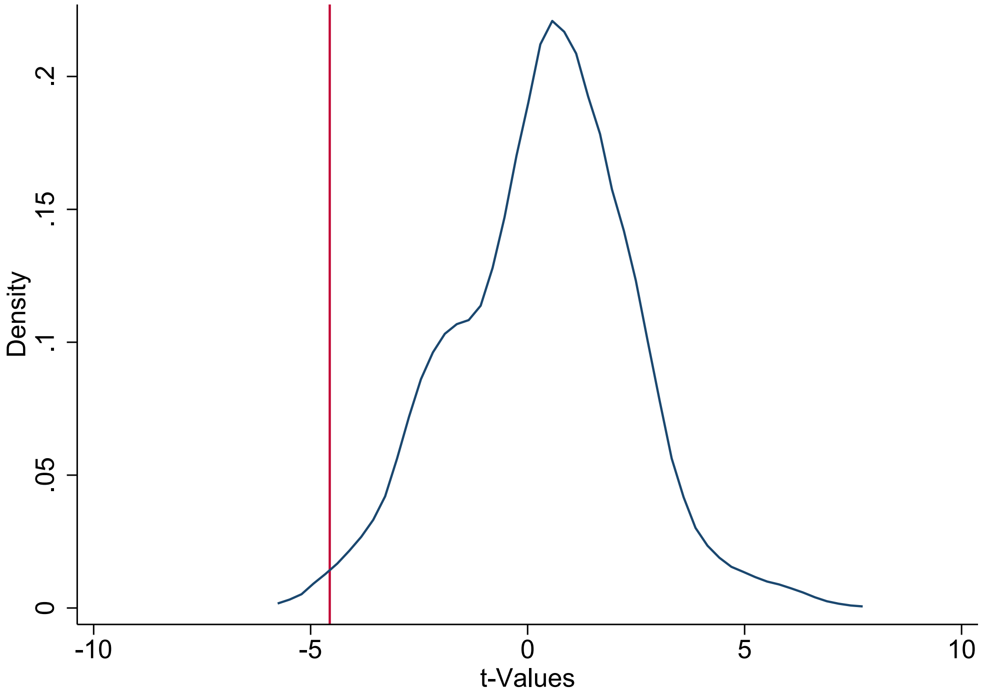

Figure 4 Placebo Regressions With Random Combinations of Similar Species: Log Distance to an Ancient City

Notes: This figure shows the distribution of the t-values of 1,000 placebo variables constructed using animal species that are similar to the 10 domesticable transport animal species. The underlying regressions are equivalent to column (5) from Table 2 with country fixed effects and full controls. The red line denotes the t-value of the domesticable transport animals measure from the respective specification in Table 2.

Tables

Table 1 Domesticable Transport Animals and Log Distance to a Trade Route

	Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.760***	-1.206***	-1.166***	-0.891***	-0.378***
	(0.293)	(0.119)	(0.096)	(0.166)	(0.047)
Ln Caloric Suitability			-0.083***	-0.074***	-0.042***
			(0.017)	(0.013)	(0.011)
Ln Historic Biodiversity			0.196***	0.197**	0.111**
			(0.047)	(0.083)	(0.045)
Ln Distance to Mineral Deposit			0.145***	0.054	0.027
			(0.047)	(0.047)	(0.042)
Latitude				0.008	0.009
				(0.005)	(0.009)
Longitude				-0.002	-0.001
				(0.004)	(0.004)
Lat X Lon				0.000	0.000
				(0.000)	(0.000)
Ln Distance to the Coast				0.048	0.022
				(0.043)	(0.036)
Ln Elevation				-0.211***	-0.067
				(0.061)	(0.049)
Ln Ruggedness				-0.196**	-0.149**
				(0.092)	(0.066)
Ln Temperature				-0.041	-0.122
				(0.050)	(0.075)
Ln Precipitation				0.082	0.029
				(0.061)	(0.048)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.445	0.638	0.686	0.725	0.891
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route). Main controls include ln(1 + caloric suitability pre 1500) , ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln(1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table 2 Domesticable Transport Animals and Log Distance to an Ancient City

	Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.648***	-1.253***	-1.227***	-1.015***	-0.387***
	(0.218)	(0.112)	(0.138)	(0.224)	(0.085)
Ln Caloric Suitability			-0.085***	-0.066***	-0.051***
			(0.019)	(0.013)	(0.012)
Ln Historic Biodiversity			0.056	0.227***	0.110
			(0.069)	(0.085)	(0.070)
Ln Distance to Mineral Deposit			0.099	-0.011	0.005
			(0.073)	(0.064)	(0.053)
Latitude				0.004	0.016*
				(0.006)	(0.009)
Longitude				-0.003	0.001
				(0.003)	(0.004)
Lat X Lon				0.000	-0.000
				(0.000)	(0.000)
Ln Distance to the Coast				0.085**	0.042
				(0.035)	(0.043)
Ln Elevation				-0.156***	0.003
				(0.057)	(0.056)
Ln Ruggedness				-0.154	-0.204***
				(0.107)	(0.067)
Ln Temperature				-0.202***	-0.098
				(0.074)	(0.074)
Ln Precipitation				0.027	-0.053
				(0.055)	(0.061)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.467	0.544	0.611	0.656	0.839
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to an ancient city). Main controls include ln(1 + caloric suitability pre 1500) , ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln(1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table 3 Domesticable Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Transport and Non-Transport Animals

	Panel A: Ln Distance Trade Route					
	(1)	(2)	(3)	(4)	(5)	(6)
Domesticable Transport Animals	-0.891***		-0.879***	-0.378***		-0.378***
	(0.166)		(0.167)	(0.047)		(0.046)
Domesticable Non-Transport Animals		-0.359	-0.252		-0.030	-0.005
		(0.271)	(0.217)		(0.150)	(0.134)
Observations	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.725	0.676	0.726	0.891	0.886	0.891
Continent FE	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Ln Distance Ancient City					
	(1)	(2)	(3)	(4)	(5)	(6)
Domesticable Transport Animals	-1.015***		-1.008***	-0.387***		-0.384***
	(0.224)		(0.223)	(0.085)		(0.082)
Domesticable Non-Transport Animals		-0.274	-0.151		-0.107	-0.082
		(0.308)	(0.235)		(0.208)	(0.189)
Observations	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.656	0.577	0.656	0.839	0.832	0.839
Continent FE	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500) , ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln(1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table 4 Suitability for Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City

	Panel A: Ln Distance Trade Route			
	No Dom. Transport Animals		Dom. Transport Animals	
	(1)	(2)	(3)	(4)
Ln Domesticable Transport Animals Suitability	0.029	0.023	-0.787***	-0.446***
	(0.038)	(0.033)	(0.145)	(0.088)
Observations	6,453	6,453	8,816	8,816
R^2	0.786	0.944	0.651	0.833
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Main Controls	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes

	Panel B: Ln Distance Ancient City			
	No Dom. Transport Animals		Dom. Transport Animals	
	(1)	(2)	(3)	(4)
Ln Domesticable Transport Animals Suitability	0.002	-0.027	-0.534***	-0.307**
	(0.040)	(0.045)	(0.129)	(0.135)
Observations	6,453	6,453	8,816	8,816
R^2	0.655	0.818	0.665	0.822
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Main Controls	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Columns (1) and (2) includes only grid cells in countries, where historically no domesticable transport animal species were present. Columns (3) and (4) only includes grid cells in countries, where at least in one grid cell domesticable transport animal species were historically present. Main controls include ln(1 + caloric suitability pre 1500) , ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln(1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Table 5 Domesticable Transport Animals and the Share of Trade-Related Motifs

	Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.355***	0.337***	0.298***	0.397***
	(0.108)	(0.051)	(0.053)	(0.069)
Ln(1 + Distance to the Coast)			0.001	0.022
			(0.025)	(0.044)
Latitude			0.003**	0.000
			(0.001)	(0.003)
Longitude			-0.001	-0.001
			(0.001)	(0.001)
Lat X Lon			-0.000	-0.000
			(0.000)	(0.000)
Date Measured			0.000***	0.000***
			(0.000)	(0.000)
Observations	951	951	951	951
R^2	0.167	0.267	0.281	0.444
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The dependent variable is ln(1 + share of trade-related motifs). Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 6 Domesticable Transport Animals and Hierarchy

	Hierarchy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	1.110***	0.644***	0.672***	0.503***
	(0.290)	(0.167)	(0.149)	(0.181)
Ln(1 + Distance to the Coast)			-0.018	-0.065
			(0.044)	(0.059)
Latitude			-0.006	-0.021***
			(0.005)	(0.007)
Longitude			-0.001**	0.003
			(0.001)	(0.002)
Lat X Lon			0.000	-0.000
			(0.000)	(0.000)
Date Measured			-0.001**	-0.001**
			(0.000)	(0.000)
Observations	951	951	951	951
R^2	0.168	0.318	0.333	0.502
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 7 Domesticable Transport Animals, Numeracy, Labor Specialization, and Class Stratification

	Panel A: Numeracy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.395***	0.449***	0.354***	0.187**
	(0.139)	(0.142)	(0.095)	(0.074)
Observations	951	951	951	951
R^2	0.089	0.145	0.185	0.454
Folklore Controls	Yes	Yes	Yes	Yes
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes
	Panel B: Labor Specialization			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	1.158***	0.598***	0.561***	0.540**
	(0.299)	(0.152)	(0.161)	(0.226)
Observations	951	951	951	951
R^2	0.187	0.386	0.410	0.490
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes
	Panel C: Class Stratification			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.356***	0.238***	0.239***	0.168**
	(0.075)	(0.057)	(0.043)	(0.073)
Observations	951	951	951	951
R^2	0.082	0.151	0.199	0.356
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). In Panel A, the dependent variable is a measure of numeracy, based on data from Berezkin (2015) and Michalopoulos and Xue (2021). In Panel B, the dependent variable is a measure of labor specialization, based on Depetris-Chauvin and Özak (2020). In Panel C, the dependent variable is a measure of class stratification, based on variables 'v66' and 'v68' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Appendix

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A Range Determinants

This section discusses some of the various determinants of species ranges. An important factor to consider are physical barriers (Gaston, 2003). For example, many species ranges in the forest regions of equatorial Africa and South America are limited by (especially large and fast-flowing) rivers. Even if some individuals of a species cross the river, the interaction between the two populations on both sides is strictly limited, such that in the long-run it is likely for two sister populations to develop (Gaston, 2003). A similar argument can be made for mountain ranges. Second, climatic factors naturally play a role. Here it often is not one isolated factor, but a combination of different factors such as temperature and precipitation that at some point create conditions that are less optimal for a species (Andrewartha and Birch, 1954). Third, another important limitation of the range of a species is the distance to its center. Central habitats have higher population densities as well as greater genetic diversity. Thus, the further away from the species' center, the lower is population density as well as genetic diversity and the probability increases that the mortality rate exceeds the reproductive rate (Guo et al., 2005). A fourth determinant of range edges is interspecific competition (Gaston, 2003). The exact border until which a species has an advantage again is also determined by the distance to the centers of the meeting species, and their population densities as well as genetic diversities in the region, where they meet.

B Additional Figures

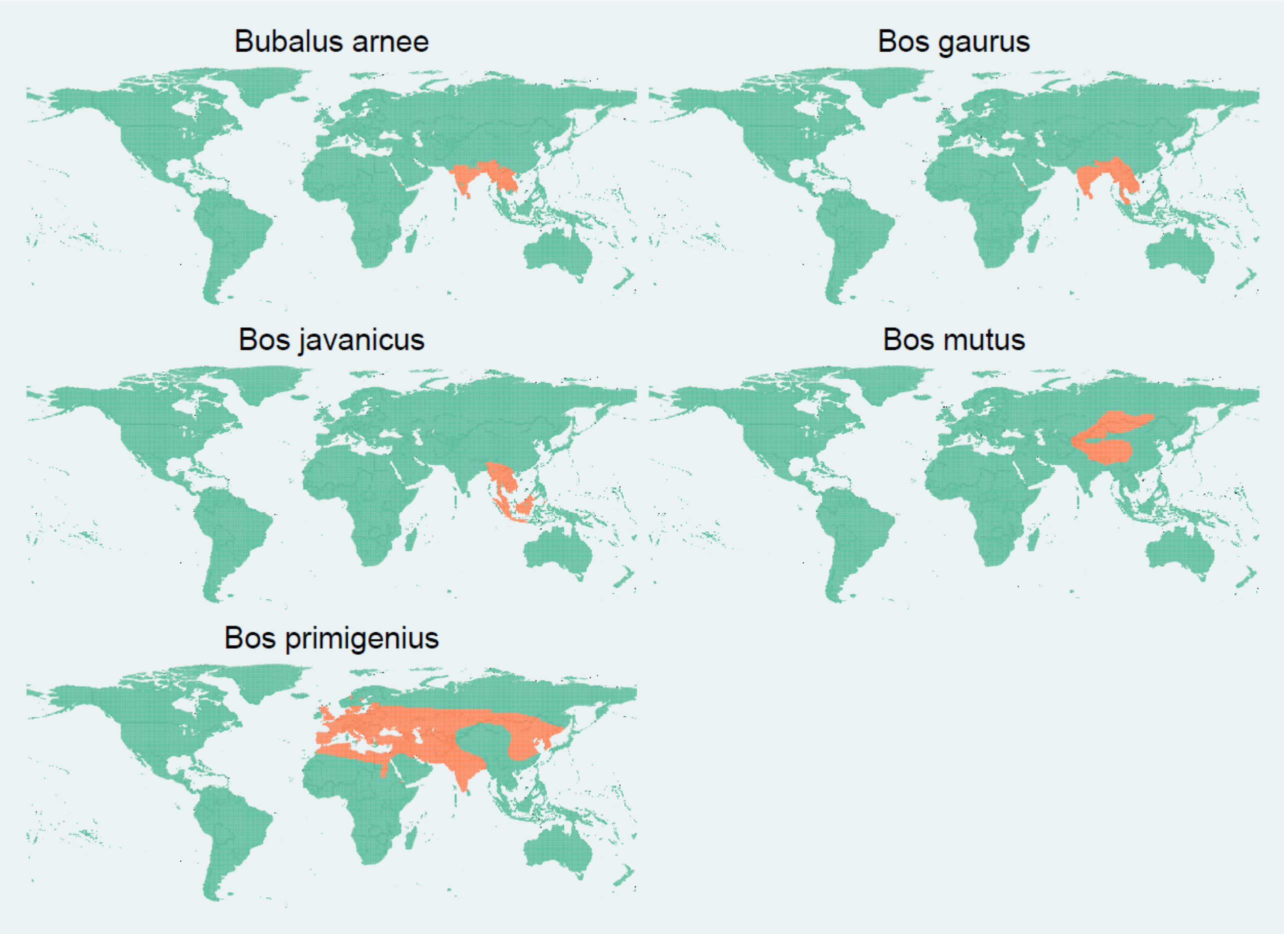

Figure B1 Domesticable Transport Animals: Historical Ranges of the Species I

Notes: This figure shows the historical ranges of Bubalus arnee, Bos gaurus, Bos javanivus, Bos mutus, and Bos primigenius. Data comes from Faurby et al. (2018, 2020).

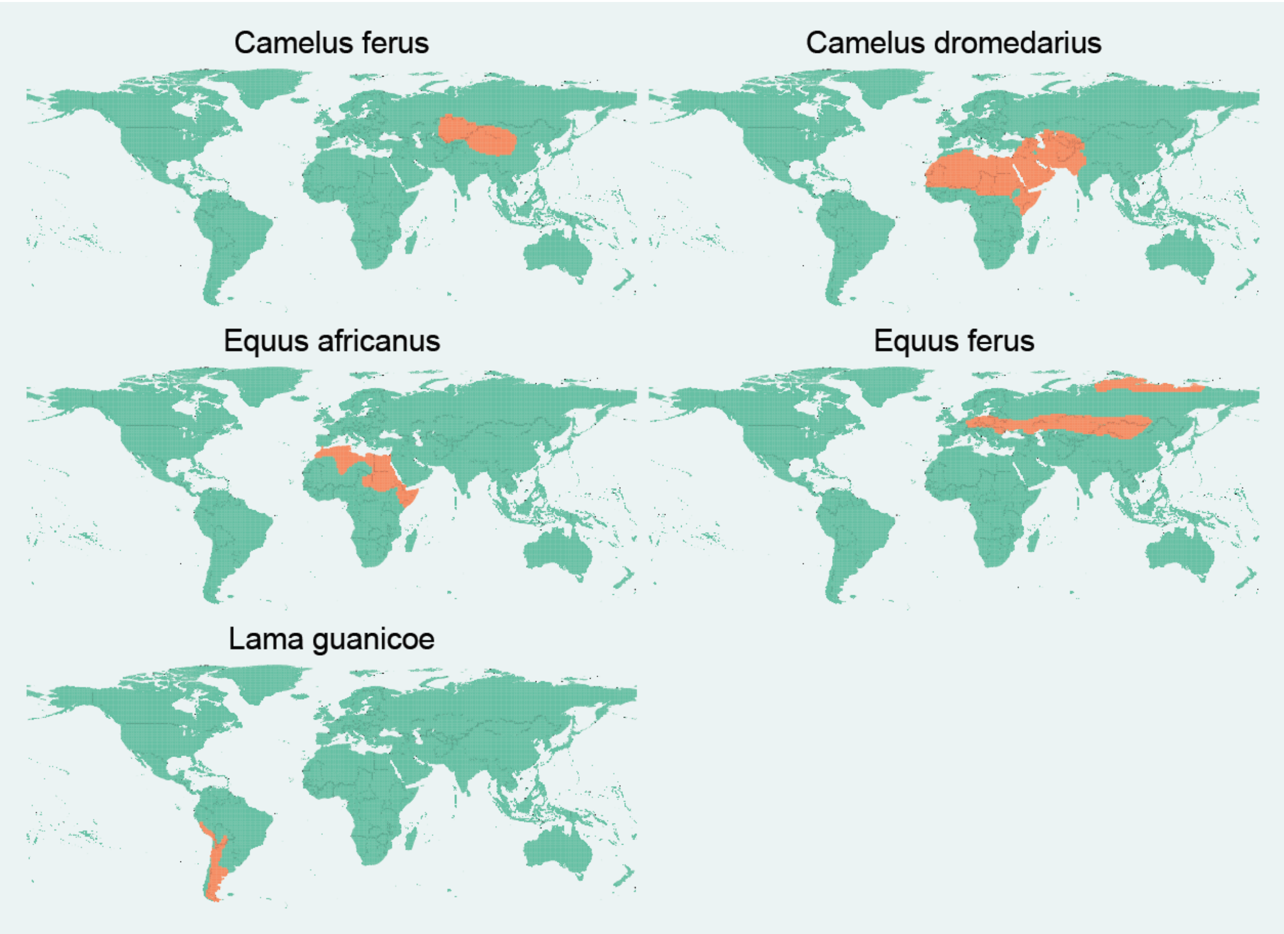

Figure B2 Domesticable Transport Animals: Historical Ranges of the Species II

Notes: This figure shows the historical ranges of Camelus dromedarius, Camelus ferus, Equus africanus, Equus ferus, and Lama guanicoe. Data comes from (Faurby et al., 2018, 2020) and Naundrup and Svenning (2015).

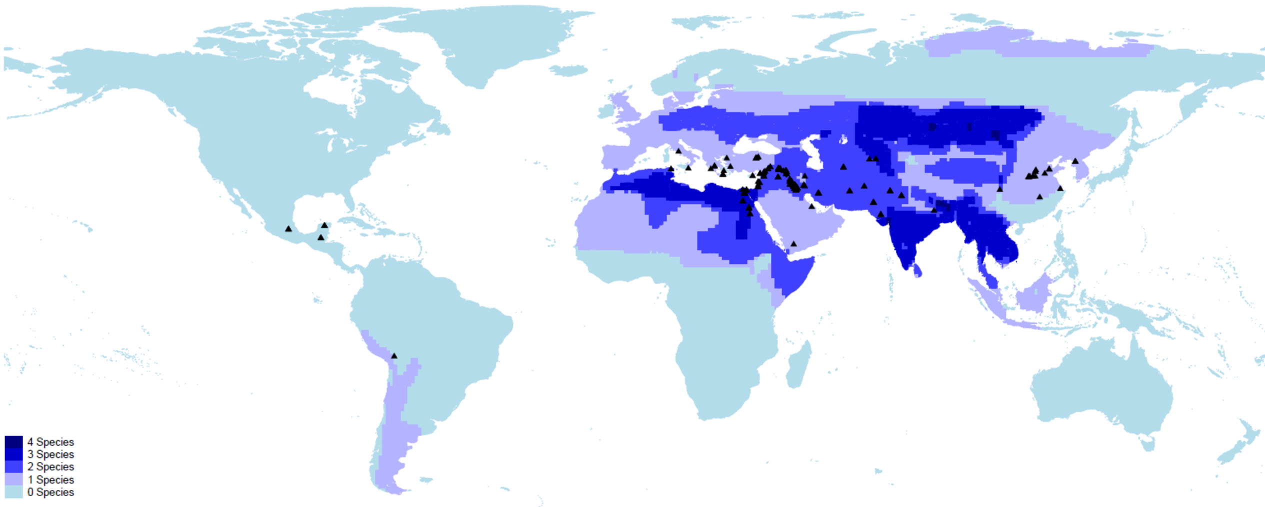

Figure B3 Domesticable Transport Animals and Ancient Cities Around the World (500BC)

Notes: This figure shows the historical prevalence of domesticable transport animal species and an alternative dataset of locations of ancient cities, referring to 500 BC. Species of domesticable transport animals include Bos gaurus, Bos javanivus, Bos mutus, Bos gaurus, Bubalus arnee, Camelus dromedarius, Camelus ferus, Equus africanus, Equus ferus, and Lama guanicoe. Data on the historical ranges of these species come from Faurby et al. (2018, 2020) and Naundrup and Svenning (2015). Data on the locations of ancient cities are from Reba et al. (2016).

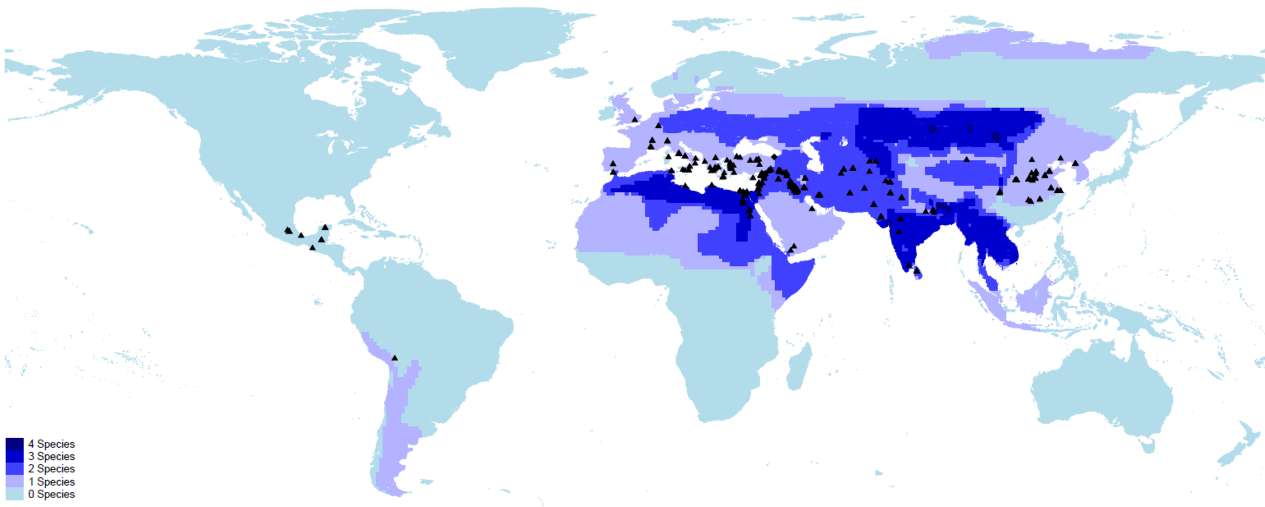

Figure B4 Domesticable Transport Animals and Ancient Cities Around the World (450AD)

Notes: This figure shows the historical prevalence of domesticable transport animal species and an alternative dataset of locations of ancient cities, referring to 450 AD. Species of domesticable transport animals include Bos gaurus, Bos javanivus, Bos mutus, Bos gaurus, Bubalus arnee, Camelus dromedarius, Camelus ferus, Equus africanus, Equus ferus, and Lama guanicoe. Data on the historical ranges of these species come from Faurby et al. (2018, 2020) and Naundrup and Svenning (2015). Data on the locations of ancient cities are from Reba et al. (2016).

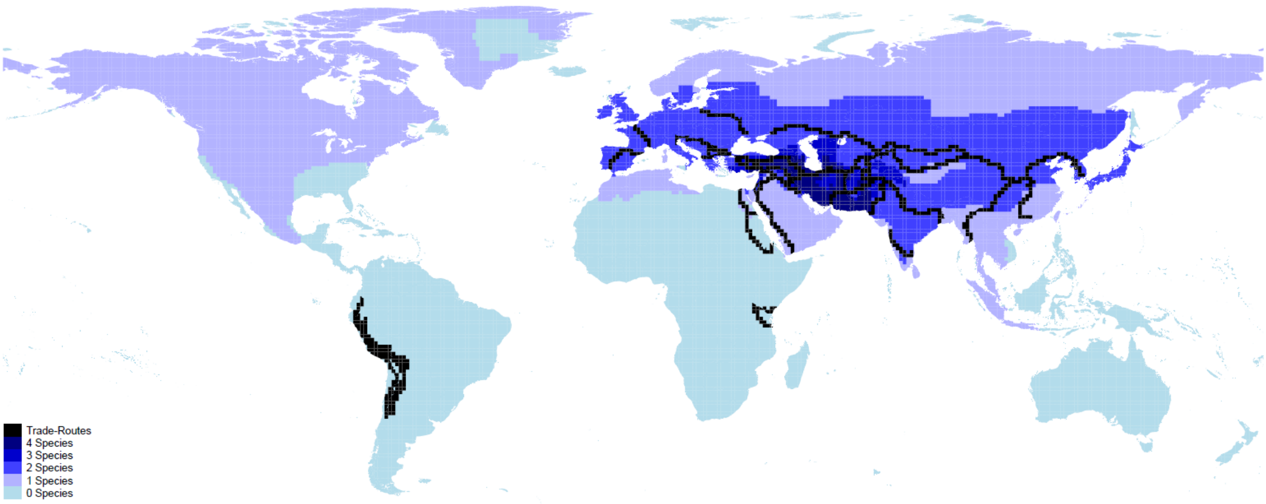

Figure B5 Domesticable Non-Transport Animals and Ancient Trade Routes Around the World

Notes: This figure shows the regional historical prevalence of species of domesticable non-transport animals and the courses of ancient trade routes. Species of domesticable non-transport animals include Canis lupus, Capra aegagrus, Ovis orientalis, and Sus scrofa. Data on the historical ranges of these species come from Faurby et al. (2018, 2020). Data on the courses of ancient trade routes are from Brice and Kennedy (2001) and Hyslop (1984).

C Summary Statistics

Table C1 Summary Statistics at the Grid Cell Level

Variable	Observation	Mean	Std Dev	Min	Max
Domesticable Transport Animals	15,269	.379	.485	0	1
Domesticable Non-Transport Animals	15,269	.646	.478	0	1
Ln (1 +Distance to a Trade Route)	15,269	2.66	1.28	0	4.83
Ln (1 +Distance to an Ancient City)	15,269	2.37	1.17	0	4.56
Trade Route Dummy	15,269	.048	.213	0	1
Ancient City Dummy	15,269	.049	.216	0	1
Ln (1 +Caloric Suitability (pre 1500))	15,269	4.69	3.72	0	9.07
Ln (1 +Historical Biodiversity)	15,269	2.76	.702	0	4.31
Ln (1 +Distance to Mineral Deposit)	15,269	1.15	.683	0	3.66
Latitude	15,269	33.0	32.0	-54.7	83.3
Longitude	15,269	17.4	84.6	-179.5	179.5
Lat X Lon	15,269	427.5	4,346	-12,794	12,296
Ln (1 +Distance to the Coast)	15,269	.469	.515	0	2.16
Ln (1 +Elevation)	15,269	6.10	.957	0	8.60
Ln (1 +Ruggedness)	15,269	8.90	.369	6.40	9.21
Ln (1 +Temperature)	15,269	7.82	1.75	0	9.30
Ln (1 +Precipitation)	15,269	6.10	1.10	0	8.64
Domesticable Transport Animals Suitability	15,269	.078	.752	-4.15	1.47
Domesticable Cereals	15,237	.193	.395	0	1
Domesticable Roots & Tubers	15,237	.080	.272	0	1
Domesticable Cereals, Roots & Tubers	15,237	.053	.224	0	1
Circumscription	15,264	.258	.290	0	.991
Ln (1 +Distance to a Major River)	15,269	1.33	.981	0	3.81
Current Distribution Domesticable Transport Animals	15,269	.051	.221	0	1

Table C2 Summary Statistics at the Ethnic Group Level

Variable	Observations	Mean	Std Dev	Min	Max
Domesticable Transport Animals	951	.201	.401	0	1
Ln (0.01 + Share of Trade-Related Motifs)	951	-4.11	.570	-4.61	-2.55
Hierarchy	951	1.89	1.09	1	5
Labor Specialization	951	.661	1.15	0	7
Class Stratification	951	.537	.499	0	1
Date measured (EA)	951	1,893	168.6	-2,000	1,965
Ln (1 +Year of First Publication)	951	7.55	.014	7.49	7.61
Ln (1 +Number of Publications)	951	2.59	.779	0	4.64
Ln (1 +Distance to the Coast)	951	1.15	.918	0	3.10
Latitude	951	16.3	23.4	-55	78
Longitude	951	-.878	88.7	-174	179
Lat X Lon	951	-1,011	2,757	-11,147	11,682
Dependence on Pastoralism	951	13.9	18.6	0	92
Land Suitability for Pastoralism Relative to Agriculture	505	-.114	.331	-.767	.674

Table C3 Large Domesticable Animal Species

Species	Family	Suited for Transportation Tasks
Bos gaurus	Bovidae	Yes
Bos javanivus	Bovidae	Yes
Bos mutus	Bovidae	Yes
Bos primigenius	Bovidae	Yes
Bubalus arnee	Bovidae	Yes
Camelus dromedarius	Camelidae	Yes
Camelus ferus	Camelidae	Yes
Equus africanus	Equidae	Yes
Equus ferus	Equidae	Yes
Lama guanicoe	Camelidae	Yes
Canis lupus	Canidae	No
Capra aegagrus	Bovidae	No
Ovis orientalis	Bovidae	No
Sus scrofa	Suidae	No

D Robustness Checks – Grid Cell Level

Table D1 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Excluding Continents

	Panel A: Ln Distance Trade Route					
	(1)	(2)	(3)	(4)	(5)	(6)
	Excl Africa	Excl Asia	Excl Europe	Excl N. America	Excl Oceania	Excl S. America
Domesticable Transport Animals	-0.393***	-0.258***	-0.353***	-0.345***	-0.378***	-0.384***
	(0.064)	(0.090)	(0.040)	(0.051)	(0.048)	(0.056)
Observations	12,711	9,331	14,478	11,602	14,519	13,740
R^2	0.900	0.925	0.888	0.858	0.886	0.906
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Ln Distance Ancient City					
	(1)	(2)	(3)	(4)	(5)	(6)
	Excl Africa	Excl Asia	Excl Europe	Excl N. America	Excl Oceania	Excl S. America
Domesticable Transport Animals	-0.401***	-0.235*	-0.355***	-0.341***	-0.389***	-0.411***
	(0.103)	(0.140)	(0.073)	(0.068)	(0.090)	(0.106)
Observations	12,711	9,331	14,478	11,602	14,519	13,740
R^2	0.849	0.886	0.827	0.860	0.835	0.845
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. In each column, one of the continents is excluded in the regression. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D2 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Excluding Species

	Panel A: Ln Distance Trade Route									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Excl Equus Ferus	Excl Camelus Dromedarius	Excl Camelus Ferus	Excl Lama Guanicoe	Excl Equus Africanus	Excl Bos Mutus	Excl Bos Javanicus	Excl Bos Gaurus	Excl Bos Primigenius	Excl Bubalus Arnee
Dom Transport Animals	-0.544***	-0.393***	-0.314***	-0.384***	-0.376***	-0.371***	-0.372***	-0.373***	-0.258***	-0.378***
	(0.105)	(0.042)	(0.080)	(0.052)	(0.047)	(0.043)	(0.048)	(0.048)	(0.036)	(0.047)
Observations	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.894	0.892	0.890	0.891	0.891	0.891	0.891	0.891	0.889	0.891
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Panel B: Ln Distance Ancient City									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Excl Equus Ferus	Excl Camelus Dromedarius	Excl Camelus Ferus	Excl Lama Guanicoe	Excl Equus Africanus	Excl Bos Mutus	Excl Bos Javanicus	Excl Bos Gaurus	Excl Bos Primigenius	Excl Bubalus Arnee
Dom Transport Animals	-0.584***	-0.443***	-0.335***	-0.414***	-0.384***	-0.363***	-0.355***	-0.385***	-0.243***	-0.386***
	(0.133)	(0.096)	(0.092)	(0.100)	(0.084)	(0.073)	(0.073)	(0.084)	(0.061)	(0.084)
Observations	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.843	0.842	0.837	0.839	0.838	0.838	0.837	0.838	0.835	0.838
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. In each column, one of the species is excluded in the construction of the historical transport animals measure. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D3 Domesticable Transport Animals and Log Distance to a Trade Route: Excluding Inca Roads and Including Roman Roads

	Panel A: Excluding Inca Roads				
	Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-2.053***	-1.110***	-1.068***	-0.852***	-0.384***
	(0.345)	(0.153)	(0.112)	(0.151)	(0.058)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.494	0.728	0.757	0.796	0.923
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

	Panel B: Including Roman Roads				
	Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.930***	-1.387***	-1.348***	-1.066***	-0.400***
	(0.304)	(0.103)	(0.123)	(0.223)	(0.055)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.488	0.669	0.702	0.728	0.892
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route). In Panel A, the Inca Roads from Hyslop (1984) are excluded from the dependent variable. In Panel B, the Roman Roads from McCormick et al. (2013) are included in the dependent variable. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D4 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Controlling for Domesticable Cereals, Roots, and Tubers, as well as for Circumscription

	Panel A: Domesticable Cereals			
	Ln Distance Trade Route		*Ln Distance Ancient City*	
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	-0.801***	-0.378***	-0.905***	-0.376***
	(0.162)	(0.045)	(0.212)	(0.081)
Domesticable cereals available	-0.425***	-0.194***	-0.559***	-0.197***
	(0.114)	(0.058)	(0.088)	(0.065)
Domesticable roots and tubers available	0.137	-0.218	-0.023	0.047
	(0.242)	(0.167)	(0.175)	(0.120)
Domesticable roots and tubers and cereals available	-0.233	-0.270**	-0.203	-0.124
	(0.166)	(0.112)	(0.143)	(0.090)
Observations	15,237	15,237	15,237	15,237
R^2	0.737	0.893	0.678	0.840
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Main Controls	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes

	Panel B: Circumscription			
	Ln Distance Trade Route		*Ln Distance Ancient City*	
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	-0.808***	-0.351***	-0.956***	-0.363***
	(0.187)	(0.062)	(0.232)	(0.093)
Circumscription	-0.812***	-0.392***	-0.580***	-0.340***
	(0.200)	(0.140)	(0.223)	(0.117)
Observations	15,264	15,264	15,264	15,264
R^2	0.738	0.893	0.664	0.840
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Main Controls	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) (Columns 1 and 2) and ln(1 + distance to an ancient city) (Columns 3 and 4). Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D5 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Current Ranges

	Ln Distance Trade Route					
	(1)	(2)	(3)	(4)	(5)	(6)
Historic Transport Animals	-0.891***		-0.902***	-0.378***		-0.372***
	(0.166)		(0.182)	(0.047)		(0.051)
Current Transport Animals		-0.386**	0.059		-0.170*	-0.044
		(0.169)	(0.196)		(0.091)	(0.089)
Observations	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.722	0.672	0.722	0.890	0.885	0.890
Continent FE	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes

	Ln Distance Ancient City					
	(1)	(2)	(3)	(4)	(5)	(6)
Historic Transport Animals	-1.015***		-1.078***	-0.387***		-0.400***
	(0.224)		(0.258)	(0.085)		(0.090)
Current Transport Animals		-0.178	0.353		-0.047	0.089
		(0.174)	(0.248)		(0.110)	(0.106)
Observations	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.656	0.576	0.659	0.839	0.832	0.839
Continent FE	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. Current Transport Animals is a measure of the current ranges of the ten domesticable transport animal species. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D6 Domesticable Transport Animals, Trade Routes, and Ancient Cities: Dummy Versions of the Dependent Variables

	Panel A: Trade Route Dummy				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	0.103***	0.103***	0.100***	0.066***	0.039*
	(0.019)	(0.015)	(0.015)	(0.017)	(0.023)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.055	0.069	0.083	0.102	0.233
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

	Panel B: Ancient City Dummy				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	0.114***	0.096***	0.094***	0.086***	0.022*
	(0.025)	(0.021)	(0.024)	(0.028)	(0.013)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.066	0.155	0.168	0.176	0.449
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is a dummy variable denoting the presence of a trade route in or within a range of 1 decimal degree from a grid cell in Panel A and a dummy variable denoting the presence of an ancient city in or within a range of 1 decimal degree from a grid cell in Panel B.Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D7 Domesticable Transport Animals, Trade Routes, and Ancient Cities: Grid Cell Fixed Effects

	Panel A: Trade							
	Ln Distance Trade Route				*Trade Route Dummy*			
	15x15 Degrees		*20x20 Degrees*		*15x15 Degrees*		*20x20 Degrees*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Domesticable Transport Animals	-0.267***	-0.246***	-0.554***	-0.497***	0.049*	0.045*	0.072***	0.068***
	(0.061)	(0.051)	(0.064)	(0.085)	(0.029)	(0.025)	(0.027)	(0.022)
Observations	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.905	0.912	0.850	0.867	0.214	0.223	0.130	0.150
Grid Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	No	Yes	No	Yes	No	Yes	No	Yes
Further Controls	No	Yes	No	Yes	No	Yes	No	Yes
	Panel B: Ancient Cities							
	Ln Distance Ancient City				*Ancient City Dummy*			
	15x15 Degrees		*20x20 Degrees*		*15x15 Degrees*		*20x20 Degrees*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Domesticable Transport Animals	-0.190***	-0.182***	-0.498***	-0.448***	0.019*	0.032**	0.022***	0.058***
	(0.064)	(0.056)	(0.059)	(0.112)	(0.011)	(0.016)	(0.008)	(0.018)
Observations	15,269	15,269	15,269	15,269	15,269	15,269	15,269	15,269
R^2	0.893	0.901	0.825	0.849	0.336	0.351	0.249	0.279
Grid Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	No	Yes	No	Yes	No	Yes	No	Yes
Further Controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. In columns (1) to (2) and (5) to (6) fixed effects spanning 15 on 15 degrees are included. In columns (3) to (4) and (7) to (8) fixed effects spanning 20 on 20 degrees are included. In Panel A The dependent variable is ln(1 + distance to a trade route) in columns (1) to (4) and a dummy denoting the presence of a trade route in a grid cell in columns (5) to (8). In Panel B the dependent variable is ln(1 + distance to an ancient city) in columns (1) to (4) and a dummy denoting the presence of an ancient city in a grid cell in columns (5) to (8). Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D8 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Different Pixel Size Cut-Offs

	Panel A: Ln Distance Trade Route									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	> 0%	> 10%	> 20%	> 30%	> 40%	> 50%	> 60%	> 70%	> 80%	> 90%
Domesticable Transport Animals	-0.388***	-0.389***	-0.386***	-0.382***	-0.380***	-0.378***	-0.377***	-0.371***	-0.371***	-0.362***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.046)	(0.047)	(0.049)	(0.050)	(0.051)	(0.053)
Observations	16,758	16,730	16,422	16,014	15,645	15,269	14,918	14,565	14,171	13,753
R^2	0.891	0.891	0.891	0.891	0.892	0.891	0.891	0.891	0.892	0.892
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Ln Distance Ancient City									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	> 0%	> 10%	> 20%	> 30%	> 40%	> 50%	> 60%	> 70%	> 80%	> 90%
Domesticable Transport Animals	-0.402***	-0.402***	-0.401***	-0.393***	-0.388***	-0.387***	-0.391***	-0.384***	-0.381***	-0.375***
	(0.084)	(0.084)	(0.086)	(0.083)	(0.084)	(0.085)	(0.087)	(0.087)	(0.087)	(0.089)
Observations	16,758	16,730	16,422	16,014	15,645	15,269	14,918	14,565	14,171	13,753
R^2	0.842	0.842	0.841	0.840	0.839	0.839	0.838	0.838	0.837	0.837
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. Each column uses a different grid cell size cut-off. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D9 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Only Europe and Asia

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.588***	-1.570***	-1.352***	-0.546***	-0.315***
	(0.131)	(0.156)	(0.219)	(0.183)	(0.105)
Observations	6,726	6,726	6,726	6,726	6,726
R^2	0.425	0.441	0.523	0.713	0.857
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes
	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.469***	-1.436***	-1.193***	-0.440***	-0.336***
	(0.111)	(0.126)	(0.190)	(0.141)	(0.106)
Observations	6,726	6,726	6,726	6,726	6,726
R^2	0.391	0.447	0.533	0.725	0.833
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The regressions only include grid cells in Europe or Asia. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D10 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Conley Standard Errors

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.760	-1.206	-1.166	-0.891	-0.378
	(0.133)***	(0.128)***	(0.113)***	(0.123)***	(0.106)***
	[0.220]***	[0.192]***	[0.167]***	[0.170]***	[0.137]***
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.445	0.638	0.686	0.724	0.891
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes
	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.648	-1.253	-1.227	-1.015	-0.387
	(0.121)***	(0.122)***	(0.112)***	(0.137)***	(0.114)***
	[0.192]***	[0.178]***	[0.169]***	[0.195]***	[0.139]***
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.467	0.544	0.611	0.656	0.839
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with Conley standard errors. The round parentheses indicate Conley standard errors with a cut-off of 500 kilometers. The square parentheses indicate Conley standard errors with a cut-off of 1000 kilometers. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D11 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Only Grid Cells within the Ranges of Domesticable Non-transport Animals

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-2.251***	-1.579***	-1.369***	-0.626***	-0.343***
	(0.463)	(0.152)	(0.190)	(0.206)	(0.057)
Observations	9,860	9,860	9,860	9,860	9,860
R^2	0.628	0.729	0.771	0.845	0.921
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes
	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.896***	-1.428***	-1.143***	-0.429***	-0.314***
	(0.334)	(0.124)	(0.159)	(0.117)	(0.067)
Observations	9,860	9,860	9,860	9,860	9,860
R^2	0.541	0.615	0.698	0.823	0.880
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The regressions only include grid cell where domesticable non-transport animals were present. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D12 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Controlling for the Presence of Major Rivers

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.751***	-1.247***	-1.180***	-0.914***	-0.381***
	(0.278)	(0.109)	(0.096)	(0.170)	(0.046)
Ln Distance Major River	0.296***	0.146**	0.054	0.066	0.017
	(0.057)	(0.063)	(0.060)	(0.064)	(0.058)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.496	0.649	0.687	0.726	0.891
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.643***	-1.291***	-1.227***	-0.997***	-0.380***
	(0.209)	(0.102)	(0.134)	(0.217)	(0.081)
Ln Distance Major River	0.173***	0.134**	-0.001	-0.054	-0.035
	(0.045)	(0.053)	(0.057)	(0.058)	(0.064)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.488	0.555	0.611	0.657	0.839
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Each column controls for ln(1 + distance to the next major river). Data on rivers comes from www.naturalearthdata.com. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D13 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Controlling for the Human Mobility Index

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.651***	-1.096***	-1.085***	-0.814***	-0.398***
	(0.269)	(0.106)	(0.108)	(0.162)	(0.056)
HMI	-3.707***	-3.662***	-2.752**	-2.975***	-3.326***
	(0.805)	(1.322)	(1.251)	(0.755)	(1.046)
Observations	15,268	15,268	15,268	15,268	15,268
R^2	0.518	0.679	0.703	0.735	0.895
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes
	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.565***	-1.083***	-1.083***	-0.865***	-0.407***
	(0.221)	(0.132)	(0.154)	(0.205)	(0.092)
HMI	-2.806***	-5.686***	-4.905***	-5.731***	-3.391***
	(0.656)	(0.965)	(0.901)	(0.673)	(0.937)
Observations	15,268	15,268	15,268	15,268	15,268
R^2	0.517	0.662	0.676	0.701	0.844
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. Each column controls for the human mobility index from Özak (2018). Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D14 Domesticable Transport Animals, Log Distance to a Trade Route, and Log Distance to an Ancient City: Log Version of Domesticable Transport Animals Measure

	Panel A: Ln Distance Trade Route				
	(1)	(2)	(3)	(4)	(5)
Ln Domesticable Transport Animals	-1.754***	-1.246***	-1.182***	-0.928***	-0.418***
	(0.255)	(0.140)	(0.093)	(0.152)	(0.070)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.433	0.651	0.692	0.732	0.891
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

	Panel B: Ln Distance Ancient City				
	(1)	(2)	(3)	(4)	(5)
Ln Domesticable Transport Animals	-1.657***	-1.278***	-1.219***	-1.026***	-0.504***
	(0.184)	(0.127)	(0.120)	(0.191)	(0.107)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.462	0.556	0.613	0.662	0.841
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to a trade route) in Panel A and ln(1 + distance to an ancient city) in Panel B. In both panels, the main independent variable is a log version of the domesticable transport animals measure. Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

Table D15 Domesticable Transport Animals and Log Distance to Ancient City: 500BC and 450AD

	Panel A: Ln Distance Ancient City (500BC)				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.141***	-0.949***	-0.931***	-0.687***	-0.161***
	(0.196)	(0.099)	(0.136)	(0.173)	(0.050)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.377	0.452	0.520	0.604	0.877
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

	Panel B: Ln Distance Ancient City (450AD)				
	(1)	(2)	(3)	(4)	(5)
Domesticable Transport Animals	-1.340***	-1.107***	-1.085***	-0.841***	-0.241***
	(0.214)	(0.110)	(0.147)	(0.199)	(0.056)
Observations	15,269	15,269	15,269	15,269	15,269
R^2	0.438	0.508	0.564	0.630	0.886
Continent FE	No	Yes	Yes	Yes	No
Country FE	No	No	No	No	Yes
Main Controls	No	No	Yes	Yes	Yes
Further Controls	No	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the (modern) country level. The dependent variable is ln(1 + distance to an ancient city). In Panel A, the dependent variable refers to 500 BC. In Panel B, the dependent variable refers to 450 AD. The data come from Reba et al. (2016). Main controls include ln(1 + caloric suitability pre 1500), ln(1 + historical biodiversity), and ln(1 + distance to a mineral deposit). Further controls include latitude, longitude, an interaction term between latitude and longitude, ln (1 + distance to the coast), ln(1 + elevation), ln(1 + ruggedness), ln(1 + temperature), and ln(1 + precipitation).

E Robustness Checks – Ethnic Group Level

Table E1 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Controlling for Animal Husbandry and Pastoralism

	Panel A: Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.225***	0.346***	0.272***	0.342**
	(0.073)	(0.079)	(0.067)	(0.134)
Dependence on Pastoralism	0.005***	0.005**		
	(0.002)	(0.002)		
Land Suitability for Pastoralism			0.155*	0.194
Relative to Agriculture			(0.086)	(0.126)
Observations	951	951	505	505
R^2	0.294	0.453	0.252	0.429
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes

	Panel B: Hierarchy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.522***	0.417**	0.665***	0.352*
	(0.161)	(0.167)	(0.193)	(0.191)
Dependence on Pastoralism	0.010***	0.008***		
	(0.003)	(0.003)		
Land Suitability for Pastoralism			0.238	-0.014
Relative to Agriculture			(0.266)	(0.419)
Observations	951	951	505	505
R^2	0.347	0.509	0.211	0.422
Continent FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
Main Controls	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E2 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Excluding Continents

	Panel A: Share of Trade-Related Motifs					
	(1)	(2)	(3)	(4)	(5)	(6)
	Excl Africa	Excl Asia	Excl Europe	Excl N. America	Excl Oceania	Excl S. America
Domesticable Transport Animals	0.517***	0.254***	0.410***	0.398***	0.383***	0.417***
	(0.085)	(0.073)	(0.073)	(0.070)	(0.072)	(0.076)
Observations	596	799	932	690	857	881
R^2	0.386	0.435	0.436	0.468	0.426	0.455
Folklore Controls	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Hierarchy					
	(1)	(2)	(3)	(4)	(5)	(6)
	Excl Africa	Excl Asia	Excl Europe	Excl N. America	Excl Oceania	Excl S. America
Domesticable Transport Animals	0.861***	0.227**	0.484***	0.454***	0.510***	0.545***
	(0.280)	(0.099)	(0.182)	(0.164)	(0.181)	(0.190)
Observations	596	799	932	690	857	881
R^2	0.575	0.553	0.460	0.470	0.487	0.487
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The dependent variable is ln(0.01 + share of trade-related motifs) in Panel A and a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas in Panel B. In each column, one of the continents is excluded in the regression. The specifications in Panel A refer to column (4) from Table 5. The specifications in Panel B refer to column (4) from Table 6. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E3 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Excluding Species

	Panel A: Share of Trade-Related Motifs									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Excl Equus Ferus	Excl Camelus Dromedarius	Excl Camelus Ferus	Excl Lama Guanicoe	Excl Equus Africanus	Excl Bos Mutus	Excl Bos Javanicus	Excl Bos Gaurus	Excl Bos Primigenius	Excl Bubalus Arnee
Domesticable Transport Animals	0.395***	0.639***	0.397***	0.416***	0.397***	0.389***	0.367***	0.396***	0.346***	0.397***
	(0.069)	(0.116)	(0.069)	(0.075)	(0.069)	(0.066)	(0.068)	(0.065)	(0.065)	(0.069)
Observations	951	951	951	951	951	951	951	951	951	951
R^2	0.444	0.457	0.444	0.445	0.444	0.444	0.441	0.445	0.440	0.444
Folklore Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Panel B: Hierarchy									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Excl Equus Ferus	Excl Camelus Dromedarius	Excl Camelus Ferus	Excl Lama Guanicoe	Excl Equus Africanus	Excl Bos Mutus	Excl Bos Javanicus	Excl Bos Gaurus	Excl Bos Primigenius	Excl Bubalus Arnee
Domesticable Transport Animals	0.522***	0.822***	0.503***	0.545***	0.503***	0.491***	0.419**	0.479***	0.264*	0.503***
	(0.194)	(0.192)	(0.181)	(0.190)	(0.181)	(0.178)	(0.166)	(0.148)	(0.155)	(0.181)
Observations	951	951	951	951	951	951	951	951	951	951
R^2	0.503	0.508	0.502	0.504	0.502	0.502	0.500	0.502	0.496	0.502
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The dependent variable is ln(0.01 + share of trade-related motifs) in Panel A and a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas in Panel B. In each column, one of the species is excluded in the construction of the historical transport animals measure. The specifications in Panel A refer to column (4) from Table 5. The specifications in Panel B refer to column (4) from Table 6. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E4 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Log Version of Domesticable Animals Measure

	Panel A: Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Ln(1 + Domesticable Transport Animals)	0.557^{***}	0.557^{***}	0.315^{***}	0.611^{***}
	(0.100)	(0.100)	(0.048)	(0.122)
Observations	951	951	951	951
R^2	0.165	0.165	0.270	0.443
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	No	No	Yes	Yes

	Panel B: Hierarchy			
	(1)	(2)	(3)	(4)
Ln(1 + Domesticable Transport Animals)	1.164^{***}	1.164^{***}	0.740^{***}	0.399^{***}
	(0.260)	(0.260)	(0.186)	(0.144)
Observations	951	951	951	951
R^2	0.070	0.070	0.319	0.496
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. The main independent variable is a log version of the domesticable transport animals measure. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E5 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Only Europe and Asia

	Panel A: Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.535***	0.531***	0.294**	0.536***
	(0.070)	(0.070)	(0.123)	(0.108)
Observations	171	171	171	171
R^2	0.246	0.250	0.351	0.556
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	No	No	Yes	Yes

	Panel B: Hierarchy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	1.073***	0.998***	0.846***	0.661*
	(0.283)	(0.243)	(0.217)	(0.364)
Observations	171	171	171	171
R^2	0.132	0.214	0.226	0.441
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The regressions only include ethnic groups from Europe and Asia. In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E6 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Conley Standard Errors

	Panel A: Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.355	0.337	0.298	0.397
	(0.072)***	(0.073)***	(0.073)***	(0.099)***
	[0.079]***	[0.067]***	[0.063]***	(0.098)***
Observations	951	951	951	951
R^2	0.167	0.267	0.281	0.444
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	No	No	Yes	Yes

	Panel B: Hierarchy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	1.110	0.644	0.672	0.503
	(0.144)***	(0.124)***	(0.128)***	(0.147)***
	[0.202]***	[0.134]***	[0.136]***	[0.177]***
Observations	951	951	951	951
R^2	0.168	0.318	0.333	0.502
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with Conley standard errors. The round parentheses indicate Conley standard errors with a cut-off of 500 kilometers. The square parentheses indicate Conley standard errors with a cut-off of 1000 kilometers. In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E7 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Grid Cell Fixed Effects

	Panel A: Share of Trade-Related Motifs			
	Grid Cell FEs 15x15 Degrees		*Grid Cell FEs 20x20 Degrees*	
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.340***	0.270***	0.302***	0.279***
	(0.063)	(0.076)	(0.070)	(0.068)
Observations	951	951	951	951
R^2	0.354	0.372	0.411	0.425
Grid Cell FE	Yes	Yes	Yes	No
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	No	Yes	No	Yes
	Panel B: Hierarchy			
	Grid Cell FEs 15x15 Degrees		*Grid Cell FEs 20x20 Degrees*	
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.429***	0.455***	0.382*	0.436***
	(0.161)	(0.164)	(0.203)	(0.139)
Observations	951	951	951	951
R^2	0.406	0.410	0.495	0.505
Grid Cell FE	Yes	Yes	Yes	No
Main Controls	No	Yes	No	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). In columns (1) to (2) fixed effects spanning 15 on 15 degrees are included. In columns (3) to (4) fixed effects spanning 20 on 20 degrees are included. In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E8 Domesticable Transport Animals, the Share of Trade-Related Motifs, and Hierarchy: Only Grid Cells within the Ranges of Domesticable Non-transport Animals

	Panel A: Share of Trade-Related Motifs			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.477***	0.477***	0.496***	0.626***
	(0.081)	(0.081)	(0.115)	(0.136)
Observations	338	338	338	338
R^2	0.281	0.281	0.344	0.464
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Folklore Controls	Yes	Yes	Yes	Yes
Main Controls	No	No	Yes	Yes

	Panel B: Hierarchy			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	1.643***	1.643***	0.882*	0.834*
	(0.266)	(0.266)	(0.467)	(0.417)
Observations	338	338	338	338
R^2	0.396	0.396	0.465	0.593
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The regressions only include ethnic groups from regions where domesticable non-transport animals were present. In Panel A, the dependent variable is ln(0.01 + share of trade-related motifs). In Panel B, the dependent variable is a measure of hierarchy, referring to variable 'v33' from the Ethnographic Atlas. Folklore controls include the log number of publications that were consulted per group and the log year of the earliest publication per group, following Michalopoulos and Xue (2021). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E9 Domesticable Transport Animals, Trade, and Hierarchy: Related Concepts

	Panel A: Trade-Related Motifs					
	Sell	Sale	Commerce	Exchange	Market	Merchandise
	(1)	(2)	(3)	(4)	(5)	(6)
Domesticable Transport Animals	0.279^{***}	0.279^{***}	0.057^{*}	0.395^{***}	0.195^{***}	0.236^{***}
	(0.056)	(0.056)	(0.029)	(0.069)	(0.047)	(0.068)
Observations	951	951	951	951	951	951
R^2	0.584	0.584	0.481	0.433	0.550	0.441
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Folklore Controls	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes

	Panel B: Hierarchy-Related Motifs					
	Authority	Power	Status	Order	Admin.	Monarchy
	(1)	(2)	(3)	(4)	(5)	(6)
Domesticable Transport Animals	0.084	0.206^{**}	0.166^{*}	0.236^{***}	0.089	0.277^{*}
	(0.082)	(0.079)	(0.095)	(0.074)	(0.054)	(0.148)
Observations	951	951	951	951	951	951
R^2	0.409	0.424	0.470	0.386	0.278	0.623
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Folklore Controls	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.

Table E10 Domesticable Transport Animals and Log Trade Importance

	Log Trade Importance			
	(1)	(2)	(3)	(4)
Domesticable Transport Animals	0.624***	0.351	0.428	0.972**
	(0.151)	(0.225)	(0.269)	(0.462)
Observations	171	171	171	171
R^2	0.057	0.161	0.186	0.635
Continent FE	No	Yes	Yes	No
Country FE	No	No	No	Yes
Main Controls	No	No	Yes	Yes

Notes: OLS regressions with standard errors clustered at the language level (building on variable 'v98' from the Ethnographic Atlas). The dependent variable is ln(1 + importance of trade) constructed from variable SCCSv1084 of the SCCS (Murdock and White, 1969). Main controls include ln(1 + distance to the coast), latitude, longitude, an interaction term between latitude and longitude, and the date at which the respective data from the Ethnographic Atlas were collected.