Vertical-axis Continents

Contrasting Demography and State Development in Africa and the Americas, 200.000 BP – 1500 AD

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Abstract
Understanding the historical origins of the post-1500 global economic divide requires comparative perspectives that go beyond the mainstream European or Eurasian-centred analyses of long-term economic development. This paper adopts the environmental approach of Jared Diamond's *Guns, Germs and Steel* to analyse the long-term evolution of human settlement and state development in the two vertical-axis continents: Africa and the Americas. The paper argues that the Africa-America comparison challenges Diamond's explanation of global inequality, and in particular the role he attributes to domesticated animals in the creation of global disease environments and in the evolution of peasant-based states and societies. Building on new insights from archaeology, linguistics and genetics, the paper develops alternative hypotheses to account for the African-American contrasts in disease environments, urbanization rates and levels of state centralization at the eve of the Columbian exchange.

1. Introduction

The historical roots of European political and economic hegemony in the post-1500 world order have been intensively debated among scholars from the humanities, social sciences and natural sciences (Weber 1904, Toynbee 1934, Wittfogel 1957, North and Thomas 1973, Jones 1981, Mokyr 1990, Diamond 1997, Landes 1998, Clark 2007, Turchin and Nefedov 2009, Allen 2011). The central facts are beyond discussion. Europe colonized large parts of the world in successive stages, established and mediated global trade networks, exported its languages and cultural values to distant corners of the world and, eventually, heralded an industrial revolution that has transformed the outlook of present-day societies beyond recognition. These 'achievements' warrant explanation.

Yet, euro-centric explanations of the global economic divide have also impeded a deeper understanding of what was essentially a global, rather than an exclusively European, phenomenon. In the debate on the nature and timing of the *Great Divergence* between Asia and Europe the issue of euro-centrism has been explicitly addressed (Pommeranz 2000, Ringmar 2007, Bin Wong and Rosenthal 2011). These critiques reside in a broader current of discontent voiced by world historians, who have scrutinized the use of biased historical sources shaped by European world views, the use of one-sided benchmarks in global comparisons and worse, the outright denial of any relevance to non-European history (Said 1979, Wolf 1981, Gunder Frank 1998, Austin 2007, Carney and Rosomoff 2011).

One of the most radical explanations of global inequality has been offered by Jared Diamond in his path-breaking *Guns, Germs and Steel* (1997). His central argument is that complex social orders emerged predominantly in Eurasia because of favourable environmental conditions for the development and diffusion of sedentary agriculture. In addition, longstanding proximity to domesticated animals gave Eurasians a comparative advantage in disease resilience, which created a highly unequal playing-field in the Columbian confrontation between Europeans and native Americans. Since Diamond's thesis is largely based on insights from evolutionary biology and the environmental sciences, it appears unaffected by Western academic pride or prejudice. According to Diamond, Europe derived its technological and military supremacy from an environmental comparative advantage, rather than from any innate racial, intellectual or cultural superiority. Moreover, by sidestepping the question 'why Europe, not Asia?', Diamond leaves ample scope for historical contingency: no matter where path-breaking technological innovations were made first

(Europe, India, China), they were simply more likely to occur in Eurasia, than in sub-Saharan Africa, the Americas or Oceania.

However, a closer inspection of Diamond's thesis cannot conceal some of the common problems associated with a backward reading of history. Since the central tenet is to explain why Eurasia was exceptional, the two other large world regions, Africa and the Americas, are predominantly analysed and discussed *in comparison to Eurasia*.[1] Diamond argues that Africa and the Americas disposed of a smaller pool of domesticable plants and animals than Eurasia; that both continents had less favourable conditions for the diffusion of high-productive agrarian systems because of the vertical orientation of the continental axis, in contrast to the horizontal axis of Eurasia; and so he concludes that Africa and the Americas had less favourable conditions for the development of the sophisticated military technology and built-in disease resilience that helped Europeans to conquer the rest of the world: guns, germs, and steel as proximate causes of global inequality rooted in the ultimate cause of varying bio-geographies.

This paper enters the discussion with a simple question: what happens if we shift the comparative lens towards the vertical-axis continents? Does the Africa-America comparison *as such* contribute to our understanding of the historical roots of global economic inequality? Does Diamond's account sufficiently explain why Europeans were able to conquer American territory with the help of 'European' diseases, while 'African' diseases kept Europeans at arms-length? Do we need the Africa-America comparison to understand the sharp division in economic specialization between both regions in the post-1500 Atlantic economy?

Of course, scholars have pointed to important African-American differences in disease environments and related demographic developments (McNeill 1976, Curtin 1989, Crosby 2003, McNeill 2011). Others have noted that there were no African equivalents of the Aztec and Inca empires that became the foci of Iberian conquest in the early 16th century (Stavrianos 1981, Allen 2011). But if we push a little further to ask when, how and why these contrasts in demography and state development originated and start looking for literature that can explain these differences, one will be quickly disappointed. In fact, the Africa-America comparison has hardly ever been seriously considered as a relevant perspective in the study of global economic inequality.[2]

[1] For sake of brevity 'Africa' refers to sub-Saharan Africa unless otherwise indicated.

[2] The study by Bates et al. (2008) on the 'lost decades' in Africa and Latin America is an interesting exception to the rule, but it deals with a later period, focussing on a comparison of early post-colonial economic and political developments. There is also a vast body of literature on the Atlantic slave trade, that analyses African-American connections, but these studies do not adopt a regional comparative perspective.

Building on recent insights from archaeology, linguistics and genetics I will develop the argument that shifting the comparative perspective confronts Diamond's thesis with three major problems. First, Africa and the Americas were underpopulated regions around 1500 AD, but for diametrically different reasons. Africa was underpopulated because of environmental constraints to population growth. America was underpopulated because of late human presence, being the last region to be settled in the global migration chain, but not because of obvious constraints to agricultural productivity growth.

Second, the role of domesticated animals in shaping the post-Columbian Atlantic disease environment requires revision. New insights from genetic research point to the role of wild animals in the evolution of human pathogens and point to Africa as the source region of smallpox, the biggest killer disease introduced in the Americas. This implies a rethinking of the environmental conditions that gave rise to Old World epidemics.

Third, the *presence* of large domesticated animals (cattle, sheep, goat, horses, camels) does not necessarily increase opportunities for state development, because it makes economic resources mobile. Without opportunities of livestock herding, native American farmers became 'trapped' in specific ecological niches -e.g. the volcanic soils around lake Texcoco in the Central Valley of the Mexican highlands - that were easier to control by non-farming elites than the nomadic pastoral peoples in Africa. Mesoamerican elites extracted surpluses through elaborate systems of state taxation and, in turn, had larger incentives to invest (part of) these resources in systems of water regulation, thus stimulating innovations in intensive agriculture. Sub-Saharan African states, in contrast, were bent on the control of long-distance trade, rather than taking command over local agricultural surpluses. The pre-dominance of agro-pastoralism in the extensive savannah ecologies of sub-Saharan Africa was a rational strategy to mediate subsistence risks in climatologically instable environments, but gave rulers hard times in mobilizing resources in their attempt to centralize power. The Africa-America comparison thus sheds a different light on the supposed channels of causation from domesticated animals to the development of centralized states than Diamond suggests in his Eurasian-centred account of pre-Columbian world history.

2. 'Guns, Germs and Steel'

In *Guns, Germs and Steel* Diamond argues that Eurasia possessed three environmental advantages for having the earliest and most widespread development of sedentary agriculture.

First, Eurasia is the largest continent of the world, covering about 36% of the world's total land mass, which gave the region the biggest chance of hosting the Neolithic revolution, ceteris paribus. Second, Eurasia is blessed with a comparatively large pool of wild plant and animal species suitable for domestication, including the species that proved to be most productive in agriculture. Third, the East-West orientation of the continental axis facilitated the diffusion of domesticated plants and animals in a comparatively uniform eco-zone (Diamond 1997). Compared to Eurasia, Africa and the Americas were (are) smaller-sized continents, with a more limited pool of domesticable plants and animals, whose diffusion was hampered by the vertical orientation of the continental axis. In the Americas the North-South axis stretches all the way from Alaska to Cape Horn, with a tight bottleneck in Central America. The huge varieties in climate zones hampered the spread of plants and animals. Moreover, the Sahara desert and tsetse-ridden rainforests created additional barriers to the diffusion of agriculture in sub-Saharan Africa (Diamond 1997, 186-9).

Village-based agriculture evolved around 11.000 BC with the domestication of starch wheat (emmer), protein-rich chickpeas, oil-rich olives, goats and sheep in the so-called *fertile crescent*. According to Diamond it is no coincidence that the first Neolithic revolution originated in Southwest Asia and spread from there comparatively quickly across Eurasia and the Mediterranean coast of North Africa. The *fertile crescent* disposed of excellent climatological and ecological conditions for the evolution of annual grasses, with large varieties in altitudes and season-bound temperatures (Diamond 1997, 135-142). The diffusion of domesticated plants and animals was further enhanced by an independent agricultural revolution in East Asia (China), where early agricultural societies emerged on the basis of domesticated rice, millet, pigs and silkworms (Diamond 1997, 100, Smith 1995).

Sub-Saharan Africa and the Americas also had occasions of independent domestication of plants and animals, but these had smaller productive potential. West Africa and the Sahel are credited with the (possible) domestication of African rice, pearl millet, sorghum, yam, palm oil and the guinea fowl. Ethiopia witnessed the domestication of coffee and teff. In Mesoamerica maize, beans, pumpkins and turkeys became the mainstays of agriculture. In the South American Andes agriculture developed on the basis of potatoes, manioc and llamas/alpacas. Yet, of the 56 wild grasses with a seed weight 10 times above average, 39 were found in Eurasia (including North Africa in Diamond's geographic conception), compared to just 4 in sub-Saharan Africa, 11 in the Americas and 2 in Australia (Diamond 1997, 140). Moreover, the wild ancestor of maize (*teosinte*), which became the most

important staple food in the Americas, required a comparatively long period of evolution to produce the high-yielding kernels we nowadays associate it with.

Of the 148 wild mammals weighing over 50 kg, 72 were found in Eurasia, 51 in sub-Saharan Africa, 24 in the Americas and 1 in Australia. From this reservoir of large mammals 13 were successfully domesticated in Eurasia, including the 'big five': sheep, goat, cattle, pig and horse (Diamond 1997, 162). Although home to vast numbers of big game, including zebras, elephants, antelopes and buffalos, none of the large mammals were domesticated in sub-Saharan Africa. In the Americas, only the llama/alpaca was domesticated in the Andean highlands, where it was used as a packing animal and a source of meat, but proved useless as a source of agricultural or proto-industrial draft power.[3] Interestingly, European agriculture emerged entirely on the basis of imported species of domesticated plants and animals. Diamond's account of global inequality thus rests crucially on the claim that the conditions of diffusion were much better in Eurasia than in sub-Saharan Africa or the Americas.

The subsequent steps in Diamond's argument are developed in lesser detail, but rely on a strong intuitive logic: more intensive forms of agriculture enabled denser populations and enhanced the development of proto-industrial technology. Domesticated animals were used for traction power (ploughs, mills), transportation, fertilizer and functioned as a source of dairy and animal protein. By sustaining larger numbers of people, opportunities for local commerce increased, cities emerged and expanded, thus creating the conditions for the centralization of power in states that invested in the provision of public goods, the development of bureaucratic technology (calendars, scripture) and the built-up of military capacity (guns, steel, navy).

Meanwhile, the intimate relations between humans and domesticated animals created hotbeds for human pathogens such as measles, flue, smallpox, pertussis, malaria and tuberculosis. These pathogens raised mortality rates but also created partial resistance against 'civilization diseases' which non-Eurasian peoples failed to develop (Diamond 1997, 206-214, see also McNeill 1976, Tanabe 2001, see for a critique Pearce-Duvet 2006). These differences in disease resilience created outright disaster in the reconnection of the Old and the New World (Crosby 2003).

Diamond's emphasis of the biogeographic roots of global inequality resonates in the work of the 'geography-school' in economics. Scholars like Jeffrey Sachs claim that the

[3] In the Americas, a number of mammals had gone extinct just before the arrival of modern humans or under pressure of early human expansion. The causes of this wave of mammal extinction are subject to a larger debate about the dating of first human settlement in the Americas. I will get back to this in the next section. See Mann (2005, Chapter 5) for an overview.

surprisingly strong correlation between distance to the equator and per capita income is not coincidental (Bloom and Sachs 1998, Gallup et al. 1999). The causality is supposed to work via the negative impact on agricultural productivity of, amongst others, tropical diseases, poor soil fertility, the impossibility of plough-based cultivation and climate-related impediments to food storage and processing. Diamond agrees with the view that temperate climates (or better: Mediterranean climates) create an advantage in the evolution of agriculture and points out that tropical diseases such as malaria and tsetse have hampered the development and diffusion of agriculture in sub-Saharan Africa (see also Goody 1971, Alsan 2012, Frankema 2014). On the other hand, Diamond argues that in comparison to the colder temperate climates prevalent in North-Western Europe, the tropics *as such* do not necessarily offer a less favourable ecology for the co-development of agriculture and civilization (Diamond 1997, 22; see also Acemoglu et al. 2001).

Diamond's thesis has received empirical support by Hibbs and Olsson (2005), who demonstrate in a cross-country regression framework that bio-geographic conditions such as absolute latitude, climate suitability to agriculture and the number of annual or perennial wild grasses and domesticable big mammals can explain a considerable part of present-day variation in per capita income (Hibbs and Olsson 2005, see also Spolaore and Wacziarg 2013). Recent studies by Putterman and Weil (2011) and Easterly and Levine (2012) document persistent effects of so-called 'state antiquity' on present-day income levels. These studies also point out that people originating from areas with early centralized states, have transferred technologies and knowledge to areas without similar histories and, by doing so, have contributed to the overall rise of global income levels.

3. Human evolution, global migration and the origins of human pathogens

The exchange of 'germs' has been one of the deepest forces of societal change in the post-1500 Atlantic world order (Crosby 2003, Flynn and Giraldez 2004, Mann 2011, McNeill 2011). Without the spread of Old World diseases, native American resistance against Iberian encroachment would almost certainly have been stronger and more persistent. Diseases are also key in explaining why Europeans failed to conquer the interior of Africa and confined themselves to the establishment of a number of forts and factories along the coast until the late 19th century. Because Africans were better equipped to survive in the tropical disease environments of the Atlantic plantation economies, their labour input was considerably higher

valued than those of native Americans or Europeans. Indeed, the diffusion of Old World diseases have had a significant impact on the cost-benefit calculations underlying the Atlantic slave trade (Mann 2011, McNeill 2011).

But if proximity to domesticated animals was so important in the evolution of epidemic disease, as Diamond suggests, why then did African societies not collapse in the same way as American societies when Afro-European trade relations intensified? And why were African diseases so lethal to both Europeans and native Americans? And why was the native American population able to grow so much faster than the Old World population, despite the lack of the environmental benefits enjoyed by Eurasians?

Moving away from the cradle

The *Out-of-Africa* theory holds that the current world population derives from a single origin in sub-Saharan Africa, where human life began and spread from there to other parts of the world. Support for this theory has originally been offered by archaeological excavations of early hominid fossils in South and East Africa from the 1940s through 1970s (Lewin 2005, 15) and has since the late 1980s received a much more solid foundation by human genetic research. Genome sequencing studies have demonstrated that African populations are genetically more diverse than non-African populations, indicating that the first splits in the human genetic tree have occurred in Africa (Cann et al. 1987, Li et. al 2008). The first hominids are estimated to have split from ancestral primates (chimpanzee, gorilla) some 5 to 9 million years ago and have developed anatomically modern features (bipedalism, large brains, thermo-regulation) in several million years thereafter.

The early hominids that migrated out of Africa were eventually replaced by the *homo sapiens*, which appeared in Africa about 200.000 BP. Recent studies of mitochondrial DNA (mtDNA) suggest that *homo sapiens* did not leave Africa before 100.000 BP, probably via the Arabian Peninsula (Thiskoff et al. 2009). This migration wave was accompanied by a population bottleneck, a phase in which the size of a given population, including its genetic variation, is greatly reduced. Scholars have now estimated that all non-African peoples can be retraced to ca. 600 effective founding females and ca. 400 effective founding males (Campbell and Thiskoff 2008, 404-5, Liu et al. 2006).[4]

[4] The group itself must have been larger as it also included 'non-founding' people, the probable census size is about 3,000 individuals (Campbell and Thiskoff 2008, 405). Another study estimates the size of this founding population at 1,500 persons (Garrigan and Hammer 2006). Whether modern humans from Africa mixed with archaic populations in Eurasia, such as Neanderthals, remains subject of heated controversy (Campbell and Thiskoff 2008, 404).

The migration into the Americas occurred much later than the migration into Eurasia, but it was characterised by a similar bottleneck mechanism - which doesn't necessarily mean that it was confined to one migratory event!-. Evidence from mitochondrial DNA obtained from people with native American roots and ancient DNA retrieved from pre-Columbian human remains indicates that the Americas became populated by a comparatively homogenous group of people with common ancestors from Eastern Siberia (Greenberg, Turner and Zegura 1986, Eshleman et al. 2003, Fagundes et al. 2008, 584). This research alos suggests that the migration went exclusively via Beringia, although there is much discussion on the question whether this occurred by foot, boat or both. Archaeological remains of the Clovis culture reveals that human presence in the Americas dates back to at least 12.500 BP, which coincides with a relatively brief period of an ice-free corridor in the Bering Strait, opening up a land route between Siberia and Alaska. Yet, the possible remains of a pre-Clovis culture in south-central Chile suggest an earlier date of human settlement. In this case it is more likely that the first migrants sailed down the coast from Alaska in self-made boats (Eshleman et al. 2003, 12; Mann 2005, xx, Blench 2008).

The latter hypothesis is consistent with the high variety in native American languages that have been recorded at the Pacific coast of North America and also with increasing genetic evidence that points to earlier dates of settlement. Linguistic researchers have questioned whether the Asian migrants spoke a similar language, or that consecutive waves of migrants were responsible for the introduction of different language families in the Americas, which then further split into a broad range of small and isolated phyla characterised by large phonological and syntactical diversity (Campbell 1997, 98). The latter view seems to have gained prominence among linguists, but most of the recent genetic studies maintain that there was a single migration event, which should be dated somewhere between 12.500 to 50.000 BP, although the majority of studies suggests a range between 13.000 - 23.000 BP (Blench 2008). The contrasting findings of geneticists (emphasizing homogeneity) and linguists (emphasizing heterogeneity) will be further discussed in section 5.

Despite the lack of conclusive evidence on the nature and timing of both migratory events -i.e. out-of-Africa and into-the-Americas-, an interesting paradox shows up in the history of human settlement. Table 1 shows the evolutionary growth rates based on estimates of first human presence and population size around 1500 AD. The long-term growth rates were considerably lower in Africa than in Eurasia, while growth rates in the New World were considerably higher than in Eurasia: the estimated growth rate in the Americas is about a factor 8 higher than in Africa and about a factor 3 higher than Eurasia's. These calculations

are largely insensitive to changes in the population estimates of 1500 AD. Even if we assume that the migration wave into the Americas would have involved as much as 10,000 founding individuals, the long-term rate of growth in the Americas would still have outpaced Africa by a factor 6 and Eurasia by a factor 2.5.

Table 1: First human settlement and population growth up to 1500 AD

	200.000 BP	100.000 BP	25.000 BP	(millions)	min	max
Africa*	1,000			50 - 100	0.005	0.006
Eurasia	0	1,000		350 - 450	0.013	0.013
Americas	0	0	1,000	20 - 100	0.040	0.046

Sources: Timing of first modern human presence in Africa and Eurasia from Thiskoff et al. 2009, 1035; For America Eshleman, 2003, 12; Lower-bound population estimates at 1500 AD from Maddison 2010; upper-bound estimates for Africa from Manning 2013, for Americas from Denevan 1992, and for Eurasia author's own mark-up. *Africa includes North Africa.

There are at least two scenario's to interpret this gap in evolutionary growth rates (see figure 1). Scenario 1 holds that evolutionary growth rates among hunter-gatherer populations were more or less equal over time and across space because the checks on population growth operated via low fertility rates. Nomadic peoples tended to raise fewer children because of the physical efforts imposed on women. Covering considerable distances by foot each day eats into energy reserves, reduces fecundity and raises the rate of miscarriages. Infanticide and sexual restraint were also widely practised methods to contain the size of nomadic bands and tribes. Fertility rates rise to a new equilibrium with the onset of sedentary agriculture, as sedentary lifestyles reduce the risk of miscarriage during pregnancy and decreases the burden of tending small children.

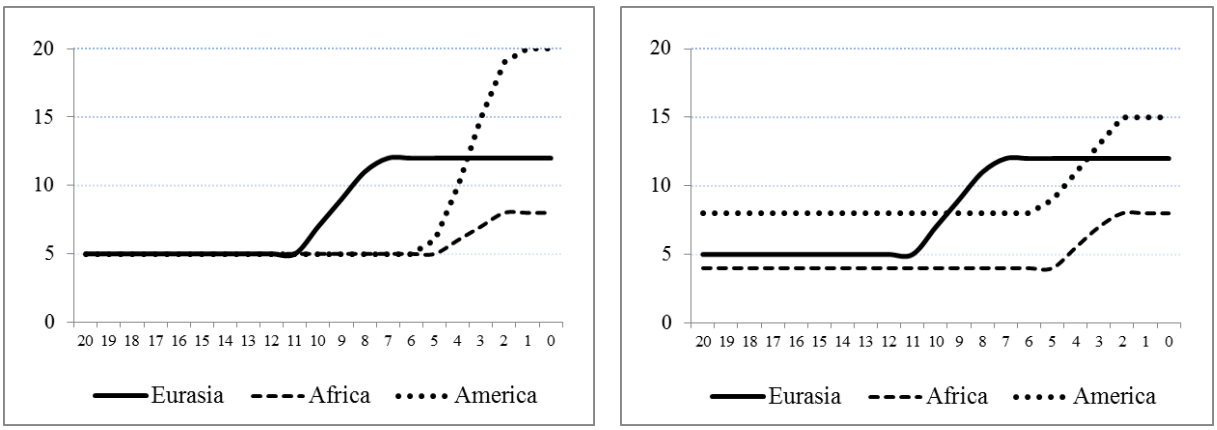
If scenario one holds, then Diamond's assessment of the differential conditions for the development of sedentary agriculture is highly problematic. After all, despite the limited pool of domesticable plant and animals, the late arrival of humans, the problems with domesticating maize and the comparatively late development of agriculture, native American peasant societies were capable of sustaining much higher rates of population growth than Eurasian peasant societies. If scenario 1 holds, then this calls for a fundamental rethinking of the supposed ecological advantages of Eurasia. The lagged development of sedentary agriculture in Africa would still perfectly make sense.

Scenario two holds that long-term rates of population growth have been higher in the Americas already *before* the onset of sedentary agriculture. This may have been the result of considerable differences in disease environments. Diamond claims that these are the result of

the presence or absence of domesticated animals. However, an alternative way to explain these differences is that human parasites have co-evolved with the growth of human populations in Africa, before migration into Eurasia. If human pathogens had several million years to evolve, mutate and diffuse in Africa, then the first migrant populations in Eurasia may have experienced a formidable head-start as they pushed into comparatively pristine disease environments (McNeill 1976, 25, Reader 1998, xx). Given the late settlement of the Americas, and the fact that migration into the New World was accompanied by a population bottleneck, the demographic 'bonus' of a disease-free environment may thus have operated from the early days of human settlement in the New World onwards.

These two scenarios are by no means mutually exclusive. The second scenario may have reinforced the first: a lower incidence of epidemics supported the development of population centres around highly productive agricultural systems in the Americas up to a point that, perhaps, native American cities such as Tenochtitlan did not depend on structural replenishments from the countryside in order to grow. In this scenario, urbanization in Africa has been retarded partly because of a higher incidence of crowd diseases.

Figure 1: Two scenarios of evolutionary demographic growth in Africa, Eurasia and the Americas, 20-0 KYA before 1500 AD



Scenario 1 ***Scenario 2***

The bottom line is that, either way, Africans and Americans must have been living in worlds apart. Both regions were considerably less densely populated than Eurasia around 1500 AD, but for distinctively different reasons. Africa was 'underpopulated' because of high constraints to population growth, while the Americas were underpopulated because of late human settlement. And although the population estimates of 1500 AD are subject to large margins of error, even a doubling of the African or American size estimates, or the subtraction

of North Africa and the Sahara desert (ca. one third of the African continent), will not change this conclusion.

Table 2: Average population densities per world region in 1500 AD

	Population (millions)	Land area (millions of km^2)	Denisty people/km^2
Africa total	50	29.5	1.7
Sub-Saharan Africa	40	18.5	2.2
Central & South America	35	19.2	1.8
North America	15	24.7	0.6
Eurasia total	350	53.0	6.6
India	110	3.0	36.7
China	100	9.3	10.8
Japan	15	0.4	37.5
Western Europe	57	3.5	16.3
Eastern Europe	14	1.1	12.7

Sources: Eurasian figures from Maddison 2010; the Americas are upward adjusted in line with progressive views in the literature (see Mann 2005 for a discussion); Land surface from FAOSTAT.

The cradle of Old World diseases?

According to Diamond the intimate relationship between people and animals had been responsible for an exceptional disease environment in Eurasia (Diamond 1997, 206-214). Disease-causing parasites evolved in animal hosts and subsequently mutated into human-borne variants. Millennia of intensive contact between increasing human and livestock populations created a transmission ecology that raised mortality rates, but also created (partial) resilience to devastating epidemics. The lack of such environments in the Americas can explain why native American population growth was higher and why the demographic impact of the Columbian exchange after 1492 was so unequal. While this argument has a strong intuitive appeal, it has been increasingly undermined by advances in genome sequencing research (Pearce-Duvat 2006).

Important killer diseases that were once thought to derive from domesticated animals, are now shown to have evolved from wild animals. Smallpox and measles are important examples since these two diseases are held responsible for the lion-share of excess mortality in the Americas during the 16th and first half of the 17th centuries (Crosby 2003, 42, Mann 2005, xx, Borah and Cook 1963). Diamond claims that smallpox and measles evolved from Eurasian livestock, since they stem from the same families as respectively cowpox and

rinderpest (1997, 207). However, recent studies of the DNA genome of the *variola virus* (VARV), the etiologic agent of smallpox, indicates that the disease has African roots (Li et al. 2007). Out of a broad geographically distributed sample of 47 VARV isolates, Li et al. were able to derive two primary VARV clades, one severe variant and one milder variant. The severe variant probably stems from an ancestral African rodent-borne variola-like virus some 16,000 to 68,000 years ago. The milder variant has likely diverged from an ancestral VARV in West Africa between 1,400 or 6,300 BP (Li et al, 2007, 15787). Europeans thus introduced an African disease in the Americas that had originated long before the first animals were domesticated in Eurasia.

Measles offer a similar story. Since *Paramyxoviridae Morbilli* are from the same family as the virus that causes rinderpest, it has long been assumed that the human variant had evolved from cattle. Recent genome sequencing studies, however, point out that the *Morbilli* genus is more closely associated to familiar types of Paramyxoviridae found in rodents, bats and snakes. Although it remains unclear when and where the Morbilli split from a shared wild animal ancestor virus, there is no evidence for a connection to domesticated animals (McCarthy and Goodman 2010).

Malaria is responsible for high rates of child mortality in sub-Saharan Africa and also became a major killer disease in the New World after 1500. With regards to *plasmodium falciparum*, the parasite that causes *malaria tropica* -the most aggressive and lethal variant - Diamond suggests that it evolved from domesticated birds like chicken and ducks (1997, table 11.1, 207). However, a close variant to *plasmodium falciparum*, has recently been retrieved in African gorilla populations. Genome sequences of the human and gorilla parasites suggest that the disease has been transmitted from gorillas to humans in Africa (Liu et al. 2010). It is not clear when this transmission should be dated. Some scholars have argued that it happened when the first hominids split from gorilla's and chimpanzees, several million years ago, others have suggested a much more recent date between 3,200 and 7,700 BP (Rich et al. 1998, Volkman et al. 2001, see Pearce-Duvet 2006, 376-377 for a discussion).[5]

To cut a long story short, out of a list of ten of the most severe Old World diseases that have been transmitted to the New World after 1492 (see table 3), the role of domesticated animals is, at the present state of research, only uncontested in the case of influenza. Influenza differs from many other epidemic diseases because it is caused by viruses that re-invent

[5] The results of Liu et al. show that there is no evidence for the idea that malaria developed among early hominids during the split from apes some 5 to 9 million years ago, but find it impossible on the basis of their evidence to propose an alternative date (2010, 424).

themselves every year. Influenza viruses have multiple origins, and tend to evolve amongst others in birds (wild and domesticated), pigs and humans.[6] The other nine listed epidemic diseases in table 3 have probably evolved from wild animals. This does not disprove that dense animal and human populations are hotbeds of diseases, but it redirects attention to the more fundamental question of why Africa and the Americas had such different disease environments before 1500 AD, despite the fact that both regions were less densely populated by humans and livestock than Europe.

If we think of the evolution of a new epidemic disease in terms of a probability function, $p(E_x) = t(h, a, te)$, which estimates the probability (p) of the evolution of a human pathogen (E) in a given historical period (x), there are at least four interrelated variables to be considered: the density of human populations (h), the density of animal populations (a), the number of eco-systems that may have functioned as suitable transmission ecologies (te), and all of these three variables interact with *t*, that is the time that microbes are granted to jump from animal to human hosts (the reverse also occurs, but is of lesser interest here). There is no evidence that wild animals in Africa were living in smaller concentrations than livestock herds in Eurasia. But more importantly, if many of the more severe human pathogens originally derive from wild animals like bats, birds or rodents, it is not so evident that domesticated animals are a principle factor in this probability function. If ecological diversity and evolutionary time are important for the evolution of human microbes, it is far more likely that Africa's vertical-axis, tropical conditions and early human presence have offered a combination of factors that maximized $p(E_x)$. If this is true, than it is a lack of time, rather than a lack of domesticated animals, that explains the low incidence of major killer diseases in pre-Columbian America.

[6] It is theoretically possible that typhus has evolved in the New World, but that is not the most likely scenario (Raoult et al. 2004).

Table 3: Origins of ten of the most severe Old World diseases according to latest genetic studies

				Genetic mutation into human disease variant			
	Epidemic	**Pathogen**	**Vector**	**Source region**	**Source animal**	**Date**	**Source**
1	**Smallpox**	*Variola major; variola minor*	Humans; airborne, direct contact	sub-Saharan Africa	Rodent-borne variola-like virus (V. major). V. minor unknown	16,000-68,000 BP (V. major) 1,400-6,300 BP (V. minor)	Li et al. 2007
2	**Influenza**	*Influenzavirus A, B, C*	Humans, mammals, birds	Multiple. Most avian and pig-borne types from South and East Asia	Multiple: birds, pigs, humans	Multiple.	
3	**Tuberculosis**	*Mycobacterium tubercolosis*	Humans; airborne, direct contact; non-pasteurized cow milk	Multiple types from sub-Saharan Africa and Eurasia	Bison or humans; Not cattle as previously thought.	At least 17,000 BP	Rothschild et al. 2001
4	**Bubonic plague**	*Yersinia pestis*	Rat fleas	East Asia	Rodents	At least since first millennium AD.	Morelli et al. 2010
5	**Malaria**	*Plasmodium falciparum; plasmodium vivax*	Mosquitos (Anopheles)	sub-Saharan Africa	Gorillas	Unknown	Liu et al. 2010
6	**Yellow fever & Dengue fever**	*Flavivirus*	Mosquitos (Aedes Aegypti)	sub-Saharan Africa	Bats, rodents?	Unknown	Cook and Holmes 2006
7	**Measles**	*Paramyxoviridae Morbilli*	Humans; airborne, direct contact	Unknown	Rodents, snakes, bats, salmon? Not cattle as previously thought.	At least since first millennium AD.	McCarthy and Goodman, 2010
8	**Typhus**	*Rickettsia typhi; rickettsia prowasekii*	Rat fleas; lice on humans	Unknown	Humans?	Before 1500 AD	McLeod et al. 2004; Raoult, Woodward and Dumler 2004
9	**Cholera**	*Vibrio cholerae*	Contaminated water, food; seafood; mainly tropical areas	India	Shellfish, zooplankton?	At least since first millennium AD.	Sack et al. 2004
10	**Leprosy**	*Mycobacterium leprae*	Humans; probably airborne	Middle East, India?	Humans or other primates	2000 - 5000 BP	Schuenemann et al. 2013

Sources listed in last column of the table.

4. Urbanization and pre-Columbian state formation in Africa and the Americas

Jeffrey Herbst (2000) has made the compelling argument that low population densities and its corollary, open land frontiers, have acted as a historical barrier to the centralization of state power in pre-colonial Africa. According to Herbst, the absence of clearly defined territorial borders and formalized land tenure regimes reflected the fundamental problem of how to organize control over vast empty hinterlands. The marginal costs of establishing and maintaining demarcated land borders outweighed the expected marginal revenues of taxation in the border areas. Herbst observes that intensive inter-state competition requiring the mobilization of fiscal and military resources did hardly develop in Africa and considers this as the key to understand the different trajectories of African and European state development in the pre-colonial era (Tilly 1990, Herbst 2000).

The Africa-America comparison nuances the relevance of *average* population densities for the analysis of state centralization processes. What really matters is the degree to which people cluster and in which particular environments they do so. Although the Americas on the whole were certainly not heavier populated than sub-Saharan Africa before 1500 AD, urbanization rates were considerably higher and, consequently, concentration rates were geographically far more unequally distributed. Cities underpinned the rise of various native American states characterized by high levels of centralized power. Why did the geographic constraints to the broadcasting of power that operated in sub-Saharan Africa not apply to the Aztec and Inca empires?

To probe deeper into the link between demography and state development I define the state as *a set of institutions that governs human activities and resource flows within a distinct territorial entity.* These institutions are enforced by a political body that has access to military power and has the capacity to broadcast a distinct state identity. States delegate authority along existing or newly imposed social strata. Urban centres fulfil a crucial role in the delegation and manifestation of power. In addition, cities offer logistic functions to govern resource flows within the state, either by offering facilities for market exchange or by facilitating the regulated allocation of public resources.

The first signs of urban-based state development in Africa and the Americas go back to the 3rd millennium BC and run more or less parallel to the emergence of the Minoan civilization in Europe (see for maps detailing the most important locations of pre-1500 state formation Appendix figures 1a and 1b). These early states emerged in specific ecological environments, where access to fresh water was the most important common feature. In sub-

Saharan Africa two of the large navigable rivers, the Niger and the Nile, formed the basis for the rise of cities such as Kerma and Djenne-Djenno. The Ethiopian highlands, another area of early African state development, were characterised by comparatively abundant precipitation, facilitating amongst others the development of plough-based agriculture (McCann 1995).

In the Americas, the earliest known state emerged in the Norte Chico region (north-central coastal Peru), where a network of cities emerged around the capital city of Caral-Supe. Mountain areas were also highly conducive to state development. Both the Aztec and Inca empires, as well as their predecessor states, benefitted from the ecological advantages of varying altitudes. The Andean highlands also served as a natural fridge for food storage (e.g. freeze-dried potatoes). In North America, the Colorado and Mississippi rivers supported the rise of civilizations such as the Anasazi and the mound-building peoples of Cahokia.

Table 4 ranks five of the largest capital cities of different pre-Columbian states according to the estimated number of inhabitants. Even the unavoidably large margins of error cannot cast doubt on the main conclusion. Urbanization rates in Mesoamerica and the Andes were much higher than in any corner of sub-Saharan Africa. The population of Tenochtitlan, the Aztec capital, is commonly estimated in the order of 200,000 to 250,000. Teotihuacan, located some 70 km to the North, was inhabited by more than 100,000 people in the first half of the first millennium AD as well. These cities were at least two to five times as large as the upper estimate for Djenne-Djenno (inland Niger delta), which most archaeologist think was the largest city in sub-Saharan Africa before 1500 AD.

Table 4: Five largest capital cities of pre-Columbian civilizations in Sub-Saharan Africa and the Americas

Americas			
Civilization	*Capital City*	*High era*	*Population (high era)*
Aztec	Tenochtitlan	1325-1521 AD	200,000-250,000
Teotihuacan	Teotihuacan	100-500 AD	100,000-150,000
Maya	Tikal*	200-900 AD	60,000-90,000
Tiwanaku	Tiwanaku	600-800 AD	25,000-40,000
Chimu	Chan Chan	1200-1470 AD	15,000-25,000
Sub-Saharan Africa			
Ancient Middle Niger**	Djenne-Djenno	400-900 AD	15,000-50,000
Mali, Songhai	Gao	1000-1500 AD	10,000-20,000
Mali, Songhai	Timbuktu	1200-1400 AD	10,000-20,000
Zimbabwe	Great Zimbabwe	1300-1500 AD	10,000-20,000
Kilwa sultanate	Kilwa	1300-1500 AD	10,000-20,000

Sources: see Appendix (under construction).

Notes: * Tikal was not formally regarded as a Mayan capital city, but it was the largest Mayan city with some distance to cities like Palenque and Copal, which size estimates are in the order of 20,000. ** Djenne-Djenno, probably Africa's largest pre-Columbian city, cannot be connected to a known state, or empire. It was located at the banks of the Niger, a centre of commerce and production, but there is no archaeological evidence that points to a civilization with a distinct social, political or cultural identity. The geographic reference adopted here is from McIntosh (2005).

The Mexican central valley, the homeland of the Aztec (14th-15th C.), Toltec (8th-10th C.) and Teotihuacan (1st-5th C.), did not only host the largest cities of the continent, but also supported the densest network of cities. In the early 16th century, there were over 20 cities within a radius of 50 kilometres along the shores of *lake Texcoco*, and several more a little further inland. Tenochtitlan was comparable in size to the largest European cities (Paris, London, Naples) around 1500 AD (Bairoch 1988, 135-141). Rough estimates yield a total population of 1 million for the entire Mexican central valley at a land surface of less than 3,000 square kilometres: a density level exceeding 300 persons per square kilometre.

The total land area of the Aztec empire at its largest extent has been estimated at ca. 200.000 square kilometres under the reign of Moctezuma II (1502-1520). A lower-bound estimate of 5 million people in the entire empire would yield an average density of 25 people per square kilometre (pp/km^2), which is largely comparable to density levels in the eastern part of China or the western part of Europe at that time (Maddison 2010). Population estimates in the range of 25 million by Borah and Cook (1963, xx) would imply densities surpassing 100 pp/km^2! Density levels in the Inca empire, which at its peak covered ca. 0.9 million km^2 (McEwan 2006, 3), were almost certainly lower. With conservative population estimates of 4 million and more widely cited figures of 10 to 16 million (McEwan 2006, 93-6), these would have ranged between 4 to 18 pp/km^2.

There were no equivalents of such concentrations of people in sub-Saharan Africa before 1500 AD, nor for a long time thereafter. For Ethiopia, which counts as one of the most stable areas of human settlement in sub-Saharan Africa during the past two millennia, there is no evidence that average density levels reached the threshold of 10 pp/km^2 before the 20th century. Perhaps the Sokotho Caliphate in Northern Nigeria reached 10 pp/km^2 in the course of the 19th century, when it may have contained over 5 million people on a surface of ca. 500,000 km^2 (Lovejoy 2005, 8), but that would still be less than half of the lower-bound estimate of the Aztec empire. Interestingly, these densities were the result of deliberate state policies forcing the pastoral Fulani people to settle in fortified towns (*ribat*), which already indicates that sedentism was not self-evident in the African context.

The inland Niger delta, with the three large cities of Gao, Timbuktu and Djenne-Djenno, counted as one of the most densely populated areas around 1500 AD, but 'population concentration' had a different meaning in this region as well. Cities evolved as a network of scattered villages without a marked centre. According to McIntosh the urban landscape of the middle Niger basin was shaped by 'cities without citadels': they lacked the signatures of centralized power, such as palaces, tombs, temples, pyramids, towers, stèles, squares, forts or giant sculptures (McIntosh 2005, 10). Although the Ghana, Mali and Songhai empires managed to 'control' territories of more than 1 million km^2 , they did not wield the power to centralize authority and pool resources in order to have ruling elites engage in conspicuous consumption. This type of urban landscape makes the task of estimating urban populations virtually impossible. Hopkins has suggested that the population size of Gao, Timbuktu and Djenne may have fluctuated between 15,000 and 80,000 inhabitants, entirely depending on the trading seasons (Hopkins 1973, 19). Indeed, The early West African cities were thriving centres of local and long-distance (trans-Saharan) trade, but levels of permanent settlement were comparatively modest.

5. Did ethno-linguistic fragmentation hamper African state formation?

In the social science literature Africa's ethno-linguistic fragmentation is often considered as an impediment to state development and economic growth. Ethno-linguistic diversity is being associated with higher levels of distrust, distributive conflicts, inter-ethnic violence and rent-seeking behaviour of ethnically-biased political elites (Easterly and Levine 1997, **insert more refs**). Bates (2008) has pointed out that colonial borders cutting through existing ethnic dividing lines have complicated post-colonial nation-building efforts, particularly at the time when revenues to administer the early independent states came under pressure of adverse global market shocks. There is also an increasing number of recent studies that points to a close relationship between ethno-linguistic fragmentation and genetic variation, both within Africa as well as on the global level.[7] The connection suggest that Africa's ethno-linguistic

[7] Thiskoff et al. (2009) have identified 14 African ancestral gene clusters in populations that correlate with self-described ethnicity and a shared cultural-linguistic background (see also Campbell and Thiskoff 2008). Ashraf and Galor (2013) found a positive correlation between genetic diversity and various contemporary measures of ethno-linguistic fractionalization. Michalopoulos (2012) has shown that linguistic variation is positively associated with ecological biodiversity, in particular regional variation in land quality and elevation. Ahlerup and Olsson (2012) found a positive relationship between the duration of human settlements since prehistoric times

fragmentation has deep historical roots. Is it possible that the co-evolution of genetic and ethno-linguistic diversity has hampered pre-1500 state development in Africa, while greater population homogeneity has facilitated more vigorous trajectories of state development in the Americas?

Genetic variation is caused in part by so-called 'genetic drift': a random process of genetic reproduction across generations that causes neutral alleles (specific gene-types) to either disappear from, or gain dominance in a given population. Genetic drift is an important evolutionary mechanism influenced by time (to drift) and population size (drift tends to be stronger in smaller populations) (Nielsen and Slatkin 2013, 21-26). Genetic drift explains why genetic diversity is larger among Africans than among native Americans: in Africa groups of *homo sapiens* split into comparatively small sub-groups since 200.000 BP. The first American migrants did also disperse, but had perhaps less than one 10th of this time to drift.

The counterpart of this random process of genetic variation, is the non-random selection of genes as a result of the *adaptation* of isolated populations to specific ecological conditions (i.e. natural selection). Sub-Saharan Africa has a wide range of eco-zones that has facilitated the splitting and subsequent isolation of human populations. A typical example is the divergence between various hunter-gather Pygmy peoples from Bantu-speaking farmer populations in Central Africa. The ancestors of contemporary pygmy peoples appear to have split from an ancestral Central African population some 70,000 years ago, followed by a long period of isolation, which accounts for large phenotypic differences, such as their short stature (Quintana-Murci 2008). The short stature of pygmies is usually interpreted as an adaptation to specific rainforest conditions, facilitating human mobility, lowering food requirements and/or lowering the age of reproduction in compensation for short life expectancy (Lachance et al. 2012, 467-468).While the pygmy populations have experienced a long period of asymmetric maternal gene flow thanks to their physical isolation, the ancestral gene pool of Bantu-speaking farmers has been enriched by admixture with other African peoples.

One of the big puzzles of American demographic history is that genome sequencing studies consistently reveal the native American population as a rather homogenous population. One study even suggests that all Amerindians may have derived from as few as 80 founding individuals (see Fagundes et al. 2008, 584). At the same time, linguistic researchers are struggling to account for an enormous diversity of Amerindian languages. In his grand survey, Lyle Campbell observes that out of the ca. 400-450 language families in the world,

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and current levels of ethno-linguistic diversity and showed that the latter is negatively correlated with the length of modern state experience and with distance from the equator.

118 are found in Southern America, 58 in North America and another 18 in Middle America, which yields a total of 194. In South America alone, there were ca. 1,500 individual languages at the time of first contact with Europeans (Campbell 1997, 170). Such a degree of variation is largely comparable to Africa, where the Ethnologue atlas of world languages reports a total of 2,146 living languages at present (Lewis et al. 2013).[8] Blench (2008) argues that if human settlement would only have occurred as late as 12.000 BP, the rate of linguistic diversification must have been extraordinary high. The large number of isolates and small phyla in the linguistic landscape of pre-Columbian America testifies to a large degree of fragmentation and isolated linguistic development. Languages, like genes, take time to vary (Blench 2008, 8, Adelaar and Muysken 2004, Campbell and Grondona 2012). In other words, there is no a-priori reason to believe that Africa and the Americas differed considerably in terms of ethno-linguistic fragmentation before 1500 AD.

It may be worthwhile to turn around the question. What do we know about the *integration* of previously fragmented populations in both continents? Apart from their finding that genetic diversity in Africa correlates with self-described ethnicity, Thiskoff et al. (2009) have also noted a considerable degree of genetic admixture among the majority of African populations, testifying to the integration of formerly distinct African populations. The Bantu migration and the spread of iron working techniques across Central, East and Southern Africa (1000 BC – 1000 AD) is a good example of a probable cause of genetic admixture and a sure cause of linguistic integration (spread of Bantu). The Bantu migration is an interesting phenomenon because it was driven by the appeal of superior cultivation technologies (use of iron) and a unifying means of communication (Bantu), but it did not come along with expanding state control.

In contrast, it is often suggested that the huge expenses made by the Aztec and Inca states in ceremonial and symbolic architecture were a (un)conscious response to the problem of unifying a highly scattered ethnographic landscape into the realms of a single political entity. The performance of religious mass ceremonies, at which thousands of war captives were sacrificed, are just one example of the way in which the militaristic Aztec empire communicated its power (Conrad and Demarest 1984). The widespread dissemination of state-symbols are another common feature of Mesoamerican states. In the Andes region, the Incas set up elaborate systems of road infrastructure, conducted population censuses and

[8] The total number of living languages in the Americas is nowadays much lower, 1,060 according to the *Ethnologue* atlas, but this is because many pre-Columbian languages have gone extinct or are critically endangered at present.

imposed forced labour services (*mita*) in order to bring distant peoples into the realms of the state. Indeed, these are examples of centralized states that, at least for some period of time, have been able to overcome ethnic diversity through a combination of (military) coercion and public goods provision. The emanation of a state-centred religion or ideology was essential to cement these power structures. As von Hagen and Morris put it:

> *"By AD 1500 the Andean city had become a place where ceremony symbolized the nature and existence of the state. In under a century the Inka stamped their distinctive architectural style across the Andes. At state ceremonies in provincial capitals like Huánuco Pampa, singers, dancers and tellers of legends and the exploits of Inka kings dazzled their audience with Inka glory, frightened them with Inka might and impressed them with Inka riches."* (1998, 161)

The spread of Islam in West Africa, and the conversion of many African leaders to Islam, can be considered as a response to a shared need of traders and rulers to facilitate long-distance trade by adopting a unifying ideological and legal framework (Loimeier 2013). The crucial difference with the American empires, however, was that with the adoption of Islam the recognized centre of worship (and the power attached to that) became located far outside the confines of the West African empires. Instead, the seats of religious and state power in the Aztec and Inca empires were combined in the capital cities (Tenochtitlan, Cusco) and occupied by the emperors themselves. Moreover, rather than spreading the language of their own ethnic group, as the Inca did, the West African empires adopted Arab as the medium of political and religious communication.

In sum, if ethno-linguistic fractionalization has been a historical impediment to African state centralization, we need to address the question why a seemingly comparable fragmented ethnic geography did not impede the rise of powerful central states in the Americas. Indeed, a safer conclusion is that the process of state development in neither region has been strong enough to erase the manifestations of ethno-linguistic diversity, although European imperialism has certainly erased more of it in the Americas than in sub-Saharan Africa.

6. Animal domestication and state centralization

In the African savannah areas outside the tsetse-infested forest belt, livestock was a key component of a typically African agricultural (r)evolution. Livestock served as a storage of wealth, as a source of risk-mediation in ecologically fragile and climatologically instable environments. It was a wanted source of dairy, animal fat and protein and offered the raw materials for handicraft production (leather, horn, bone etc.). Cattle was introduced in sub-Saharan Africa as early as 6,000 BP and functioned as a central object of worship in the early kingdoms along the middle Nile (Kerma, Nubia). Cattle spread to the Niger basin around 4,000 BP. The first known states in Southern Africa that culminated into Great Zimbabwe (1000-1500 AD) were organized around agro-pastoral subsistence production as well. In all these early states cattle played a role in state symbolism (**ref. Hb Afr. Arch)**.

Mesoamerican farmers disposed of dogs and turkeys, but neither of these animals were critical to the development of agriculture, nor useful as packing animals for long-distance trade. The ecological advantages of the Mexican basin consisted of a combination of volcanic soils, fresh water sources and the possibility to mediate subsistence risks by using the variation in altitudes to diversify food production. Maize, beans, squash, cocoa and a variety of fruits offered a decent combination of protein, vitamins and calories to support growing populations. Contrary to African rock paintings of cattle herds, in Mesoamerica wild animals such as the jaguar, the feathered bird and the serpent featured as objects of worship and artistic expression.

In Diamond's world view domesticated animals support the process of agricultural intensification, population growth and state centralization. Reasoning by analogy, would mean that sub-Saharan Africa held the better cards for state centralization than the Americas. However, the sharp contrast in the nature of state development in West Africa and Mesoamerica suggests the reverse: the *presence* of domesticated animals complicated attempts to centralize power in Africa, whereas the *absence* of domesticated animals does not seem to have impeded, and may even have facilitated, state centralization in pre-Columbian America. The key is that domesticated animals are, in principle, mobile economic assets. And resource mobility influences the design of fiscal systems.

In political-economic theory the design of fiscal systems that mediate state-contolled resource flows are usually considered as the result of conflicting interests. On the one hand rulers need to raise revenues to keep the army aligned, to co-opt political allies, and to provide public goods (defence, infrastructure, law and order) that strengthen societal cohesion and

contain the use of inter-personal violence (North et al. 2009). On the other hand, rulers risk popular revolts, long-term erosion of the tax base or large-scale tax evasion if they set their tax rates too high (Levy 19XX, **add refs**). In the context of open land frontiers - i.e. pre-Columbian Africa and America – the opportunities of tax evasion have a direct bearing on cost-benefit calculations of both tax-setters and tax-payers. Suppose that a given tax rate T surpasses the threshold level *t** at which tax payers would be willing to evade state taxes by crossing the land frontier. In this case, the optimal tax-setting policy would be to choose a tax rate where the additional revenue of T - t* compensates for the losses incurred by tax-payers exiting out of the state orbit.

Figure 2 presents a scheme to reflect upon the role of domesticated animals in fiscal policy making. Domesticated animals enter this scheme in two ways. Horses or camels can be used by the state to strengthen fiscal control, since they enable the dispatching of small and mobile army units into distant territories. Herding animals, on the other hand, enlarge the mobility of economic resources and enable tax-payers to escape fiscal control. Of course, it is theoretically not impossible to tax nomadic pastoralists, but the costs involved in doing so may soon outweigh the marginal revenues. Marchetti and Ausubel have argued that the costs will particularly increase beyond distances of 5 to 10 kilometre, that is, beyond distances that can be covered by travelling back and forth in one day. Beyond that point, fiscal control requires overnight stays and additional logistic provisions (Marchetti and Ausubel 2012).

If economic resources are mobile beyond a certain threshold level (R > R*), states will prefer to control long-distance trade, provided that they dispose of the military reach (M > M*) to secure the main trade routes and markets. The upper-right quadrant describes the conditions that underpinned the rise of West African empires (Ghana, Mali, Songhai). These empires had limited options to tax local agricultural surpluses, because the majority of the population combined sedentary cultivation practices, with foraging and pastoral activities. However, the West African states disposed of a relatively large military reach because of their recourse to horse-back soldiers. The primary task of these soldiers was to guarantee the safety of the trading caravans and reduce the number of price-raising middlemen, in order to secure higher trade margins for the home market. These armies were mainly composed of elite-warriors, because they required considerable investments in equipment (horses, weapons, armour). These investments, in turn, were recovered by the rents extracted from the Trans-Saharan trade, which by itself also depended on domesticated animals (camels). The major challenge of the ruling elite was to keep these militia aligned, since they could relatively easily split into opposing factions (Reid 2012).

Figure 2: Implications of resource mobility and military reach for state development

	Resource mobility	
Military reach	R < R*	R > R*
M > M*	State revenues from local economic surplus and long-distance trade	State revenues from control of long-distance trade
M < M*	State revenues from local economic surplus	Centralization of power impossible

Source: author's own.

The bottom-left quadrant best describes the conditions in the Mexican basin. These states invested in the regulation of water supplies to promote agricultural intensification and to accommodate the need for central coordination with expanding farming populations. The fiscal systems were designed around two main sources of revenue: mandatory labour services for construction projects and agricultural work on elite estates; and tributes in kind consisting of agricultural and non-agricultural commodities (Wohlgemut 1989). Military capacity was not based on the ability to rapidly cover large distances - this actually proved a problem for keeping the state unified (Conrad and Demarest 1984, xx) -, but on the mobilization of large numbers of foot soldiers that could exert sufficient credible threats to keep potentially disloyal states committed to the central political body.

Although the lessons we can draw from the comparison between West African and Mesoamerican fiscal policies do not unconditionally translate to other parts of the vertical-axis continents, there are many aspects that carry broader implications. Also in the Andean empires, such as the Inca empire, investments in sedentary agriculture were seen as the key to maintain a stable state-regulated resource flow. The fiscal system of the Incas was based on an elaborate system of census-taking, including detailed population counts and land surveys. State taxes consisted of mandatory labour services and tributes in kind, and were re-invested into impressive networks of highways (40,000 km of paved roads and bridges!) and a large

army of foot soldiers. Herding animals such as the llama and alpaca complimented plant cultivation, but their mobility was restricted to the upper highlands (McEwan 2006).

The state of Ethiopia offers the most important deviation from the savannah empires in West Africa and it may be argued that Ethiopia had more in common with the Inka empire than with any other African state. It was the only place south of the Sahara where cattle was used in a system of mixed farming, supplying draft power for plough-based cultivation. Variations in altitude were exploited to diversify food production and harvest water for field irrigation. Also in terms of the organisation of its information and communication infrastructure the Ethiopian state bore more in common with the major American states. The state used its own language, its own system of record keeping and adopted a highly successful strategy of tying the power of the ruling dynasty to a shared Christian identity and history (McCann 1995).

7. Conclusion

The reconnection of the Old and the New World in 1492 fundamentally transformed the outlook of the Atlantic economy. The Iberian conquest brought large parts of the Americas under colonial rule for three centuries. The native American population was decimated in a few decades time. Africa became the main supplier of slave labour to produce cash crops for the European market, but was not colonized before the Americas gained independence. To understand these highly unequal trajectories of economic and political development, requires a thorough understanding of the differences in disease environments and demography that shaped the Atlantic market for African slaves. It also requires a deeper understanding of the differences in pre-Columbian state development at both sides of the Atlantic.

In this paper I have explored the current historical knowledge of the contrasting demography and state development in the vertical-axis continents. I have made a plea for taking serious the Africa-America comparison and underpinned my call with a number of questions that scrutinize existing interpretations of the global economic divide. More in particular, I have argued that dropping the aim of explaining Eurasian ‘exceptionalism’, opens up a new perspective on the role of varying continental bio-geographies. By way of conclusion I highlight the three most important aspects of this new perspective.

First, I have stressed the fundamental differences in demographic regimes and how these may be related to differences in human disease environments. The Africa-America comparison calls for a de-emphasis of the role attributed to Eurasian domesticated animals,

and a more systematic reflection on the question why Africa has been the source region of so many severe human diseases and whether there is a relationship with the history of hominid evolution or not. Second, I have argued that there is no a-priori reason to believe that Africa and the Americas differed considerably in terms of ethno-linguistic fragmentation before 1500 AD, but that there is ample reason to believe that processes of *integration* of previously fragmented populations differed in both continents. In Africa the admixture of ethnically differentiated groups has taken places largely outside the confines of state control. In the Americas states have played an active role, albeit with different degrees of effectiveness. Third, I have argued that domesticated animals are a necessary condition for the development of mixed farming systems, but certainly not a sufficient condition. The Africa-America comparison reveals that domesticated animals are as likely to impede processes of agricultural intensification and related state centralisation. All these issues warrant further *historical* research, but for the time being most of the new insights are generated by linguists, archaeologists and geneticists.

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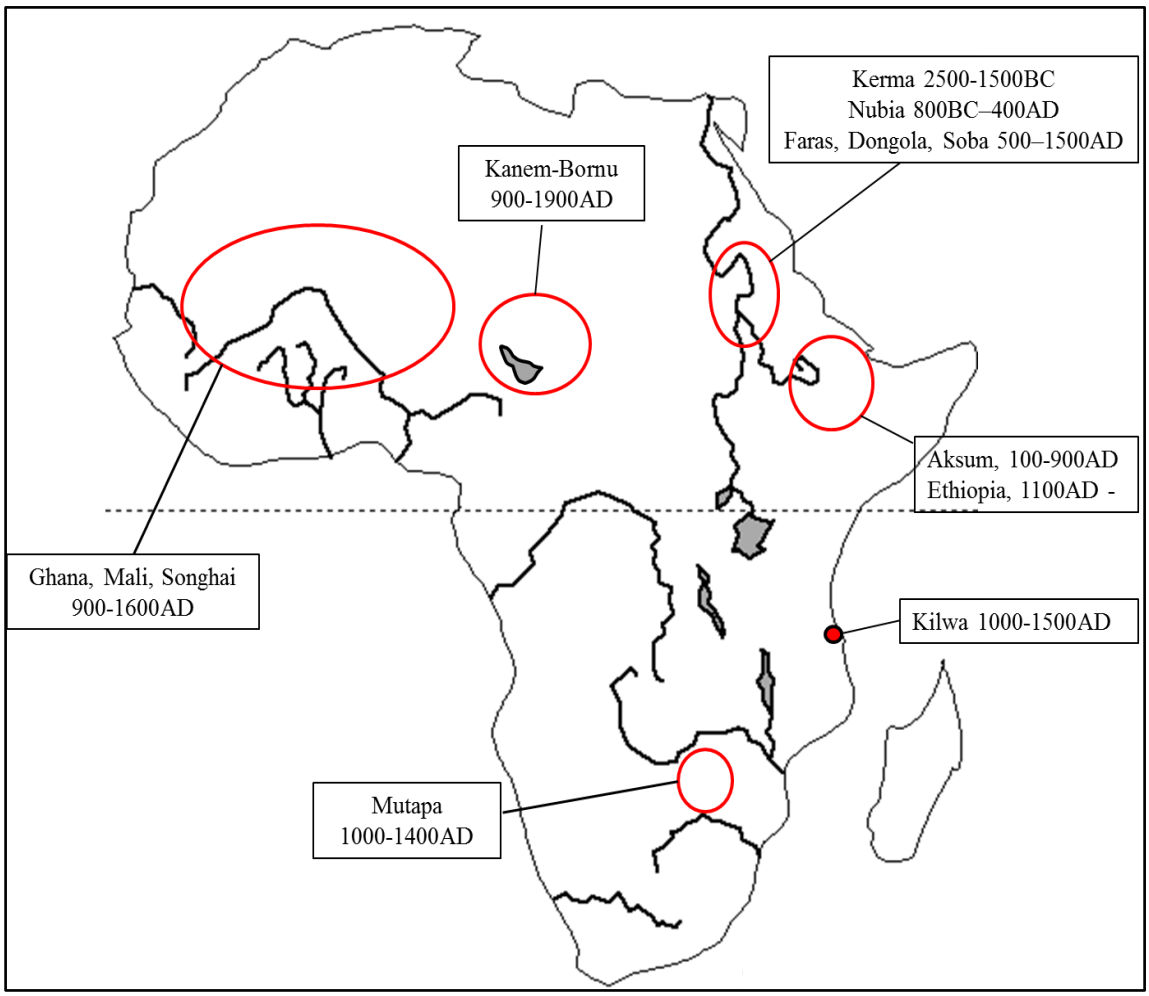
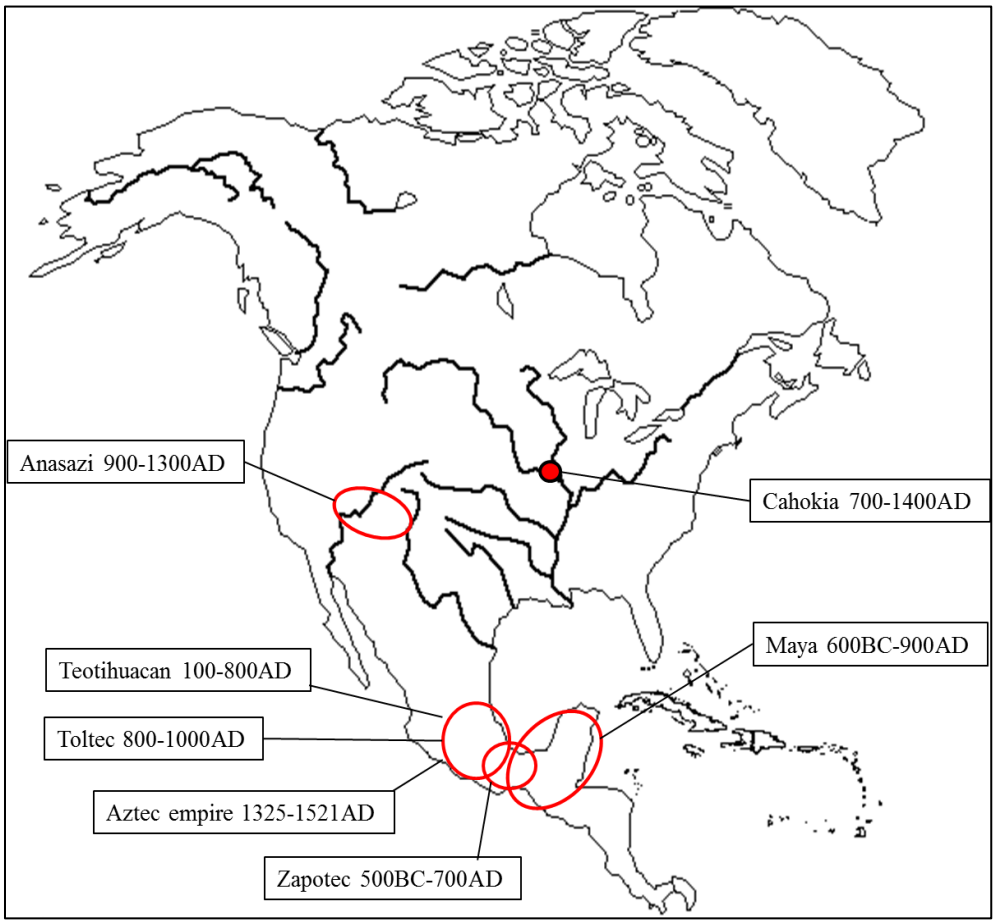
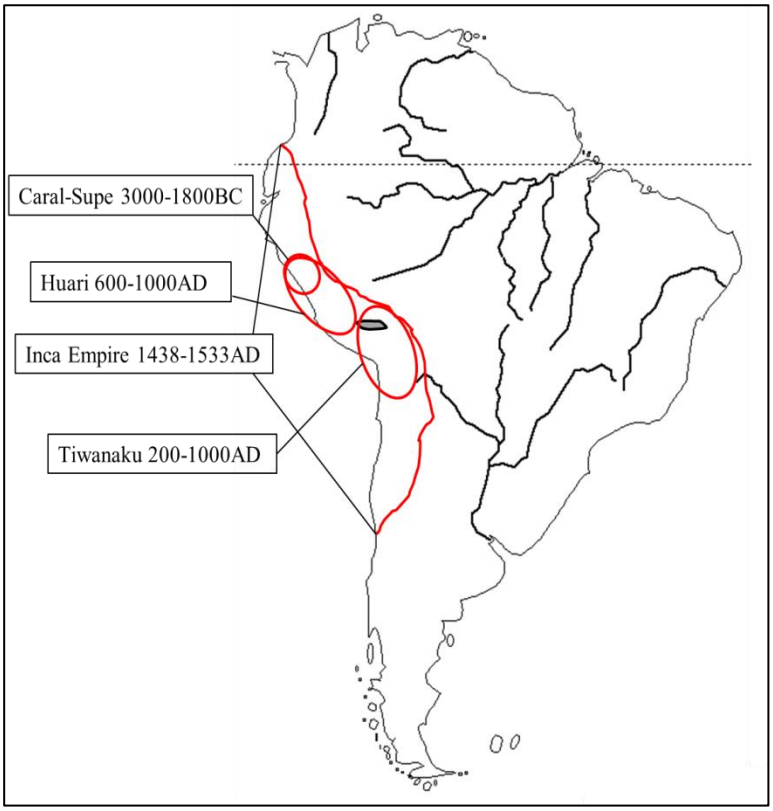
Appendix figure 1a: Important locations of pre-1500 African state development



Appendix figure 1b: Important locations of pre-1500 American state development