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Working Paper 23002

June 2023

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First Draft, April 4, 2023 This version; May 25, 2023

Adam Smith famously observed a tight connection between geographic features, the extent of the market, and economic development. In recent decades, scholars have used GIS technologies applied to latitude-longitude grid cells to operationalize these hypotheses. A limitation of this approach is that human beings do not make location and investment decisions based on grid cells, but do so based on the extent of the market, which they take as conditional on the contiguous features of the earth's surface, human-made alterations to those features, and the available transportation technologies. We therefore estimate the size of markets around the world in Smith's time, conditional on 18th century river flows and lakeshores, 18th century transportation technologies, the distribution of (time invariant) natural harbors, pre-global warming sea ice extents, and potential staple crop output using pre-green revolution cultivars and production methods. We refer to these units of analysis as Transport Corridors. We construct a measure of economic development at the transport corridor level by identifying, geolocating, and estimating the population of any city or town that meets a threshold size of 20,000 inhabitants circa 1700, 1800, 1850, 1900, 1950, and 2000. We find that in Smith's time 81 percent of the Old World's urban population was located in large, agriculturally productive transport corridors that include at least one natural harbor—even though those corridors account for only 10 percent of the Old World's ice-free surface. We also find that these results attenuate very slowly, such that in 2000, half of the world's urban population lives in those same transport corridors. The New World provides a quasi-natural experiment of Smith's hypothesis because of the introduction of new transport technologies, tools, and cultivars as a result of the Columbian Exchange. We find that large, agriculturally productive transport corridors that include at least one natural harbor account for 25 percent of the urban population in 1700, and then grows to 1900, by which time 85 percent of the urban population was located in those corridors. We think that our contribution to the estimation of the extent of markets has applications beyond the distribution of economic activity, because human beings make a broad range of decisions based on spatial reasoning. We therefore (upon publication) will make all of the GIS shape files, computer scripts, urbanization data, and machine-learning regression algorithms available to other scholars so that they may use, improve, or build upon our estimates.

* We acknowledge support from Stanford's Institute for Research in the Social Sciences, Freeman Spogli Institute, VPUE, School of Humanities and Sciences, Center for Global Poverty and Development, and Hoover Institution, as well as the UPS Foundation, and the John Templeton Foundation. Melda Alaluf, Ava Aydin, Nicholas Baldo, Andrew Brooks, Roger Cain, Victor Cárdenas Codriansky, Ian Claras, Kevin Cook, Eva Davis, Kara Downey, Lauren Felice, Adriane Fresh, Anne Given, Qianmin Hu, Kirill Kalinin, Abigail Kessler, Scott Khamphoune, Dorothy Kronick, Melissa Lee, Michelle Lee, Ian Lewis, Cole Lupoli, Annamaria Prati, Cara Reichard, Jeffrey Tran, Xinyi Wang, and Tracy Williams provided invaluable research assistance. The usual caveats apply. We are grateful to Ross Levine, as well as participants in the "Phil-Fest" at the California Institute of Technology, for their comments on an earlier version.

Introduction

Adam Smith in *the Wealth of Nations* (1776) observed a tight connection between the extent of the market and economic growth. He is most remembered for his critique of trade policies, but he also pointed to limits on the market created by geography. “England, on account of the natural fertility of the soil, of the great extent of the sea-coast in proportion to that of the whole country, and of the many navigable rivers which run through it, and afford the conveniency of water carriage to some of the most inland parts of it, is perhaps as well fitted by nature as any large country in Europe, to be the seat of foreign commerce, of manufactures for distant sale, and of all the improvements which these can occasion.” The contrast he drew to the poorer regions of the planet were stark. “The Sea of Tartary [Central Asia] is the frozen ocean which admits of no navigation, and though some of the greatest rivers in the world run through that country, they are at too great a distance from one another to carry commerce and communication through the greater part of it. There are in Africa none of those great inlets, such as the Baltic and Adriatic seas in Europe, the Mediterranean and Euxine [Black] seas in both Europe and Asia, the gulfs of Arabia, Persia, India, Bengal, and Siam, in Asia, to carry maritime commerce into the inland parts of that great continent; and the great rivers of Africa are at too great a distance from one another to give occasion to any considerable inland navigation.”[1]

The discipline of economics set aside Smith’s insights about geography and economic development for two centuries (Nordhaus 2006) until a group of influential books and papers

[1] Smith expanded on the importance of soil quality in *Lectures on Jurisprudence*, p. 223. “The soil must be improveable, otherwise there can be nothing from whence they might draw that which they should work up and improve. That must be the foundation of their labour and industry. It is no less necessary that they should have an easy method of transporting their sumptuous produce into foreign countries and neighbouring states. When they have an opportunity of this, then they will exert their utmost industry in their severall businesses; but if their be no such opportunity of commerce, and consequently no opportunity of increasing their wealth by industry in any considerable degree, there is little likelyhood that they should ever cultivate arts to any great degree, or produce more sumptuous produce than will be consumed within the country itself; and this will never be wrought up to such perfection as when there are greater spurs to industry.”

put geographic factors back onto center stage (e.g., Diamond 1997; Engerman and Sokoloff 1997; Mellinger, Sachs, and Gallup 2001). The decline in the cost of computing power and the increasing availability of geospatial datasets over the past two decades has allowed scholars to operationalize hypotheses from that literature.

A central challenge for the literature has been to define the relevant geographic-economic unit of analysis. The initial phase of this research program carried out analyses at the level of present-day nation states or sub-national present-day political jurisdictions (Easterly and Levine 2003; Hibbs and Olsson, 2004; Olsson and Hibbs, 2005; Putterman 2008; Zuleta, 2012). That approach had a limitation: nation states contain numerous regions with vastly different geographic characteristics.

Scholars went beyond nation states as the unit of analysis in a subsequent phase of research by estimating the relationship between geophysical features and economic phenomena at the level of latitude-longitude grid cells. As Nordhaus (2006) makes clear, grid cells were chosen as the unit of analysis in this phase of research for practical, rather than theoretical reasons.

As the costs of computation fell scholars worked with increasingly smaller grid cells. Masters and McMillan (2001) divides the world into 1 degree by 1 degree grid cells, and finds that the number of days of frost (controlling for other biophysical variables) accounts for present-day population density and agricultural cultivation density. Nordhaus (2006) divides the world into 1 degree by 1 degree grid cells, and finds that precipitation, elevation, latitude, and distance from the coast all have major and systematic, but highly non-linear, impacts on the level of 1990 per capita income (as measured by GDP at the grid cell level). Nordhaus and Chen (2009) extends these results to 1995 and 2000. Motamed, Florax, and Masters (2014) divides the world into 0.5 degree by 0.5 degree grid cells, and finds a robust association between earlier urbanization and agro-climatic suitability for cultivation, having seasonal frosts, better access to the ocean or navigable rivers, and lower elevation. Henderson et. al., (2018) divides the world into 0.25 degree by 0.25 degree grid cells and focuses on temperature, precipitation, elevation, terrain ruggedness, coasts, navigable rivers, natural ports, and biomes. It finds that in early developing countries (as measured by a dummy for the level of pre-1950 economic development) the location of economic activity (as measured by present-day night lights) is driven more by factors determining agricultural productivity than trade suitability as compared to late developing countries. "Many of us familiar with individual developed countries think of the strong role that location on lakes or rivers and access to the coast played in their historical evolution. However, we show explicitly that all the trade-related variables play a much more important role in today's developing countries."

There are theory-based reasons why analyses based on grid cells might miss important geographic and economic relationships. Human beings do not make location and investment decisions based on the characteristics of grid cells. Rather, they make those decisions based on their judgement of their relevant market, which they take as conditional on the contiguous features of the earth's surface, the human-made alterations to those features (e.g., tunnels through mountains, canals around waterfalls), and the available transportation technologies at a point in time. The relevant economic-geographic unit might extend over numerous grid cells, over portions of numerous grid cells, or be smaller than a grid cell. The issue is not simply that a grid cell approach overstates the number of units of analysis, potentially biasing downwards standard errors. When the question is about how geographic factors determine the extent of markets, the appropriate unit of analysis is the market.

To be concrete, the labor, capital, and product markets of New York City and Philadelphia have been integrated since the 18th century because of the navigable bodies of water and flat terrain between them. In Smith's time they were two nodes of a single network—and it was the specialization that network made possible that generated the region's prodigious economic surplus. An analysis based on grid-cells at a resolution of one degree by one degree (or finer) would, however, treat New York and Philadelphia as independent units, and would therefore provide a biased estimate of the relationship between their levels of economic development and their surrounding geographic factors.

Estimating the Extent of Markets and Their Levels of Economic Development

We build upon and go beyond the grid-cell approach by approximating the extent of the market given the alterations in the earth's surface and the transport technologies during Adam Smith's time. Because the extent of the market is influenced by three factors (its size, depth, and access to other markets via ocean transport) we take three steps. First, we develop a measure of market size by estimating the distance one ton of bulk goods could be moved to any one of 50,603 terrestrial points on the globe, given a uniform energy budget, access to navigable rivers (as they flowed in Smith's time), lakes (as they existed in Smith's time), ice-free seas (as they existed prior to global warming), terrain slopes, and tsetse fly endemicity (which precluded the use of draft animals in transport). Our model permits shippers to use the most efficient combination of three 18th century transport technologies; pirogues and keelboats for riverine, lake, and coastal transport;[2] horse-drawn Conestoga Wagons for overland transport; and human

[2] These boats were smaller that ocean-going vessels, thereby overestimating the energy costs of ocean transport and biasing against our hypotheses about the importance of transport corridors, because countries in North America and Western Europe, which tend to have high levels of economic development have long coastlines relative to their size.

porters for areas of Africa where tsetse fly-transmitted trypanosomiasis precluded the use of draft animals. The model yields geographic shapes, which we refer to as transport corridors, that vary in size from 250 km^2 (roughly the size of the Cayman Islands) to 758,000 km^2 (roughly the size of Norway and Sweden combined). Second, we estimate the depth of the market in Smith's time within each of the 50,603 transport corridors by taking the the maximum potential output per acre of 22 major staple crops, conditional on rainfed production methods, traditional cultivars, and pre-Green revolution pest and weed control technologies from FAO-GAEZ 4.0. We translate outputs by volume into calories using data from the U.S. Department of Agriculture (2016). Third, we estimate transport corridor access to ocean transport by drawing data from U.S. Navy (1953) and Deasy (1942) on the world's natural harbors.

We construct a measure of economic development at the transport corridor level based on the density of urban settlement. We identify, geolocate, and provide a population estimate of any city or town that meets a threshold size of 20,000 inhabitants in any year circa 1700, 1800, 1850, 1900, 1950, and 2000 by integrating information across multiple online datasets, books and articles by historians and archaeologists, historical dictionaries, gazetteers, traveler's accounts, and encyclopaedias. The data is arranged as a panel.

Main Findings

Our analyses indicate that circa 1700 (the closest year in our dataset prior to the publication of *The Wealth of Nations*) 81 percent of the Old World's urban population was located in large, high agricultural productivity transport corridors that included at least one natural harbor—even though those transport corridors only accounted for 10 percent of the Old World's terrestrial surface. Other combinations of factors yield much weaker results. For example, large transport corridors with low agricultural productivity accounted for only 11 percent of the Old World's urban population, even though they accounted for 15 percent of the Old World's terrestrial surface. We also find that these patterns are remarkably persistent: as late as 2000, the large, high agricultural productivity transport corridors that included at least one natural harbor accounted for 50 percent of the Old World's urban population—a result we consider remarkable considering that our estimates of transport corridor boundaries are based on 18th century transport technologies and geographic features. We obtain similar results when we focus on the New World, though there is a lag in the level of development because the size and depth of markets increased when Old World cultivars, tools, draft animals, tools, and transport technologies began to be introduced in the 16th and 17th centuries. In 1700 large, high agricultural productivity transport corridors that included at least one natural harbor accounted for 19 percent of the New World's terrestrial surface and 25 percent of its urban population. That proportion grew rapidly, reaching 44 percent in 1800, 74 percent in 1850, and 85 percent in 1900.

Data Development

We want other scholars to improve and build upon our estimates and therefore explain our methods in detail.

We estimate as closely as we can the navigability of the world's rivers in the late 18th century by drawing on country- and region-specific historical sources that describe navigation and attempted navigation with pirogues and keelboats. We put back into GIS shape files of the world's present-day major perennial rivers all rapids, waterfalls, and sandbars noted in the historical sources. We also remove all canals, except for China's Grand Canal, because it was constructed between the 7th and 12th centuries. We code as navigable any stretch of river that could be traveled upstream and downstream at least six months per year using boats of a similar size and shape to those used by Lewis and Clark to travel up the Missouri River in 1804. We code all lakes as navigable, except those above 65 degrees north latitude, because they would have been frozen for at least six months per year.[3] We code all oceans as navigable, except those that were frozen (at a threshold of 60 percent) per the analysis of Vanhatalo et. al. (2021) on the probability of a ship becoming beset in sea ice. We draw sea ice coverage from the NOAA, Gridded Monthly Sea Ice Extent and Concentration dataset, published by the National Snow and Ice Data Center, and chose the data from April, 1850 (the earliest year in the dataset, and outside the range of global warming).[4] We focus on April because if a region has no ice in April it would not have been ice-covered again until the autumn, allowing for six months of navigability.

We draw transport corridors in three steps. First, we place hexagonal grid cells on a plate carrée projection of the earth's surface whose centroids are set at a uniform distance of 75 kilometers from one another. If the centroid of a terrestrial grid cell falls in a river, lake, or ocean, or if a terrestrial grid cell is cut by one of those bodies of water, we snap the centroid to the nearest riverbank, lakeshore, or coast provided that the centroid is within 37.5 kilometers of the water (that is it is halfway to the body of the water).[5] Second, from each centroid point we

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[3] Our estimate of the hinterlands around Mexico City takes into account that it was historically surrounded by a shallow lakes that have been drained. That process began in the 16th century and did not end until the late 20th century. Modern hydrographic maps therefore no longer include them. We restore Lake Texcoco, Lake Zumpango, and Lake Xochimilco to their approximate extent in the 18th century based on Stangl, Werner, Austrian Science Fund (FWF), Data: Lago Texcoco, 18th century, 2019-04-04, V1, Harvard Dataverse, https://doi.org/10.7910/DVN/DOT5EY. Accessed September 16, 2022. We also check that our shape files for the Aral Sea, Lake Chad, and the Great Salt Lake reflect their historical extents, not their current sizes and shapes using a Natural Earth supplement, https://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-lakes/

[4] https://nsidc.org/data/g10010/versions/1

[5] To the extent that people chose to live on high ground for reasons of defense, rather than on the water, we are over-estimating the size of their transport corridors. As a practical matter, this implies that we have over-estimated the size of transport corridors in the interior of Africa. See, for example, Vansina 1990.

estimate the accumulated costs of moving a metric ton of goods over a cost surface using the most efficient combination of an 18th century river boat, Conestoga Wagon, and human porter, along the least cost path, using the Path Distance Allocation tool in ArcMap 10.4. For any centroid point, the tool begins calculating the accumulated transport costs at that point and works its way outwards until the accumulated transport costs reach the budget constraint. That is, we estimate least-cost paths, conditional on pre-steam-power technologies, in which the uneven spatial distribution of navigable water, flat terrain, and tsetse fly endemicity drive variation in the distance one metric ton could be moved. We set costs and budget constraints in terms of physical parameters (friction, energy, work) rather than economic costs (dollars per ton-mile). We refer to these first-order units of market extent as hinterlands.

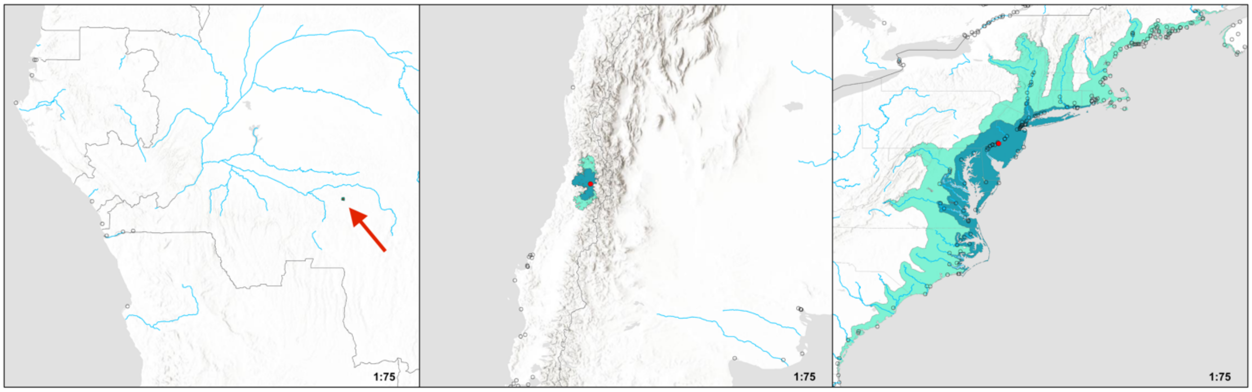
Hinterlands may overlap one another. It is precisely the existence of contiguous features of the earth's surface, generated by rivers, lakes, seacoasts, and flat terrains, that influenced human location and investment decisions. As a third step, we therefore combine hinterlands into a second-order spatial unit we refer to as a transport corridor. Our procedure is to aggregate all hinterland shapes that overlap a hinterland's centroid point. Conceptually, a transport corridor represents the potential network of markets that served a centroid point.

We provide as inputs for the Path Distance Allocation tool a map of the world composed of six layers. The first is a dataset that geocodes every centroid of every 75-kilometer hexagonal grid cell on the planet, adjusted as discussed above for those that fall on or near navigable water. The second input is a raster Digital Elevation Map (DEM) that encodes the average elevation of each .225 by .225 kilometer cell on the map (resampled to 1km by 1km for computational efficiency). The DEM enables the tool both to calculate transportation costs due to elevation changes (i.e. fighting gravity) and also allows the tool to calculate the true transportation distance along a 3-dimensional surface (i.e. the hypotenuse rather than as the crow flies when traveling up or down hill). The third input is a raster cost surface that encodes the per meter physical costs incurred by transporting one metric ton of goods through each 1 km by 1 km raster cell, using the three technologies discussed below. The fourth is a physical model that translates elevation gains to quantities of physical work expended. The fifth is a set of assumptions about the physical limits of wheeled vehicle transportation technology (e.g. a maximum grade beyond which a team of horses cannot pull a load). The sixth is a budget constraint for the total amount of energy available.

This process allows us to estimate the size and shape of 50,603 hinterlands, and therefore also allows us to determine the hinterland centroid points that are overlapped by hinterlands drawn from other centroid points, yielding 50,603 transport corridors. To give readers a sense of the size and shape of hinterlands and transport corridors we provide three examples in Maps 1, 2, and 3, which show the hinterlands and transport corridors for the centroid points closest to N'shenge (the capital of the Kuba Kingdom in the present-day Democratic Republic of the Congo), Santiago, Chile, and Philadelphia, USA. The centroid points are shown in red, the hinterlands in blue, and the transport corridors in green. We also include in Maps 1, 2, and 3 the natural harbors located in those hinterlands and transport corridors, which are shown as grey circles. The maps are drawn to scale. Thus, the transport corridor of Philadelphia really is 1,800 times bigger than the transport corridor of Nshenge. Note as well that the transport corridor of Philadelphia contains 98 natural harbors, while that for Nshenge contains none.

Maps 1, 2, and 3:

Hinterlands and Transport Corridors of N'shenge, Santiago, and Philadelphia



Transport Technologies

We expand in this section on our choices of transport technologies and the methods by which we estimated their relative efficiencies. Wagon transport was the most efficient option for the overland transport of bulk goods in the 18th century. We focus, in particular, on the Conestoga Wagon, because of its documented use in transporting bulk goods over long distances and over mountain passes. We rely on historical data to determine the physical characteristics of a typical Conestoga wagon, a typical load size, the energy required to move a loaded wagon over flat terrain, the additional energy required to overcome changes in elevation, and the impact of varying road surfaces and road conditions.

Our strategy is to estimate the amount of energy required for a loaded Conestoga wagon to maintain a constant speed on flat land, and then account for the additional energy required to overcome elevation changes. That is, we assume away the question of acceleration and simply calculate the energy required to overcome friction (primarily rolling resistance) and gravity. Diameter and width of the wagon wheels are two important factors that determine the rolling resistance of a wagon. Conestoga wheels were made in a range of sizes to suit the service intended and the size of the wagon. The largest wheels were used on the heavy trans-mountain freighters of the 1820-1850 period. Generally, the rear wheels on these big wagons had a diameter between 60 and 70 inches. Wheels of 70 inches typically had a width of 3.75 to 4 inches. Wagons of medium size typically had rear wheel diameters between 54 and 60 inches, and widths of 3 inches or more. Based on Shumway (1964), we estimate an average rear wheel diameter of 59.9 inches, an average front wheel diameter of 44.8 inches, and average wheel widths for both front and back of 3.4 inches. Rolling resistance, for any given wheel diameter and width, is a function of the gross weight of the vehicle because the road surface deforms in proportion to the gross weight of a vehicle as spread over the surface of the wheel in contact with the road. We assume a wagon weight of 3,250 pounds and a cargo of 7,000 pounds based on data in Shumway (1964: 66).

Road surface conditions could impact the difficulty of travel by wagon tremendously, with poor conditions capable of increasing the total resistance by an order of magnitude or more, relative to good conditions. Based on data in Osborn (1918: 18) we assume a resistance of 68.5 pounds per ton based on the average for freight wagons on a nearly dry earth road in very good condition. This decision biases upwards the size of hinterlands and transport corridors in tropical environments, where heavy rains would have turned roads to mud, and thereby biases against the Smithian hypothesis that England and Continental Europe had large markets relative to other regions of the Old World.

We estimate 492 newtons as the force required to overcome the total resistance (per metric ton of cargo) of a loaded Conestoga wagon on a flat, earthen road in good condition. Applying that force over 1 meter implies 492 newton-meters, or joules, as the amount of energy expended per metric ton in hauling cargo over a flat, earthen road in good condition, at constant speed. This is the value we encode for wagon-based overland travel in the friction surface used by the Path Distance Allocation tool in ArcMap 10.4.

To account for the energy required to overcome elevation changes based on the gross weight of the wagon and the gradient of the path, we draw on data in Baker (1918). Following Baker (1918) we limit wagon transport to a 10% grade, at which point a horse can barely generate enough power to transport itself over any appreciable distance.

Overland Transport: Human Porters

In regions of Africa in which tsetse flies were endemic, wagon transport would not have been an available option because tsetse fly-transmitted animal trypanosomiasis killed horses, mules, and oxen. We therefore assign human porters to any raster cell in which tsetse flies were endemic, drawing on a predicted distribution of tsetse fly groups and species developed and put online in raster format by the FAO.[6] The FAO tsetse distribution index runs from 0 to 1, but the distribution of values is bimodal. To determine the breakpoint, we consulted country histories to determine whether horses, mules or oxen were employed. For example, the region around Addis Ababa, Ethiopia has a tsetse index of 0.0014. Upon review of Ethiopian history, we found that during the Italian-Abyssinian War of 1895-96, there was an Abyssinian cavalry equipped with Dongol horses, a breed that is native to Sudan, Eritrea, and Ethiopia. We found that regions with values below 0.1 historically employed horses, while those above 0.1 did not. Thus, if a raster cell has a tsetse index value greater than 0.1 we require transport through it to use human porters.

To calculate the energy cost of moving one metric ton of bulk goods one meter using human porters we estimate the relative energy efficiency of human porters compared to horse-

[6] http://www.fao.org/geonetwork/srv/en/main.home?uuid=f8a4e330-88fd-11da-a88f-000d939bc5d8

drawn wagons by applying some basic mechanics. Unlike a horse-drawn wagon, human porters did not pull wheeled vehicles, they carried the loads on their heads or shoulders, using tumplines or litters. This meant that they had to forego the mechanical advantage afforded by a wheel and axle. The formula for mechanical advantage is the ratio of the radius of the wheel divided by the radius of the axle. A Conestoga Wagon with a 60-inch diameter wheel typically had a five inch axle, yielding a mechanical advantage of 12. Human porters would, however, gain some advantage over a horse drawn wagon by being able to climb grades steeper than 10 percent and by being able to take paths too narrow for a wagon. We therefore scale down the 12:1 mechanical advantage of horse drawn wagons to human porters to 10:1. Thus, we assume 4,920 newton-meters to move one ton one meter, and input this value into the Path Allocation Tool. We account for elevation changes using the same parameters we use for wagon transport. Horses are also more efficient than human beings, with much of the difference coming down to the fact that horses exert power and balance loads over four legs, rather than two. We do not include this differential in our estimates but note that its elision underestimates the advantages of horse-drawn wagons over porters, thereby biasing the size of transport corridors in tsetse fly endemic regions upwards.

Water-Based Transport

In dealing with water-based modes of transportation, we make several simplifying assumptions. First, we do not distinguish river travel from travel along major lakes, seas, and oceans. Second, assume away the effect of river currents in the physical model, with the exception that we code rivers with sufficiently strong currents as non-navigable using pre-steam technologies. Given that coastal and ocean transport are cheaper than riverine transport (in terms of energy expended per ton of cargo), the first assumption leads us to overestimate the energy costs of ocean transport. Since North America and Western Europe have long coastlines relative to their overall size, our procedures bias the size of North American and Western European transport corridors downwards.

Parallel to our treatment of land-based transport, our strategy is to estimate the amount of energy required to pull a loaded boat, at a constant speed, through still water. Again, we assume away the question of acceleration and calculate the energy required to overcome resistance, primarily drag resistance in the case of water travel. We rely on historical data to determine the physical characteristics of boats, a typical load size, the typical draught for a loaded boat, and the drag coefficients given the shape of the boats.

As with land-based transport, determining the physical cost of transportation over water requires that we fix a pre-steam transportation technology from among the available options. We chose two of the boats used by Lewis and Clark in their westward expedition between 1804 and 1806, Lewis and Clark's keelboat and the boat known as the "white pirogue" because detailed knowledge of their shapes, drafts, and cargo capacity has been preserved. These boats were typical of the smaller vessels used for riverine transport in the United States in the late 18th century, less capacious than river barges or flat boats, but better designed to navigate smaller rivers.

We estimate 53 newtons as the force required to overcome the drag resistance (per metric ton of cargo) for the Lewis and Clark boats moving through still water. Applying that force over 1 meter implies 53 newton-meters, or joules, as the amount of energy expended per metric ton in hauling cargo via Lewis and Clark's boats through still water at a constant rate of 3 miles per hour. This is the value encoded for water travel in the friction surface used by the Path Distance Allocation tool. We explain below the data and calculations behind this number.

Physical Characteristics of Lewis and Clarks' boat and the white Pirogue

Drag is the main source of resistance encountered by an object moving through water at low speeds, and is determined by the formula

$$F_D=1/2\ \rho v^2\ CD\ A$$

where FD is the drag force, ρ is the density of fluid (in this case water), v is the relative velocity of the object, CD is the drag coefficient, and A is the cross-sectional area of the object, in this case the area submerged in water. At low speeds we can safely ignore drag forces due to air resistance.

The value of ρ is given for water (approximately 1000 kg/m3 at 4°C). We assume the velocity to be 3 miles per hour. We calculate the cross-sectional area based on the shape and draft of the boats, from Boss (1993), Mussulman (ND-A), and Mussulman (ND-B). We employ a drag coefficient of 0.295 based on the shape the keelboat and pirogue, which approximates a bullet form (rounded in front, squared at back).

Converting the historical data to metric units, we arrive at a drag force of 56.6 newtons (per metric ton of cargo) for Lewis and Clark's keelboat, and a drag force of 49.1 newtons (per metric ton of cargo) for the white pirogue. Averaging the two, we arrive at the estimate of 53 newtons of drag force (per metric ton of cargo) for waterborne transport.

Navigable waterways

We assume that all oceans, seas, and lakes, except those covered in ice, were navigable using pre-steam technology. River navigability is, however, more complicated. One cannot simply rely on present-day maps of navigable rivers. Human beings have altered rivers for economic reasons since time immemorial. Their ability to widen and deepen channels, dredge sand bars, and dig canals around waterfalls and rapids increased dramatically after the invention of dynamite in 1867 and earth moving machines in the 1920s.

We combed the historical record for sources that describe navigation and attempted navigation with pre-steam technology for each major perennial river in the world to assess the stretches of rivers that were navigable circa 1800 by boats of the types discussed above. In the case of the United States, we were able to find a single map detailing the conditions on principal waterways circa 1890 [Statistical Atlas of the United States (1898) retrieved from the David Rumsey map collection (www.davidrumsey.com)]. We overlaid the historical map on a modern geo-referenced map using ArcGIS, matched the images of rivers from the historical map to a vector dataset of rivers and streams on the geo-referenced map, and then coded each on the latter for navigability manually. Given that most of the dredging of rivers and dynamiting of rapids by the U.S. Army Corps of Engineers took place after 1930, this affords a reasonably accurate portrayal of the state of these rivers circa 1800.

For the remainder of the world, we started with a universe of cases consisting of major perennial rivers from the Natural Earth dataset (http://www.naturalearthdata.com/), as well as the CIA World Databank II (now incorporated into the Global Self-consistent, Hierarchical, High-resolution Geography Database http://www.soest.hawaii.edu/pwessel/gshhg/). Using country- and region-specific historical sources, we found references to 19th century (and earlier) navigation attempts for every river in the dataset. We then coded as navigable any stretch of river that was navigable at least six months of the year both upstream and downstream using pre-steam technology. We remove all canals, except for Chinas' Grand Canal, because construction of it began during the Sui dynasty (581-618 CE), making it infeasible to redraw the rivers that connected with it prior to its construction. Appendix A provides a codebook that details our decisions, river by river. We will make it available upon publication of this paper.

The Budget Constraint

The final input used for calculating the size and shape of a hinterland (and hence a transport corridor) is the budget constraint, or the total amount of energy available for transporting a metric ton of cargo from each of the 50,603 centroids in the dataset. We set the energy budget based on historical evidence on the distance of typical wagon hauls for staple agricultural goods in the United States contained in Fogel (1964; 75-79). Based on Fogel's estimates, we set our energy budget at 40 megajoules, the total amount of energy it would take to transport a metric ton of goods 50 miles on perfectly flat land using a horse and wagon.

Constructing Hinterlands and Transport Corridors

We used the Path Distance Allocation tool in ArcMap 10.4, with the inputs as described above, to draw polygons representing the hinterlands accessible from each polygon centroid, as described above. For every hinterland, we determine the number and size of overlapping hinterlands, and draw polygons representing their combined sizes and shapes. These second order shapes are the transport corridors.

Natural Harbors

We draw on two sources to code the natural harbors of the world. We begin with the 1953 (first) edition of the U.S. Navy's *World Port Index*. We count as natural harbors those coded by the U.S. Navy (1953) as Coastal (natural), River (natural), and River (basins).[7] One

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[7] United States, Department of the Navy (1953) defines Coastal (natural) as "A coastal harbor sheltered from the wind and sea by virtue of its location within a natural coastal indentation or in the protective lee of an island, cape, reef, or other natural barrier." Examples include San Francisco (USA) Sydney (Australia), and Freetown (Sierra Leone. It defines River (natural) as "A harbor located on a river, the waters of which are not retained by any artificial means. The

potential concern is that there might be natural harbors in Africa not included in the *World Port Index* because they had not been developed as of 1953. Geographer George Deasy enumerated the harbors of Africa in 1942, including both those in use as well as those that had the necessary topographic and bathometric characteristics but remained undeveloped. We therefore add the harbors identified by Deasy (1942) to those identified by U.S. Navy (1953).

Estimating Potential Agricultural Output

For each hinterland and transport corridor we calculate the maximum potential calorie yield of 22 staple crops using data from the Global Agro-Ecological Assessment for Agriculture (GAEZ 4.0).[8] GAEZ 4.0 provides a collection of raster datasets covering the globe that estimate the potential yield per hectare of a variety of crops under a variety of conditions, based on crop characteristics, soil characteristics, and climate.[9] To approximate the potential yields of those

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facilities may consist of quays or wharves parallel to the banks of the stream, or piers or jetties which extend into the stream." Examples include New York (USA), Singapore, and Tokyo (Japan). It defines River (basin) as "A river harbor in which slips for vessels have been excavated in the banks, obliquely or at right angles to the axis of the stream." One might be tempted to argue that the excavation of slips in the banks is evidence of a man-made harbor. Examples of such River (basin) harbors include, however, many places that have been ports since the middle ages, such as Dublin (Ireland) and Le Havre (France), as well as others that have been ports since antiquity, such as London (England), Rouen (France), and Rostov on Don (Russia). We therefore exclude all ports categorized as Coastal (breakwater), Coastal (tide gate), River (tide gate), Canal or Lake, Open Roadsted, or No Data.

[8] Our analysis includes wheat, sorghum, rye, wetland rice, dryland rice, pearl millet, foxtail millet, oats, maize, barley, buckwheat, peas, green gram, chickpeas, cowpeas, soybeans, groundnuts, bananas/plantains, sweet potatoes, white potatoes, cassava, and yams.

[9] For the assessment of rain-fed land productivity a water-balance model is used to determine the beginning and duration of the period when sufficient water is available to sustain crop growth. Soil moisture conditions together with other climate characteristics (radiation and temperature) are used in a simplified and robust crop growth model to calculate potential biomass production and yield….The calculated potential agro-climatic yields are subsequently combined with a number of reduction factors directly or indirectly related to climate (e.g., pest and diseases), and with soil and terrain conditions. The reduction factors, which are successively applied to the potential yields, vary with crop type, the environment (in terms of climate, soil and terrain conditions) and depend on assumptions regarding level of inputs/management….In order to ensure that the results of the suitability assessment relate to production achievable on a long term

crops using the technology of the 18th century,[10] we set the GAEZ 4.0 conditions to rain-fed, low inputs.[11] To approximate the highest potential yields available to farmers across crop groups, transport corridor by transport corridor, we calculate the maximum potential yield across the 22 crops separately, allowing each raster cell to produce the crop with the highest yield.[12] We then sum across all raster cells in each hinterland or transport corridor. We convert metric tons to calories for each of the crops based on U.S. Department of Agriculture (2016). We will make the .tiff files that we employ from GAEZ 4.0 available upon publication.

Economic Development as Measured by Urbanization

We stand on the shoulders of numerous other scholars in constructing our dataset of cities and towns. We geolocate any city or town that meets a threshold size of 20,000 inhabitants in

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basis, (i) fallow periods have been imposed, and (ii) terrain slopes have been excluded when inadequate for the assumed level of inputs/management or too susceptible to topsoil erosion. In essence, the GAEZ 4.0 assessment provides a comprehensive and spatially explicit database of crop production potential and related constraint factors.

[10] Our analysis assumes that cross-sectional differences in production capacity for the period on which GAEZ makes its estimates (1960-1990) have not changed appreciably since the 18th century. Turchin et. al., (2019) estimates pre-modern yields for three major crops across eight world areas. It shows that average yields today are 3.5 times higher than in 1500, but that the cross-sectional variation in 1500 is highly correlated with the cross-sectional variation today (R^2=.7). Historical crop yields and current crop yields are both affected by climate, directly through precipitation and temperature, and indirectly through the effect of precipitation and temperature on soil quality. While there have been fluctuations over time (e.g., the Little Ice Age, Global Warming) dendrochronological evidence indicates a remarkably stable climate for at least the past two millennia such that the cross-sectional differences in climate we observe in recent decades existed circa 1500-1800. See Le Roy Ladurie (1971: 35).

[11] Low inputs are operationalized in GAEZ 4.0 as traditional cultivars, labor intensive techniques, no application of nutrients or chemical fertilizers, no use of chemicals for pest and disease control, and minimum conservation measures.

[12] Raster cells cannot be subdivided during spatial analysis, so any cell that overlaps the transport corridor boundary is removed from analysis. It is therefore crucial to resample raster cells into smaller cell-sizes to minimize the data that is lost to omitted cells. A point is reached, however, when further improvements from resampling into smaller cell sizes are outweighed by the associated increase in file size and process run time. The cell size we have chosen for this process represents a balance point between accuracy and excessive runtime.

any year circa 1700, 1800, 1850, 1900, 1950, and 2000. We then construct a panel by matching cities over time, taking into account changes in city names and spellings. We adopt the protocol of reporting the population data at the level of the city proper, rather than at the level of the urban agglomeration, or the municipality or district in which a city is located. For example, rather than providing an estimate for the urban agglomeration of San Jose, California, which includes multiple surrounding satellite cities (e.g., Los Altos, Palo Alto, Sunnyvale), we provide separate estimates the city of San Jose and for each of the satellite cities. In cases in which the only observation for a particular city-year is for an agglomeration, we note that fact and make sure to exclude observations of the surrounding satellite cities for that year to avoid double counting. We note that, as a practical matter, the difference between cities proper and agglomerations only becomes consequential in the 20th century. We provide a discussion of the methods and sources in Appendix B, which we will make available, along with the dataset, upon publication.

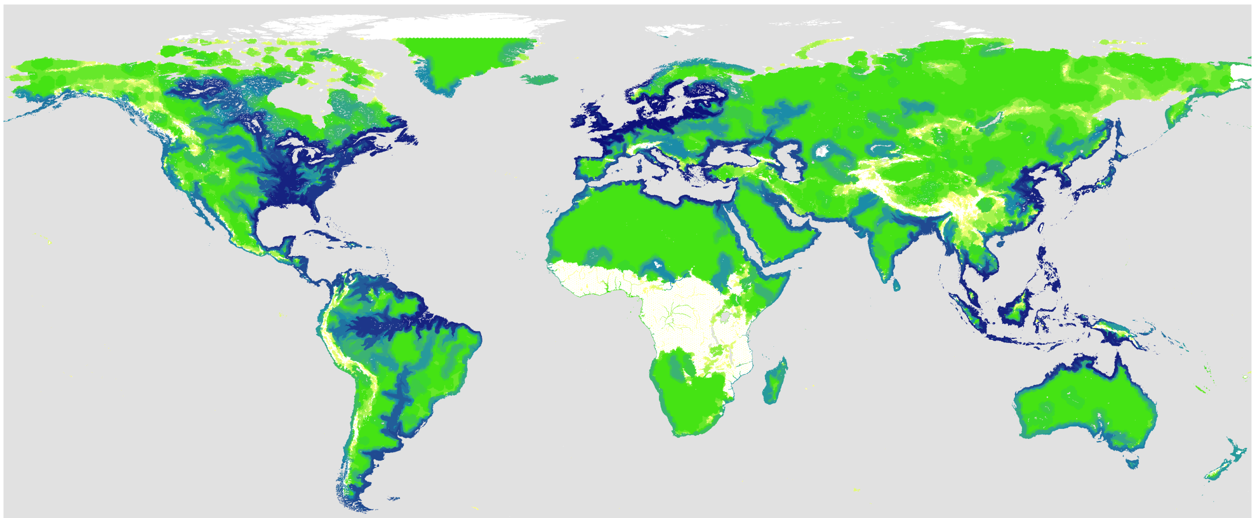
There is a difference between the location of city-centers today and their location in the 18th century. Generally, historical city centers were located on the banks of rivers, lakes, and oceans, but as cities grew in the 19th and 20th centuries city-centers shifted inland. That means that modern geo-coordinates for cities (typically fixed at their city hall or similar office) may not accurately capture their historical proximity to navigable water. We therefore "snap" the geo-coordinates of modern city-centers to the banks of the nearest historically navigable body of water, provided that the modern city center is located within 10 kilometers of that body of water.

Analysis

Map 4 presents a plate carrée projection of the world in which hinterland sizes are color coded. The top five percent are shown in dark blue. The bottom five percent are shown in white.

Intermediate five percent increments, going from lower to higher, are shown in shades from light yellow to medium blue.

Map 4: Transport Corridors by Size Distribution



The expanses of the earth coded in white or light yellow warrant discussion. They point to places in which markets for bulk products would have been tiny. There are basically two circumstances that generate this outcome. The first is high altitude mountain ranges. Note, for examples, the white and light yellow areas corresponding to the Himalayas, Pamir, Hindu Kush, Alps, and Andes mountains.

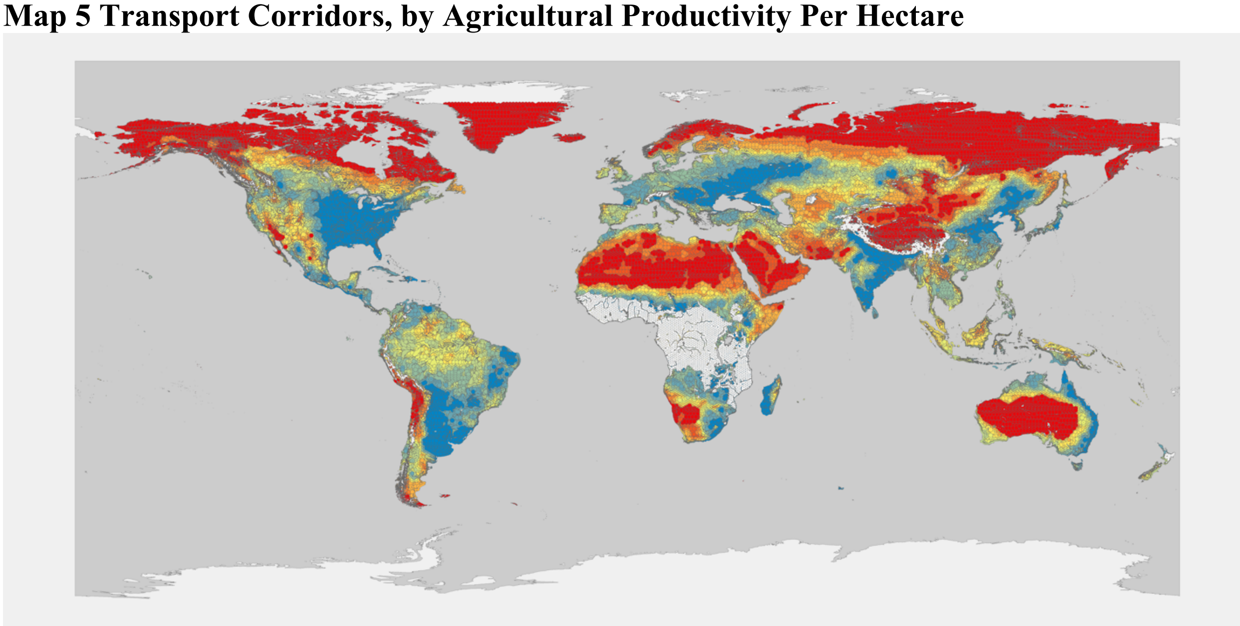
The second region of extremely small transport corridors is Africa south of the Sahel and north of the veldt. This region corresponds to the extent of endemic animal trypanosomiasis, carried by tsetse flies, which kill horses, mules, and oxen. Once bulk goods were offloaded from a boat or canoe onto a riverbank or lakeshore in this region they had to be moved human porters, rather than wheeled vehicles, exhausting the energy budget in our model after only a few kilometers. Making matters more difficult still, the coast of Southwest and Central Africa is characterized by an escarpment of steep slopes ranging from 700 to 3,000 feet high that rises within only a few miles of the Atlantic Ocean. This escarpment not only raised the energy costs of overland transport, it also caused the rivers emptying into the Atlantic to flow at breakneck speeds, rendering them non-navigable—even with present-day diesel powered water craft. The Congo River, the second largest river in the world by discharge volume, for example, cannot be navigated inland from the port of Matadi, on the Atlantic Ocean, to the capital city of Kinshasa. In fact, the 32 rapids and waterfalls on that 164 mile stretch have been successfully navigated *downstream* only once—in 2012 by four of the world's best whitewater kayakers.

The large corridors merit discussion as well. Readers will not need to squint to see that there are only a few regions of the world where nature made it easy to move bulk goods. North America east of the Rocky Mountains jumps off the map. Virtually the entire region from Newfoundland to Montana, extending south to the Gulf of Mexico, can be thought of as a single interlocking network of transport corridors. Much the same is true of the Great European Plain (Western, Central and Eastern Europe north of the Pyrenees, Alps, and Carpathians). Other large networks of transport corridors connected the Amazon basin, the Rio de la Plata and Parana river basins, the North China Plain and lower and middle Yangtze river basin, the Ganges and Brahmaputra River valleys, and the Baltic Rim and Black Sea (via the Volga and Danube river valleys).

Adam Smith also drew attention to fertile soils. Prior to the invention of steamships, railroads, trucks, and refrigeration in the 19th century, most food was eaten close to where it was grown. In fact, most European cities relied on the provision of foodstuffs from a within a circle of only 20 to 30 kilometers (Dittmar 2011). Even in England and the Netherlands, which historians point to as importers of grain from the Baltic Rim, imports never accounted for more than 10 percent of consumption before 1800 (Allen 2000:14). Hoskins (1964) lays bare the grim implication: "In [England]…in which one-third of the population lived below the poverty line and another third barely on or barely above it; in which the working class spent fully 80 to 90 percent of their incomes upon food and drink; in such a country the harvest was the fundamental fact of economic life."

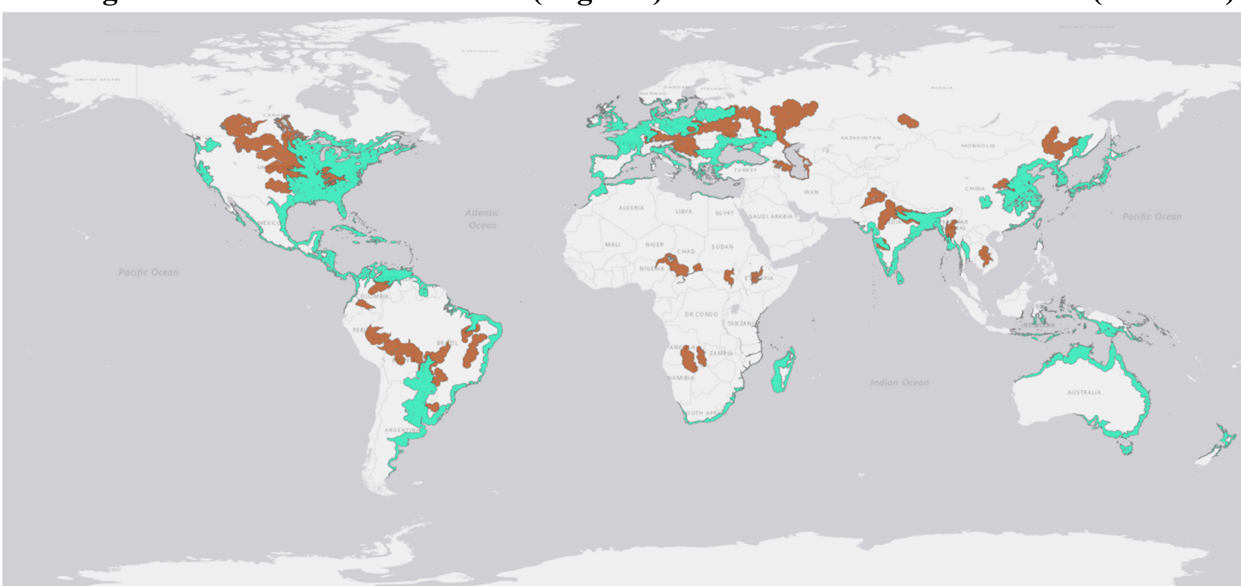
Map 5 therefore codes each of the world's 50,603 transport corridors by potential agricultural productivity, showing the data in five percentile intervals, with dark blue representing the top five percent, dark red the bottom five percent, and all other percentiles shown in shades of orange, yellow, green, and light blue. A few regions of the world pop off the map for their unusually high potential agricultural productivity: North America from the drainage basin of the Mississippi river to the Atlantic Ocean; South America from the Argentine, Uruguayan, and Brazilian pampas to the pantanal of Paraguay and Brazil; the plains of Central and Eastern Europe; the North China Plain and Manchuria; and the Ganges river basin. Smaller pockets of high agricultural productivity transport corridors are located on Australia's west coast, and in Madagascar, Central Mexico, and the Sahel. (Central Africa is white because the transport corridors are small; their agricultural productivity is represented by colored dots).

Map 5 Transport Corridors, by Agricultural Productivity Per Hectare



To make the regions of the world that had large and high agricultural productivity transport corridors easy to visualize, Map 6 shows the transport corridors that fall into both the top quartile of the size distribution *and* the top quartile of potential agricultural productivity. We focus on the top quartile of agricultural productivity because the bottom half of the agricultural productivity distribution is close to zero (note all the red regions in Map 5), and thus the 75th percentile is the top half of distribution of places that could grow staple crops. Those corridors that include at least one natural harbor are shown in green, while those that do not include at least one natural harbor are shown in brown.

Map 6: The Top Quartile Transport Corridors (By Size and Agricultural Productivity) Showing Those With Natural Harbors (in green) and Without Natural Harbors (in brown)

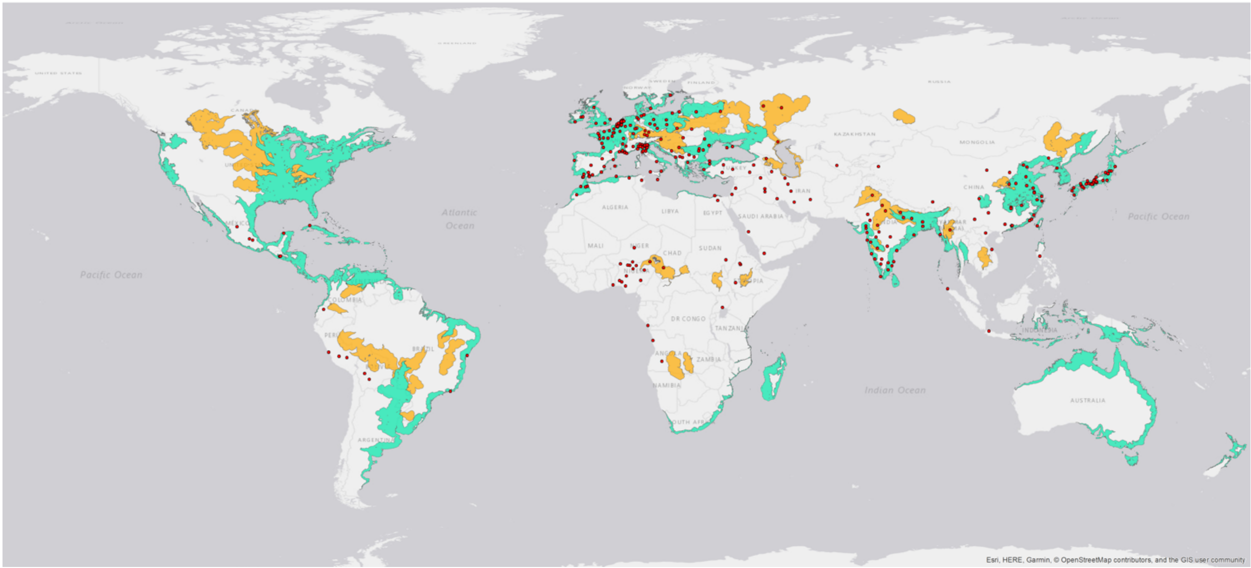


Readers should need to squint to see that the basic pattern: in Adam Smith's time there were a few regions of the world that were characterized by networks of overlapping high agricultural productivity transport corridors with natural harbors. Among the largest was the region with which Smith was directly acquainted, Great Britain and the Great European Plain. Others include North America east of the Rocky Mountains, the Rio de la Plata and Parana river basins, the Ganges and Brahmaputra river basins, and East Asia from Japan to the Yangtze river basin, including Korea and the North China Plain.

We cannot overemphasize the point that there is spatial correlation among large, high agricultural productivity transport corridors that included natural harbors. What you see in the green expanses of Map 6 are not single transport corridors; they are regions covered by multiple, overlapping transport corridors—sometimes hundreds of them, stacked unevenly atop one another becaus their boundaries (being drawn from slightly different centroid points) are slightly different. This is not a bug; a threat to inference. It is the phenomenon of interest. Map 6 is showing the regions of the world where, according to Smith, extensive markets should have existed.

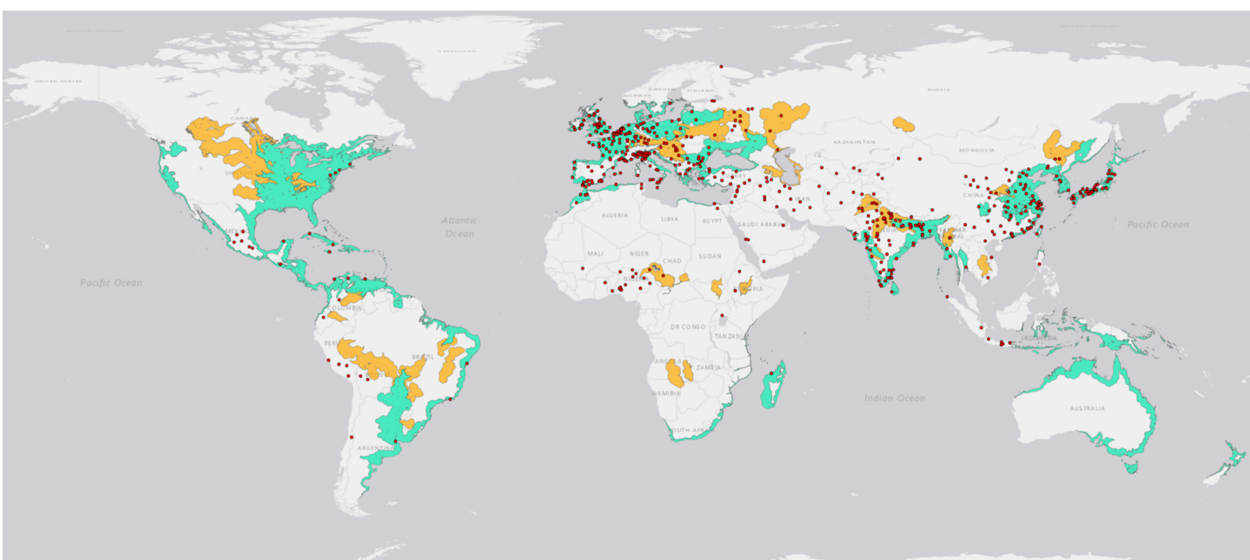
Was Smith right? To answer that question we include the cities and towns with more than 20,000 people in 1700 (displayed as blue dots) to see where economic activity was concentrated and display the results in Map 7. Readers will notice that in 1700 there were very few cities outside of the large, agriculturally productive transport corridors (the regions shown in green and brown). The exceptions are the silk road caravan cities Central Asia and the Middle East, West African cities along the Trans-Saharan trade route, Sub-Saharan African cities that were slave-trade ports, and the mining sites and pre-Columbian administrative centers of the Andes and Mesomerica.

Map 7: The World's Cities and Towns in 1700

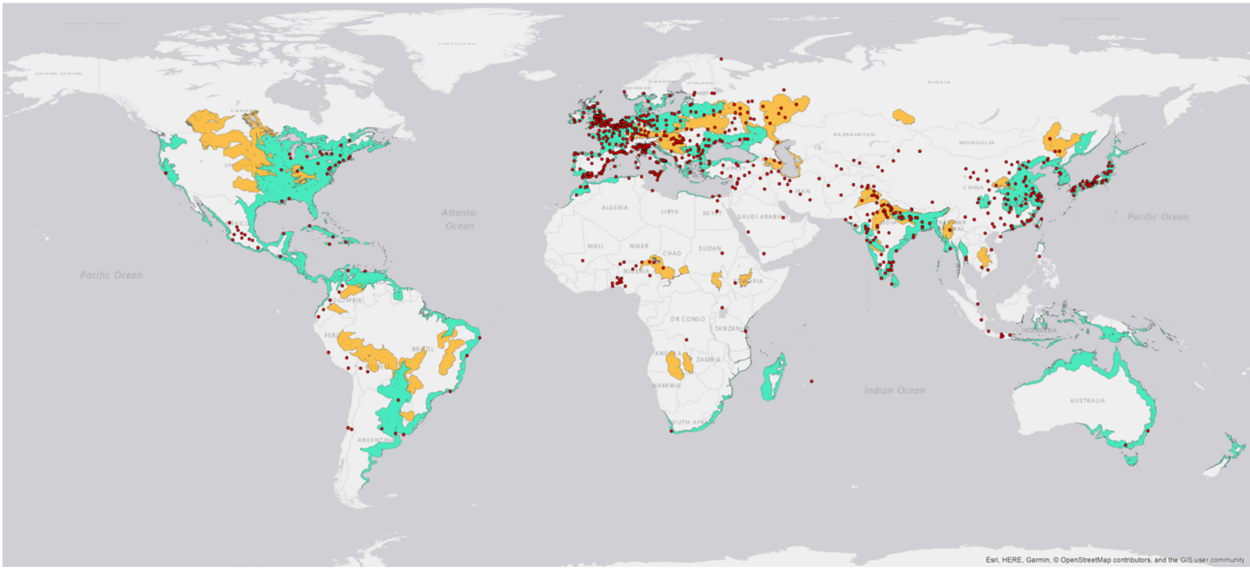


Maps 8, 9, 10, 11, and 12 follow the same protocols as Map 7, except that they substitute the cities and towns in 1800, 1850, 1900, 1950, and 2000, respectively. The pattern they depict is striking; until the second half of the 20th century, non-agricultural economic activity (as measured by urbanization) continued to concentrate in the regions that Smith would have predicted.

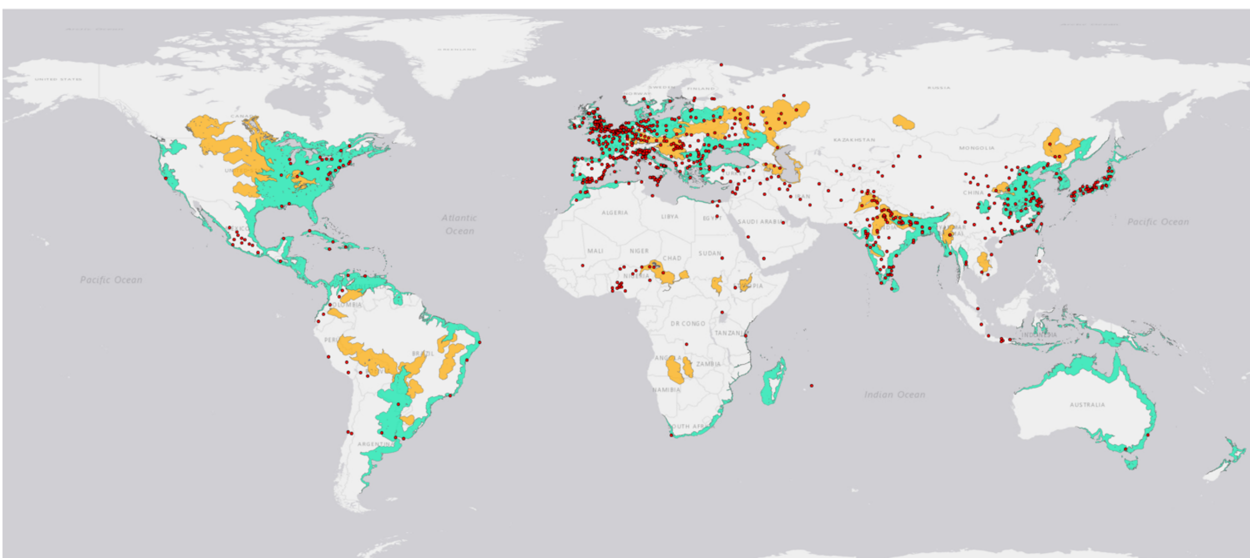
Map 8: The World's Cities and Towns in 1800



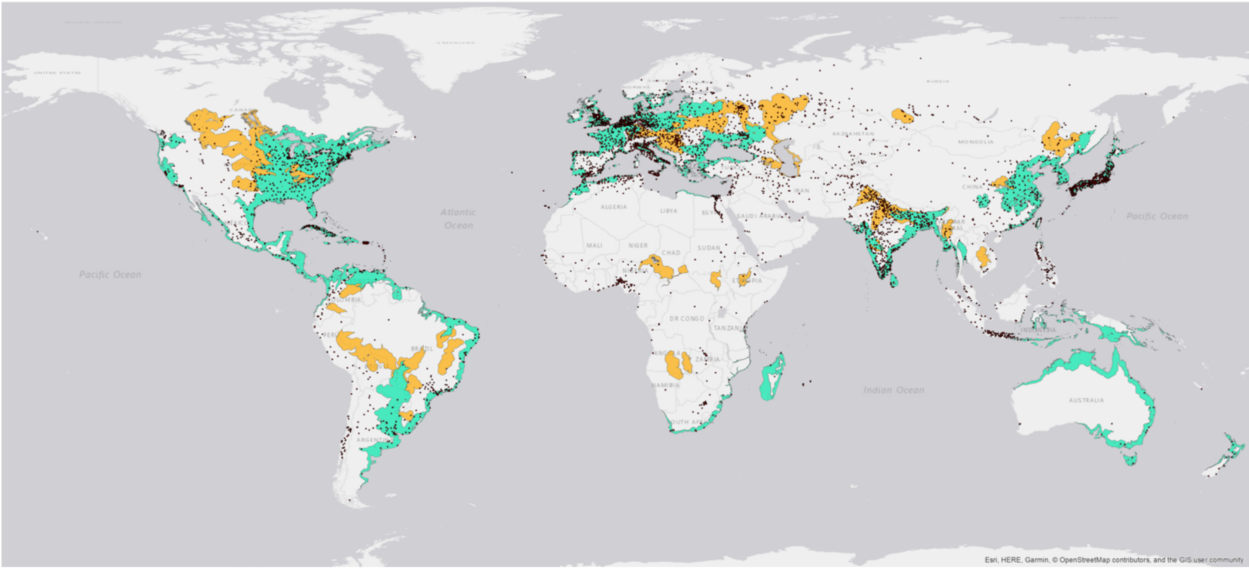
Map 9: The World's Cities and Towns in 1850



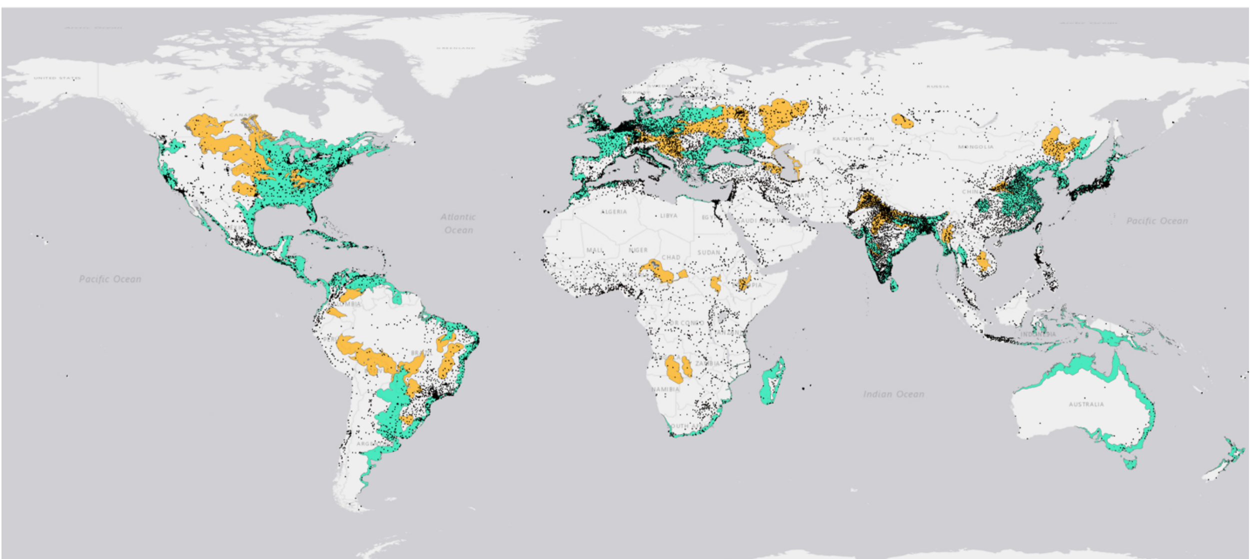
Map 10: The World's Cities and Towns in 1900



Map 11: The World's Cities and Towns in 1950



Map 12: The World's Cities and Towns in 2000



Discussion

The New World and Old World had quite different demographic and technological experiences prior to 1700. Many of the cities of Eurasia were of considerable antiquity. The regions in which those cities were located had been exchanging seeds, animals, tools, weapons, and diseases for millenia. The peoples of the New World had, however, been technologically and epidemiologically isolated from the peoples of the Old World since the Bering Strait Land Bridge was submerged 11,000 years ago. It therefore provides a quasi-natural experiment of Smith's hypothesis. Horses and oxen, unknown in the America's until the 16th century, increased the size of markets: agricultural goods could now be shipped by wagon, instead of being carried by human porters. Eurasian crops, such as wheat, barley, oats, and rice, coupled to steel ploughs and tools, increased the depth of markets by increasing labor productivity in agriculture. These technologies did not move all by themselves, they were carried by people—and pathogens moved with them. Native American populations, confronting diseases for which they had no immunity, collapsed catastrophically. Historians debate the magnitude of the pre-Columbian population of the Americas, but there is near unanimity that populations declined on the order of 80 to 90 percent by the mid-17th century.

Let us therefore examine the data for the Old World and New World separately. Before we do so, however, we call readers' attention to the fact, once again, that transport corridors (and the hinterlands of which they are composed) are not necessarily independent units. Large transport corridors (roughly speaking, those in the top quartile of the size distribution) tend to overlaps other transport corridors, such that it is not meaningful to ask the questions, to which transport corridor (A or B) does City 1 belong? The answer is that City 1 has population Y because it belongs both to Transport Corridor A and Transport Corridor B, which both also contain secondary cities 2 and 3 that are part of a network with City 1. Thus, rather than estimate OLS regressions in which transport corridors are units of analysis and their size, agricultural potential, and number of harbors are continuous variables, we pose the question as Smith likely would have put it: which regions of the Earth surface would have been likely to give rise to extensive markets? We answer that question as Smith would have: by generating simple interactions of three dummy variables: is a transport corridor in the top quartile of the size distribution; is it also in the top quartile of the potential agricultural productivity distribution; and does it have at least one natural harbor?

Tables 1 and 2 shows the data for the Old World, first by population density and then by number of cities, respectively--and there is nothing subtle about the patterns that emerge. Regions of the earth covered by small transport corridors (those in the bottom three quartiles of the size distribution) accounted for 70 percent of the ice-free surface area, but in 1700 they had so few cities (only 15!) that their urban population densities were less than 0.1 people per square kilometer. (For readers who are curious, that 70 percent of the Old World's s ice-free surface accounted for only 4 percent of its urban population). Large transport corridors had far more cities and higher urban population densities, but only if they also had high potential agricultural productivity and a natural harbor. Large transport corridors with low agricultural potential, and large transport corridors with high agricultural potential but without a natural harbor have urban population densities of only 0.1 people per square kilometer. The Old World's cities and urban populations concentrated overwhelmingly in regions characterized by large, potentially productive transport corridors that had access to the ocean via a natural harbor. Those regions accounted for only10 percent of the Old World's surface area, but held 76 percent of the cities and 81percent of the urban population. As Table 1 shows, they displayed population densities roughly 10 times higher than similar regions without harbors.

Perhaps equally striking is the fact that these patterns persisted. This can be seen in both tables 1 and 2, but perhaps even more clearly in Figure 1, which displays the urban population density as natural logs. Plainly put, the regions of the Old World that were the most urbanized in Smith's time continued to be the most highly urbanized. Similarly, the regions that were the least urbanized continue to be the least urbanized. We think that this is remarkable, considering that our transport corridor sizes are drawn based on 18th century transport technologies.

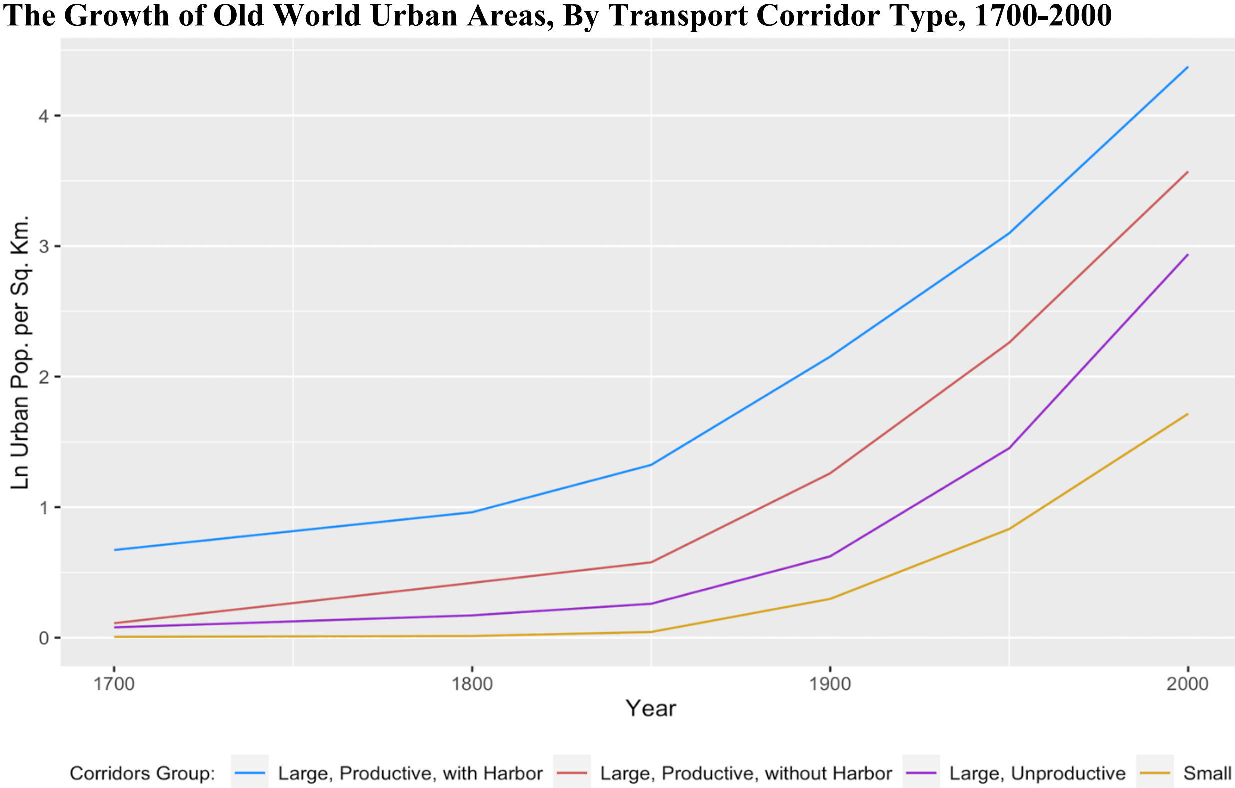
Table 1
The Distribution of the Urban Population of the Old World, by Corridor Type, 1700-2000

Corridor Characteristics	Land Surface %	1700 Urb. Pop. Per Km2	1800 Urb. Pop. Per Km2	1850 Urb. Pop. Per Km2	1900 Urb. Pop. Per Km2	1950 Urb. Pop. Per Km2	2000 Urb. Pop. Per Km2
Small (Bottom 75% Area)	70%	0	0	0	0.3	1.3	4.6
Large (Top 25% Area)	30%	0.4	0.7	1.2	3.3	9.9	40
Large, Unproductive (Bottom 75% Pot'l Prod)	15%	0.1	0.2	0.3	0.9	3.3	17.9
Large, Productive (Top 25% Pot'l Prod)	15%	0.7	1.3	2.1	5.9	17	63.9
Large, Productive w/out Nat. Harbors	5%	0.1	0.5	0.8	2.5	8.6	34.6
Large, Productive With Nat. Harbors	10%	1	1.6	2.8	7.6	21.2	78.4

Table 2
The Distribution of Old World Cities, by Corridor Type, 1700-2000

Corridor Characteristics	Surface %	1700 Cities	1800 Cities	1850 Cities	1900 Cities	1950 Cities	2000 Cities
Small (Bottom 75% Area)	70%	15	30	64	375	1,146	3,539
Large (Top 25% Area)	30%	227	418	610	1,610	3,559	11,586
Large, Unproductive (Bottom 75% Pot'l Prod)	15%	27	61	100	259	680	2,811
Large, Productive (Top 25% Pot'l Prod)	15%	202	360	524	1,360	2,906	8,865
Large, Productive w/out Nat. Harbors	5%	19	53	78	221	466	1,730
Large, Productive With Nat. Harbors	10%	183	307	446	1,146	2,453	7,158

Figure 1
The Growth of Old World Urban Areas, By Transport Corridor Type, 1700-2000



Are the patterns for the New World, where demographic and technological shocks took place in the 16th and 17th centuries, different from those of the Old World? Basically stated, tables 3 and 4, and figure 2 indicate that the answer is no. There were only 16 cities with a population of 20,000 or greater in the New World in 1700. Of these, three were remote silver mining sites, while an additional five major pre-Columbian political and administrative centers. Six of the nine new cities were located in large, potentially agriculturally productive transport corridors with a natural harbor. By 1800, as populations grew and the number of cities expanded, the Old World pattern begins to reappear: 14 of the 30 cities were located in large, agriculturally productive transport corridors with a natural harbor. These accounted for 44 percent of the urban population, but only 19 percent of the land area. The pattern becomes stronger still in 1850 and 1900, such that by the latter year the population density differential between regions covered by large, agriculturally productive transport corridors with a natural harbor versus all other categories (small, large but unproductive, and large and productive, but without a harbor) was 26 to 1. In 1900, those cities accounted for 85 percent of the urban population. As also happens un the Old World, those differentials began to attenuate in the 20th century—though as late as 2000, citie located in large, agriculturally productive transport corridors with a natural harbor accounted for 60 percent of the urban population and displayed urban population densities five times that of small transport corridors, nine times that of large but agriculturally unproductive transport corridor and large productive corridors without natural harbors. Given that we draw our transport corridor based on 18th century technologies, we consider these results remarkable.

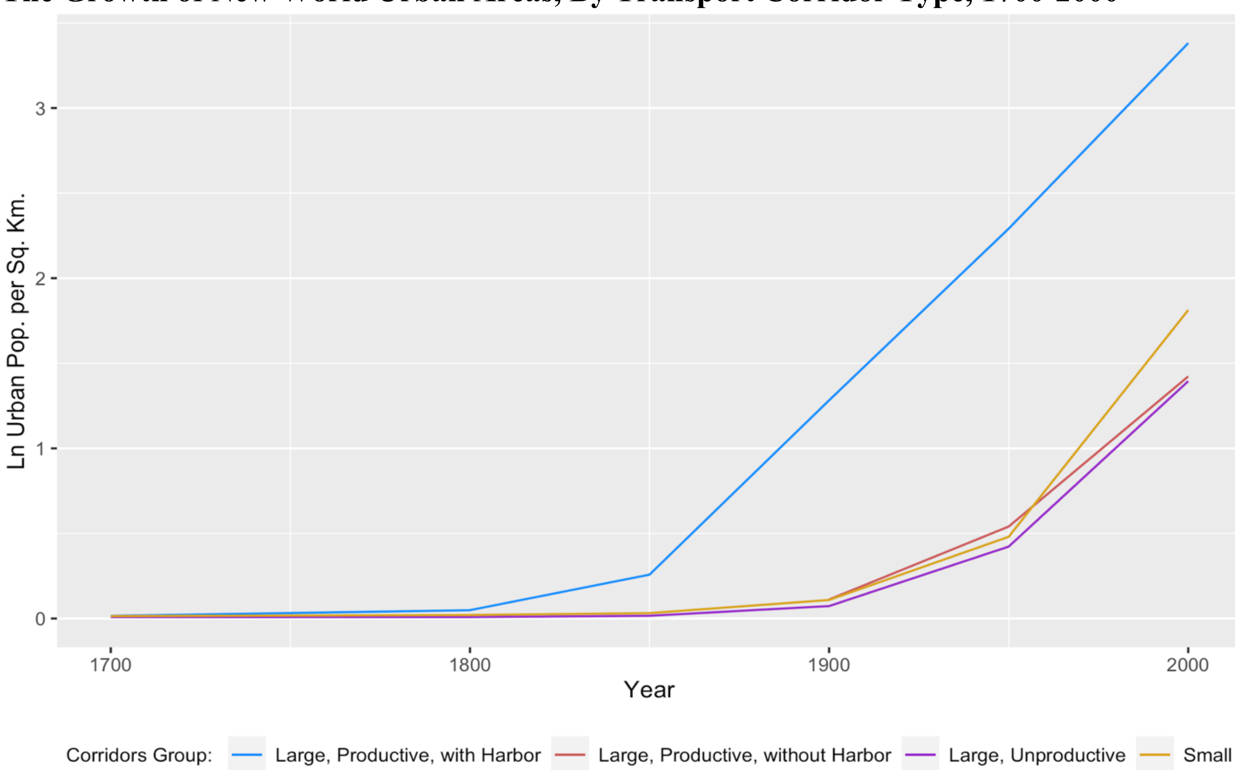
Table 3
The Distribution of the Urban Population of the New World, by Corridor Type, 1700-2000

Corridor Characteristics	Land Surface %	1700 Urb. Pop. Per Km2	1800 Urb. Pop. Per Km2	1850 Urb. Pop. Per Km2	1900 Urb. Pop. Per Km2	1950 Urb. Pop. Per Km2	2000 Urb. Pop. Per Km2
Small (Bottom 75% Area)	43%	0	0	0	0.1	0.6	5.1
Large (Top 25% Area)	60%	0	0	0.1	0.9	3.1	10.9
Large, Unproductive (Bottom 75% Pot'l Prod)	32%	0	0	0	0.1	0.5	3
Large, Productive (Top 25% Pot'l Prod)	28%	0	0	0.2	1.7	6.1	19.7
Large, Productive w/out Nat. Harbors	10%	0	0	0	0.1	0.7	3.1
Large, Productive With Nat. Harbors	19%	0	0.1	0.3	2.6	8.9	28.4

Table 4
The Distribution of New World Cities, by Corridor Type, 1700-2000

Corridor Characteristics	Surface %	1700 Cities	1800 Cities	1850 Cities	1900 Cities	1950 Cities	2000 Cities
Small (Bottom 75% Area)	43%	7	12	17	57	164	981
Large (Top 25% Area)	60%	9	18	47	319	996	3,474
Large, Unproductive (Bottom 75% Pot'l Prod)	32%	3	4	6	23	103	440
Large, Productive(Top 25% Pot'l Prod)	28%	6	14	41	296	896	3,045
Large, Productive Without Natural Harbors	10%	0	0	0	13	44	206
Large, Productive With Natural Harbor	19%	6	14	41	284	852	2,838

Figure 2
The Growth of New World Urban Areas, By Transport Corridor Type, 1700-2000



Conclusion

Over the past two decades social scientists have rediscovered the importance of geophysical factors in economic development. A major challenge to that research program has been to operationalize hypotheses at the level of the relevant geographic-economic region. We offer a methodologicl solution to that challenge. Our results indicate that Smith was more right than he knew. Most of Africa, which we show had few of the advantages pointed to by Smith, remains poor. The "Sea of Tartary" continues to be underdeveloped. Moreover, the places that were not yet developed in Smith's time—particularly the United States and Canada—but that had the geographical attributes he thought important, emerged as two of the wealthiest societies on the planet.

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