Long-Distance Trade and Long-Term Persistence*

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Abstract

Do changes in the location of trading opportunities lead to changes in the location of economic activity? This paper explores this question using a staggered lifting of restrictions on direct trade with Europe across the Spanish Empire in the 18th century. I combine a difference-in-differences approach with a dynamic spatial equilibrium framework and detailed georeferenced data on maritime travel from historical logbooks to examine this issue. I find that the reform improved market integration and induced urban growth, but had a smaller effect in locations with larger internal markets. The findings provide evidence that the location of economic activity adapts to changes in the location of trading opportunities, but can persist when these changes are preceded by urban growth.

Keywords: Economic Geography; Trade; Institutions.

JEL Codes: F62, R110, O110.

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1 Introduction

What determines the location of economic activity? Historical patterns of trade are widely recognized to have played a role through shaping the emergence and growth of cities. The growth of many of the world's largest cities was initiated by access to long-distance trade, but have long since ceased to be important trading locations. Do historical patterns of trade dictate the location and size of cities today despite the marked change in patterns of trade? Or does the location of economic activity adapt to changes in the location of trading opportunities if given enough time? If so, under what conditions?

To provide answers to these questions, I exploit a large-scale historical reform: the expansion of direct trade with Europe in the Spanish Empire during the 18th century. Early Spanish trade policy restricted the direct trade of goods with Europe. However, driven by political developments in Europe and dynastic changes in Spain, these restrictions were gradually lifted beginning in the second half of the 18th century. While only four ports were permitted to trade goods directly with Europe in 1765, this number had increased to more than 45 by the beginning of the 19th century. By this time, no major ports in Spanish America were subject to restrictions on direct trade with Europe (see Figure 1).

My paper is based on a novel dataset of cities, settlements, shipping times, and trade for the Spanish Empire in the 18th and 19th centuries. To quantify how the reform affected empire-wide shipping times, I construct a directed network of trade costs. For maritime shipping, I estimate sailing speeds based on historical maritime logbooks and georeferenced data on wind patterns. To estimate travel speed on land, I account for key geographic factors that historically shaped mobility, such as the slope, elevation, landcover, and the location of roads and ports. This approach results in time-varying bilateral transportation time matrices between all locations in the sample, which I validate using historical and contemporary sources. These time-varying measures of bilateral transportation times are then matched with data on geographical characteristics, agricultural potential, urban populations, and the locations of settlements to construct a panel covering Spanish America during the 18th and 19th centuries.

I leverage this variation using a difference-in-differences approach, comparing changes in population growth in cities where transportation times to Europe changed differentially because of the reform. The identification assumption is that changes in population growth in such locations would have been the same in the absence of the reform. I challenge this assumption in several ways and provide evidence supporting a causal interpretation of the estimates.

The setting is well suited to address the question for several reasons. First, time-varying transportation times enable me to control for unobserved and time-invariant factors that determine the location of trading opportunities and urban development. Second, the setting enables comparison across a large geographic area while keeping other important determinants of long-run growth, such as institutional and legal origins, fixed. Finally, the large geographic scope enhances external validity.

I document four main results. First, I find that the reform improved market integration between Europe and America. Second, I find that this market integration increased urban growth. In the preferred specification, a one-day reduction in the transportation time to Europe increases the urban population by around 2.5 percent over 50 years. Third, I find that the effects are driven by smaller cities and initially more isolated regions. Finally, I find that the correlation between the pre-reform and contemporary population density is lower in areas more intensively treated by the reform. Taken together, the findings provide evidence that the location of economic activity adapted to the change in the location of trading opportunities. However, this occurred to a greater extent in less populated cities and regions, suggesting the spatial distribution of economic activity was more malleable in these locations.

To explore mechanisms and long-term implications, I interpret the findings through the lens of a quantitative spatial general equilibrium model calibrated to the historical data. The model is consistent with key features of the historical context and accounts for potential changes in migration frictions induced by increased trade. In the model, individuals can migrate between cities that differ in their productivity, their trade and migration opportunities, and their availability of arable land. The pre-reform location of trading opportunities can continue to shape the location of economic activity by giving rise to self-sustained concentrations of economic activity. Alternatively, the continued impact can reflect a gradual transition to a new spatial equilibrium. Crucially, the model allows me to distinguish between these competing mechanisms by incorporating historical agglomeration economies following Allen and Donaldson (2022).

The main counterfactual exercises simulate the long-term impact of changes in the location of trading opportunities while fixing the local productivity and land endowment. I then examine how initial endowments and the spatial incidence of the shock mediate the long-term impact of reduced transportation times to Europe. I find that lower transportation costs to Europe increased population growth in affected cities by lowering transportation costs on traded goods, but due to the lower reliance on external trade in larger home markets, this effect was muted in areas sustaining larger cities. Furthermore, I find that potential changes in migration frictions induced by lower transportation times reinforce the impact of lower trade costs. The findings therefore highlight that the adjustment of the spatial distribution of economic activity is contingent on initial first and second-nature fundamentals. As such, the findings suggest that the location of economic activity adapts to changes in the location of trading opportunities, but that the influence of historical trading locations can persist when such changes are preceded by urban growth.

My paper contributes to the literature on history dependence in economic geography. Persistence in the location of economic activity is consistent with the persistent impact of locational advantages (Davis and Weinstein, 2002; Maloney and Valencia, 2016; Alix-Garcia and Sellars, 2020; Bakker et al., 2021) and multiple spatial equilibria (Krugman, 1991; Redding, Sturm and Wolf, 2010; Bleakley and

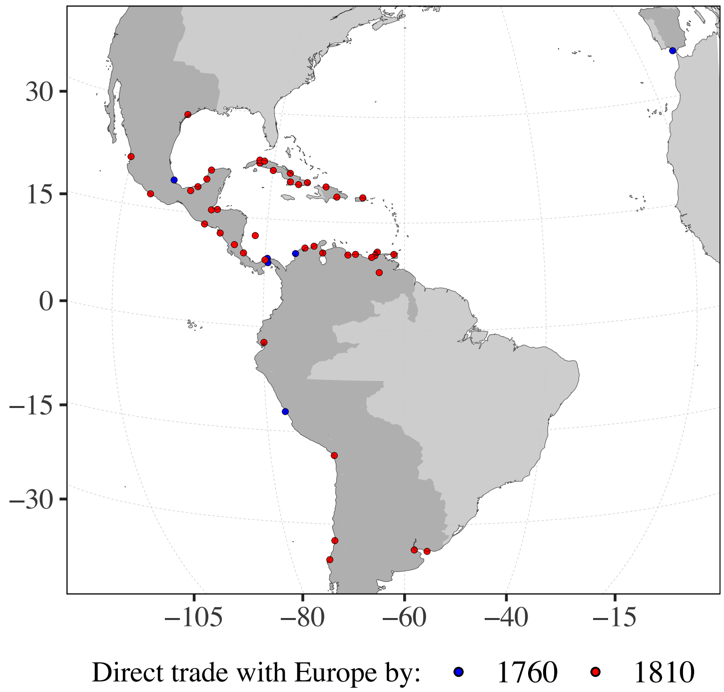

Figure 1: This map depicts ports marked according to status. Ports marked in blue were licensed for direct trade with Europe before 1765, while those marked in red were licensed to trade with Europe by 1810. Sources: Stangl (2019*d*) and Fisher (1997).

Lin, 2012; Michaels and Rauch, 2018).[1] In an important paper, Henderson et al. (2018), demonstrate the varying importance of locational advantages facilitating trade across countries. Using cross-sectional data, the authors show that such fundamentals matter less in "early developers", i.e. countries that developed in the context of high transportation costs. However, unobserved differences in fundamentals between early and late developers might contribute to this pattern. By considering *changes* in trading locations, and thereby controlling for time-invariant unobserved fundamentals, this paper supports their findings and sheds light on the long-term impact of changes in the location of trading opportunities

[1]History dependence also shapes patterns of trade through various channels including learning by doing externalities (Juhász, 2018), sunk costs in forming relationships (Xu, 2022), or convergence in preferences (Flückiger et al., 2022).

on the location of economic activity.

I also contribute to the literature on the effects of international transportation costs on national income. Reduced-form approaches have documented sizable impacts (Frankel and Romer, 1999; Feyrer, 2019; Maurer and Rauch, 2023), while structural approaches uncover more modest effects (Arkolakis, Costinot and Rodríguez-Clare, 2012). However, Pascali (2017) finds little evidence that increased trade due to the diffusion of steamships promoted economic development, except in countries with inclusive institutions. This is consistent with lower transportation costs leading some countries to specialize in sectors with fewer growth-enhancing externalities (Grossman and Helpman, 1990), weaker economies of scale (Matsuyama, 1992), or adverse effects on institutions (Acemoglu, Johnson and Robinson, 2005; Puga and Trefler, 2014). In contrast, this paper focuses on development *within* countries, thereby limiting the role of national institutions in mediating the impact. It highlights that reductions in international transportation costs can influence the spatial pattern of economic development within countries, even in the presence of extractive institutions.

My paper also contributes to the literature that explores the long-term economic impacts of historical institutions in general, (Acemoglu, Johnson and Robinson, 2001, 2002; Dell, 2010) and the economic legacy of the Spanish Empire in particular (Grafe and Irigoin, 2012; Bruhn and Gallego, 2011; Engerman et al., 2012). Acemoglu, Johnson and Robinson (2002) establish a negative relationship between pre-industrial and contemporary population densities. They show that lower pre-industrial population density necessitated institutions that enabled broader participation in the economy, such as property rights. Since these institutions were conducive to sustained growth, this contributed to economic development in the fringes of Spanish America starting in the 18th century. I complement these findings by exploring the role of institutions governing trade in this context. The findings support the view that the reversal of fortune in the Americas is rooted in institutional change, such as the transition from Habsburg to Bourbon rule in Spain, but highlight the importance of how these changes interacted with pre-existing geography. In this sense, the paper also builds on the quantitative literature on institutional reforms in the late Spanish Empire (see e.g. Valencia, 2019; Alvarez-Villa and Guardado, 2020; Arteaga, 2022; Chiovelli et al., 2024).

Finally, the findings shed light on the drivers of the growth in world trade in the 19th century (see e.g. Estevadeordal, Frantz and Taylor, 2003). The importance of the breakdown of monopolies controlling long-distance in the late 18th century has been emphasized in the literature (O'Rourke and Williamson, 2002; O'Rourke, 2006), however, previous efforts to test this relationship directly have been constrained by a lack of historical data. I contribute to this literature by providing direct empirical evidence of the importance of the breakdown of monopolies governing long-distance trade for urban growth.

The remainder of the paper is structured as follows. Section 2 presents the historical background. Section 3 presents the data sources. Section 4 describes the reduced-form results. Section 5 presents the model and Section 6 the counterfactual exercises. Section 7 concludes.

2 Background

This section outlines the key institutional features. A more detailed historical background is provided in the Appendix.

The Spanish commercial system. A central aim of commercial policy in the 18th century was to promote state wealth acquisition through trade surpluses (Findlay and O'Rourke, 2007). This was achieved through a range of policies restricting trade. First, trade was restricted to four ports in the Americas (Cartagena de Indias, Callao, Portobello/Nombre de Dios, and Veracruz) and only Seville (later Cadiz) in Europe. Further, the frequency of travel and the routes were restricted.[2] Third, participation in Atlantic trade was restricted to Spanish merchants. Finally, there were high tax rates on imports and exports. These measures effectively monopolized trade in the merchant guilds in Seville, Mexico City, and Lima. These cities in turn mediated trade with other locations in their respective viceroyalties. While as a rule, there were no restrictions on inter-regional trade (Elliott, 2006, p. 111), there were exceptions and instances where inter-regional trade was

[2]Typically, only two fleets left Spain every year: the New Spain *flota* destined for Veracruz, and the *Tierra Firme galeones* destined for Cartagena and Portobello. In the Pacific, shipping was conducted by *Armada del Sur*, which carried goods from the trade fairs in Portobello to Pacific ports in South America (Walker, 1979). Moreover, the Manilla galleon would sail between Acapulco and Manilla. Official information was carried by *aviso* ships, which were light carriers operating separately from the commercial system and were not permitted or equipped to carry freight.

discouraged.[3]

The system limited trade with Europe outside the core areas of Spanish settlement in the Americas, however, there was still some communication and trade with locations that were remote relative to the large trade routes. In addition to dispatch ships (*avisos*), ships sailing under special permission of the crown (*registros*) occasionally supplied remote ports. However, this was never done at a sufficiently large scale (Walker, 1979), and the reliance on contraband was high. Restrictions on trade and high trade costs ensured that trade was limited to non-competing goods with a high value-to-weight ratio. Beyond precious metals, hides, tallow, sugar, indigo, and cochineal were important exports (Rahn Phillips, 1990).[4]

While a likely consequence of Spanish mercantilism was the underdevelopment of peripheral areas in America (Fisher, 1997, p. 73), the measures did facilitate the naval defense of convoys and limited imports in the Americas. The policies therefore limited the flow of bullion beyond the Iberian Peninsula and kept the terms of trade in Spain's favor. It also facilitated the management of risk in a context where long shipping times and costly communication made it difficult to predict demand (Baskes, 2013). As a result, in addition to remittances directly controlled by the crown, private remittances to Spain were substantial (Cuenca-Esteban, 2008). However, reforming and adapting the system which

[3]For example, there were policies in place to limit trade between the Viceroyalties of Peru and New Spain to reduce the demand for the goods of the Manilla Galleon in Peru. Another example is the erection of a customs barrier in Córdoba (Argentina) in 1618 (Scobie, 1971, p. 53)

[4]The slave trade was subject to different rules. Trade of slaves was allowed for British ships from early to the mid-18th century as a result of the treaty of Utrecht, the *asiento* (Walker, 1979).

came under increased pressure in the 18th century proved difficult. In part, this was due to the limited ability of the Spanish crown to commit to compensating the stakeholders in the old system (see e.g. Acemoglu and Robinson, 2000).

Reforming the commercial system. Beginning in the 18th century, political tensions originating in Europe encouraged Spanish policymakers to reform the trading system (Elliott, 2006). In the immediate aftermath of Spain's defeat in the Seven Years' War, a special *junta* was appointed under Charles III to "review ways to address the backwardness of Spain's commerce with its colonies and foreign nations" (Stein and Stein, 2003). Drawing on ideas for reforming the system of government in America that had been circulating for a long time, the *junta* proposed the abolition of the Cadiz monopoly as well as the fleet system. Further, it proposed opening 14 ports on the Iberian Peninsula as well as 35 ports in the Americas (Fisher, 1997).

Several ports in the Caribbean were opened in 1765 (see Table 1). Further reform was delayed by the Esquilache riots in 1766, but the liberalization proceeded and culminated in the decree of free trade in 1778, which opened several remaining ports.[5] In the 1780s, additional important ports followed. Spanish communication with the Americas was disrupted during the Napoleonic wars (O'Rourke, 2006). Out of necessity, trade with neutral nations was therefore allowed. This marked the end of Spain's ability to enforce restricted trade with

[5]This was with the exception of Venezuela (Caracas), where it was believed the Caracas companies tobacco monopoly was worth protecting, and New Spain. Even so, especially Veracruz was affected by the changes before the late 1780s due to the abolition of the convoy system and the increased prevalence of register ships.

the colonies. By the beginning of the 19th century, Spanish America enjoyed *de facto* although not *de jure* unrestricted trade with foreigners (Fisher, 1998). As a result, direct trade with Britain, grew in importance (Prados de la Escosura and Casares, 1983). Independence was mostly followed by high tariffs, often driven by the revenue needs of post-independence governments. However, it also improved access to international markets, which promoted economic growth (Prados De La Escosura, 2009).

The reform was motivated by the increased revenue needs resulting from an intensified interstate competition in the 18th century (Kuethe and Andrien, 2014). Particularly important was the need for a modernized imperial defense. Highlighted as an important impetus for the reform was the "humiliating" capture of Havana and Manila by the British during the Seven Years' War. This opened a window of opportunity for reform-minded policymakers in Spain who could now justify reforming the commercial system with concerns about the territorial integrity of the empire in what has been described as a "defensive modernization" (Stein and Stein, 2003). Furthermore, the commercial expansion of Havana during the British occupation showcased the economic potential of the Spanish colonies. The reform was therefore initiated rapidly after the Seven Years' War (Fisher, 1997).

The timing of the reform is therefore mainly driven by intensified interstate competition in Europe, rather than economic development in the Americas directly. Moreover, the reform was implemented from above, and no significant ports in which the policies were applied were excluded. This is also apparent from the fact that the policies were resisted by the stakeholders in the old system such as the merchant guilds (Baskes, 2013). Finally, the decision of which ports to open was unlikely to be driven by a given port's commercial potential. This is best illustrated by considering the case of New Spain. As it was the most prosperous colony, there was concern that direct trade with New Spain would divert trade away from other regions (Fisher, 1997). Moreover, the reform in New Spain was delayed further since the Spanish crown sought to avoid confrontation with the merchant guild of Mexico City. As a result, New Spain was not subject to the reform until the late 1780s.

It is generally agreed upon that the reform promoted trade (Fisher, 1985; Cuenca-Esteban, 2008). This was recognized by contemporaries as well as in the historical literature.[6] Between 1782 and 1796, precious metals still accounted for 56.4 percent of imports, but also high-value agricultural commodities were important (Fisher, 1993). Cadiz remained the dominant port for trade with Spanish America, with an average of 76.4 percent of total exports between 1778 and 1796 (Fisher, 1997, p. 150).

[6] Floridablanca (minister under Charles III) wrote about a fortunate revolution (*feliz revolución*) when referring to Spanish export growth after 1778. When referring to Veracruz, a recent immigrant described that the city went from "gloomy and ugly" to "elegant and growing" (Stein and Stein, 2003).

3 Data

To explore the impact of lower transportation times to Europe, I construct a dataset of cities, settlements, shipping times, and trade for the Spanish Empire in the 18th and 19th centuries. I restrict the sample to locations in Spanish America that were claimed by Spain during the 18th century.[7] Summary statistics are reported in Table 2 and a more detailed data description is provided in the Appendix.

3.1 Main Data Sources

Cities. The main data set describes the population in major Spanish American cities every 50 years starting in 1600. The sample of cities is based on a reconstruction of the urban system during the late 16th century using primary sources described in Diaz-Cayeros (2022). I obtain the longitude and latitude of the historical city center as well as the legal status of each city from a gazetteer of colonial Spanish America (Stangl, 2019*c*).[8] I then keep cities designated *city* or *villa* to obtain places that were centers of Spanish settlement, governance, and economic activity before the 18th century.

I use city-level population data from Buringh (2015) made available by the

[7]The contemporary countries partly or entirely contained in the sample are Argentina, Brazil, Chile, Bolivia, Peru, Uruguay, Ecuador, Colombia, Paraguay, Venezuela, Panama, El Salvador, Honduras, Costa Rica, Guatemala, Mexico, Nicaragua, Cuba, the United States, and the Dominican Republic. This mainly excludes parts of what today are Brazil and the US states of Louisiana and Florida. These locations had limited trade with Spain throughout the period.

[8]The longitude and latitude of each city is typically the main town square, church, or cathedral.

Centre for Global Economic History at Utrecht University, which provides data for large cities after 1500. Following Bairoch (1988), they apply a threshold rule and collect data on cities with a population exceeding 5,000 inhabitants in 1850 or 20,000 inhabitants in 2000. Following Arroyo Abad and van Zanden (2016), I supplement and corroborate this database by consulting national and regional sources. These sources are largely based on population and urbanization studies, colonial censuses, and regional economic studies. Overall, I find a strong association between Buringh (2015) and the sources consulted for the period covered by this study. This approach results in a balanced panel of 62 cities for every 50 years between 1600 and 1850 which constitutes 62 cities $\times$ 6 periods $= 372$ observations. Finally, data on population density at the province and state level are from Denevan (1992) but made available by Maloney and Valencia (2016).[9]

Settlements. I supplement the analysis by combining a grid of 0.5×0.5 degrees for each decade between 1710 and 1810 which I combine with the territorial gazetteer (Stangl, 2019*c*). The gazetteer contains around 15,000 places that existed in the Spanish Empire during the 18th and early 19th century (Stangl, 2019*c*) and synthesizes various primary and secondary sources.[10] It contains the founding,

[9]The dataset combines "the most recent available geographical, anthropological, and archaeological findings" (Maloney and Valencia, 2016)

[10]"Sources include archival material like census tables, mission reports, visitations of dioceses and provinces, but also more ephemeral documents like petitions of some city council which was mostly not written for giving geographic information but may touch one specific detail or incidentally exposes some relevant information. Non-archival contemporary sources include mostly highly systematic sources for information like so-called "Foreigner Guides" (printed calendar manuals which included also lists of office holders of many parts of the Empire), maps, or geographical descriptions both printed and manuscripts." (Stangl, 2018).

and legal status, as well as the longitude, and latitude of each place. In the main analysis, I restrict the sample to places with the status of city, town, or village to capture the location of population centers. Altogether, the final dataset contains $2,125$ places that I refer to as settlements. To analyze these data, I construct an indicator variable taking the value one if a grid cell contains a settlement in a particular decade. The result is a balanced panel consisting of 11 decades $\times$ $4,871$ cells resulting in $53,581$ observations.

Shipping and trade. I use maritime logbooks from the Cliwoc 2.1 database (García-Herrera et al., 2005) to estimate sailing speed. The data was originally collected for studying historical oceanic climate and contains around 280,000 logbook entries for ships of various nationalities between 1750 and 1850. The logbook entries contain the daily longitude and latitude, wind speed, and direction as well as voyage-level characteristics such as the ship name, origin, destination, captain name, and ship type. Data on wind speed and direction of sea-surface winds by $0.5^\circ \times 0.5^\circ$ cells for each week between 2011 and 2017 is from the Global Forecasting System (GFS) atmospheric model provided by NOAA and National Centers for Environmental Prediction.

Data on trade between Spain and Spanish America at the port level for the period 1782 and 1820 is from Fisher (1985) and Fisher (1993) who collected it from primary sources, mainly from the General Archive of the Indies in Seville. It contains information on the total value of Spanish imports (1782-1796) and exports (1797-1820) to 19 ports in the Americas. Moreover, it contains data on the composition of trade and the number of ships arriving at Cadiz from a range of American ports. Furthermore, I digitized data on prices in Spain (New Castile) from Hamilton (1947) and combined this with price data from the Global Prices and Incomes Database.[11] Finally, information on urban nominal wages (measured in grams of silver) is from Arroyo Abad, Davies and van Zanden (2012).[12] I assign the country-level information to cities by assigning the same wage to cities in the same viceroyalty.

Infrastructure and borders. I use data on the location and trading status of each port in Spanish America from Stangl (2019*d*). I validate the data using the information in Fisher (1997) and the text of the original decree.[13] The list of ports can be found in Table 1. I also include the location of the principal mining centers (*Reales de Minas*) in the 18th century from Fisher (1997). I use shapefiles of courier routes to approximate the location of roads (Stangl, 2019*b*). Viceregal and *audiencia* borders are from Stangl (2019*c*) while present-day province borders are from the Global Administrative Areas dataset GADM (2024).[14] Finally, present-day country borders are from Natural Earth.

Geography and endowments. Data on agricultural suitability under rain-fed, low-input agriculture is from the United Nations Food and Agricultural Organization Global Agro-Ecological Zones (GAEZ) dataset. The staple crop in Mexico and

[11] Available at `https://gpih.ucdavis.edu/`.

[12] The data can be found in Table 4 in Arroyo Abad, Davies and van Zanden (2012).

[13] *Reglamento y aranceles reales para el comercio libre de España a Indias de 12. de octubre de 1778*.

[14] Viceroyalties and *audiencias* were basic territorial units of Spanish colonial rule. The viceroyalties were subdivided into *audiencias*, which were further subdivided into governorships and provinces (Mahoney, 2010).

the Andean countries is assumed to be maize while wheat is assumed to be the staple in Chile and Argentina. I supplement these data with the maximum attainable caloric yield using data from Galor and Özak (2015, 2016).[15] I calculate the terrain ruggedness index, average slope, and elevation using the ETOPO Global Relief Model (Amante and Eakins, 2009). I include data on potential vegetation to control for various location fundamentals and to calculate travel speeds (Ramankutty and Foley, 1999). Finally, data on the location of rivers and lakes is from Natural Earth and Stangl (2019*a*).[16]

The European economy. Europe is modeled as a city centered on Cadiz with the population and average nominal wages of Spain and its biggest European trading partners, France, and the United Kingdom in 1700. Data on total population in 1700 is from (Álvarez-Nogal and De La Escosura, 2013; Broadberry et al., 2015; Ridolfi and Nuvolari, 2021; Bolt and Van Zanden, 2024). Nominal wages for Europe are approximated by the average nominal wages of building laborers in grams of silver per day across cities in the above countries between 1700 and 1749 (Allen, 2001).[17]

[15]The potential caloric yield is chosen because the relative caloric content is economically important in a pre-industrial context. Furthermore, it isolates features of the natural environment affecting attainable yields, but that are exogenous to human intervention.

[16]I remove Lake Gatun (an artificial lake) and include information on the location of Lake Texcoco in the 18th century (Stangl, 2019*a*) to better reflect the 18th-century geography.

[17]I average the wages for London, S. Eng. towns, Paris, Strasbourg, Madrid, and Valencia.

3.2 Transportation Network Connectivity

In this section, I describe the construction of the transportation network. The procedure results in a directed graph, where nodes denote localities and edges the shipping times between adjacent nodes.

Maritime transportation. I estimate the sailing speed using data from maritime logbooks between 1750 and 1855. The dataset contains 280,280 daily logbook entries recording the date, position, wind speed, and additional variables. From each logbook entry, I calculate the average speed of travel as well as the direction of travel relative to the direction of the wind. I follow Kelly and Ó Gráda (2019) and remove observations for which the inferred speed is implausibly high (above 10 knots). I also remove observations that are recorded in coastal waters, ships that are anchored, and steamships. The final sample contains 188,723 observations with 4,837 unique voyages. I then estimate the association between sailing speed, the direction of travel relative to the direction of the wind, and wind speed using the following regression model,

$$s_{it}^{sea} = \alpha + \beta w_{it} + \omega \cos(\theta_{it}) + \lambda_{it}, \tag{1}$$

where s_{it}^{sea} denotes the average daily speed for logbook entry i between days t and $t-1$. w_{it} denotes the wind speed recorded in the logbook, θ_{it} denotes the angle between the direction of travel and the direction of the wind, while λ_{it} is an unobserved error term. I estimate the model on a training sample using ordinary least squares to obtain the predicted sailing time $\hat{s}_{it}^{sea}$. I find a positive association between sailing speed, wind speed, and sailing in the direction of the wind. The estimates are precisely estimated and robust to the inclusion of journey as well as day-fixed effects. Finally, I evaluate the fitted model on the validation sample. I find that the mean squared error in the validation sample is 2.21 which suggests that the model captures important determinants of historical sailing speeds.

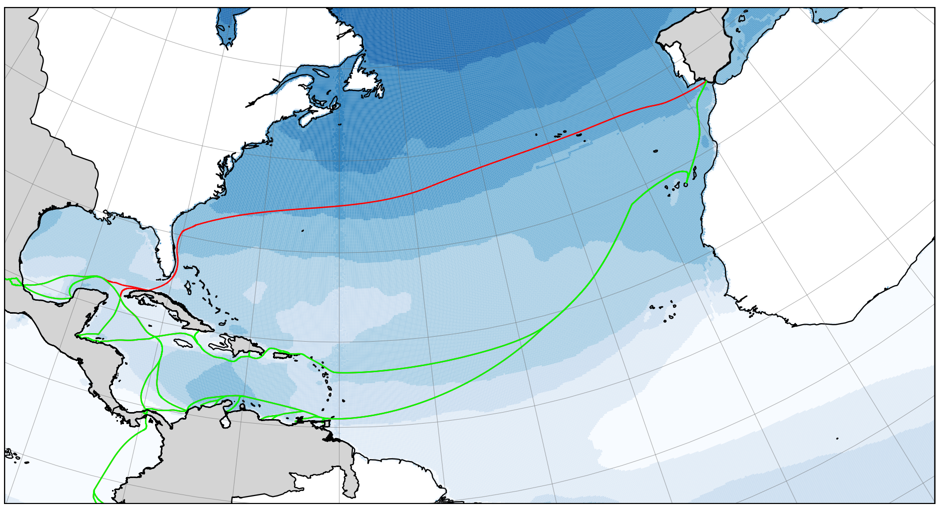

Figure 2: The figure depicts the cost surface of maritime transportation. The map plots the average cost for each $0.16° \times 0.16°$ cell where darker colors indicate higher predicted sailing speed. The cost surface is calculated by predicting sailing speeds from wind direction and speed. The estimated relationship is extrapolated on gridded data of wind direction and wind speeds covering the world's oceans. The red and green lines denote historical trade routes. Red denotes the eastward travel while green denotes the westward travel. Sources: NOAA, CLIWOC, Stangl (2019*e*).

Land transportation. Mules were the most common means of bulk transportation for most of the colonial period and up to the second half of the 19th century. I therefore calculate travel time faced by transportation with pack animals using geographical features, drawing on least-cost analysis tools. The pace will depend on whether travel occurs on a road, the slope of the terrain, the elevation, and the landcover. In particular, the transportation times between locations i and j is based on the following model

$$s_{ij}^{land} = 6\kappa_i e^{-3.5|\text{slope}_{ij}+0.05|-\gamma \text{elev}_i}, \tag{2}$$

where s_{ij}^{land} denotes the speed attained in kilometers per hour (Weiss et al., 2018).[18] Furthermore, slope_{ij} denotes the average slope between locations i and j, elev_i the elevation and κ_i is a coefficient summarizing the landcover in the origin.

I combine different sources of data to parameterize Equation 2. I use a digital elevation model to calculate the slope and elevation. To adjust for landcover, I use data from Ramankutty and Foley (1999) and rely on coefficients from Weiss et al. (2018).[19] I follow the same author by setting $\gamma = -0.0001072$. I use data on the location of courier routes on land from Stangl (2019*b*) to approximate the location of roads. I assume that travel on a road is affected by the slope and elevation, but not the landcover. I denote the predicted travel time on land $\hat{s}_{ij}^{land}$. It follows that the predicted travel speed on flat terrain on a road at sea level is around 5 kilometers per hour.

Transportation network. Equipped with measures of transportation times between adjacent locations both on land and sea, I construct a directed graph $\mathcal{N}$.

[18] While Equation 2 models walking speed, the use of pack-animals will not have affected the speed much since these were typically accompanied by humans on foot (Verhagen, Joyce and Groenhuijzen, 2019).

[19] Five terrain types have a natural mapping between historical landcover data and the terrain coefficients. These are tropical forests, temperate forests, deserts, savanna, and shrubland. The terrain factors are 0.324 in a tropical forest, 0.648 in a temperate forest, 0.97 in a savanna, 0.6 in shrubland, and 0.6 in deserts. Inland water can be crossed at half the speed (Herzog, 2014).

Edges in the graph denote cells of $0.16° \times 0.16°$ and nodes denote the transportation times. The transportation time between edges i and j is given by $\hat{s}_{ij}^{land}$ if i is on land and $\hat{s}_{ij}^{sea}$ otherwise. I assume transshipment times between transport modes of transportation are zero.

To predict the transportation time between any two locations in the network, I assume that traders used the time-minimizing routes which are calculated using the Dijkstra algorithm (Dijkstra, 1959). For locations in America, the transportation time between any two locations i and j is the time-minimizing route denoted $T_{ij} = LC(\mathcal{N})_{ij}$. Europe is treated as a point-like location centered on Cadiz since the majority of legal trade with Europe was channeled through this port. For transportation to Europe, I calculate the time-minimizing route for every decade, accounting for which ports were open to direct trade with Europe. In particular, the transportation time to Europe at time t is given by

$$T_{iet} = \min_{k \in I_t} \{T_{ik} + T_{ke}\}, \tag{3}$$

where I_t denotes the set of ports permitted to trade directly with Europe at time t.

3.3 Validation Exercises

I validate the predicted transportation times in various ways. First, I explore the association between the predicted transportation times and alternative measures. For maritime transportation, I compare the predicted transportation times to measures from a database of bilateral sailing times. For transportation on land, I compare the predicted transportation times with walking times using the Human Mobility Index (Özak, 2018) and Google Maps. These comparisons show a robust association between the above transportation time predictions and these alternative measures. This suggests that the geographical determinants of transportation times used to generate the predictions are important.

To construct the transportation network $\mathcal{N}$, I estimate Equation 1 on modern-day data on wind speed and wind direction. A potential concern is that wind patterns might have changed since the 18th century which would introduce measurement error. However, I find a positive correlation between average wind speed (0.24) and wind direction (0.33) between 2011 and 2017 and the entries reported in the logbooks. A related concern is that changes in maritime technology changed transportation times over the period. However, improvements in maritime technology were unlikely to be the most important determinant of productivity gains in shipping before the 19th century (North, 1968; Harley, 1988; Menard, 1991). This suggests that measurement error in transportation times are unlikely to change much over time. I explore this issue further in Section 5.

4 Reduced-Form Evidence

In this section, I use the changes in transportation times to examine the effects of the reform on trade and urban growth.

4.1 Transportation, Trade, and Market Integration

I first examine the evolution of the predicted transportation times from 1750 onwards. Figure 3A. depicts the transportation times for each grid cell in the years 1760 and 1810. The red curve denotes the distribution of transportation times in 1760, while the blue curve denotes the distribution of transportation times in 1810. The figure shows a leftward shift in the distribution. The reduction in transportation time ranges from 0 to 38.4 days and is 7.7 days lower on average. The pre-reform average transportation time to Europe is 92.5 days. As a result, the reduction is economically significant and ranges from 0 to 40 percent of the average.

Did lower transportation times promote transatlantic trade? Figure 3B. depicts the value of Spanish non-bullion imports from the Americas in constant prices from Cuenca-Esteban (2008). While there was no secular increase in imports before 1765, there is a positive trend coinciding with the onset of the reform. After the largest wave of port openings in 1778, the value increased nearly fourfold.[20] Exports from Spain exhibit a similar pattern for the period between 1778 and

[20]The slightly delayed response is explained by the Spanish involvement in the American Revolutionary War which disrupted trade. It could also in part be driven by capacity constraints in newly opened ports.

1796, as is depicted in Figure 4. Seen together, the timing of the increase in trade suggests that the reform promoted trade.

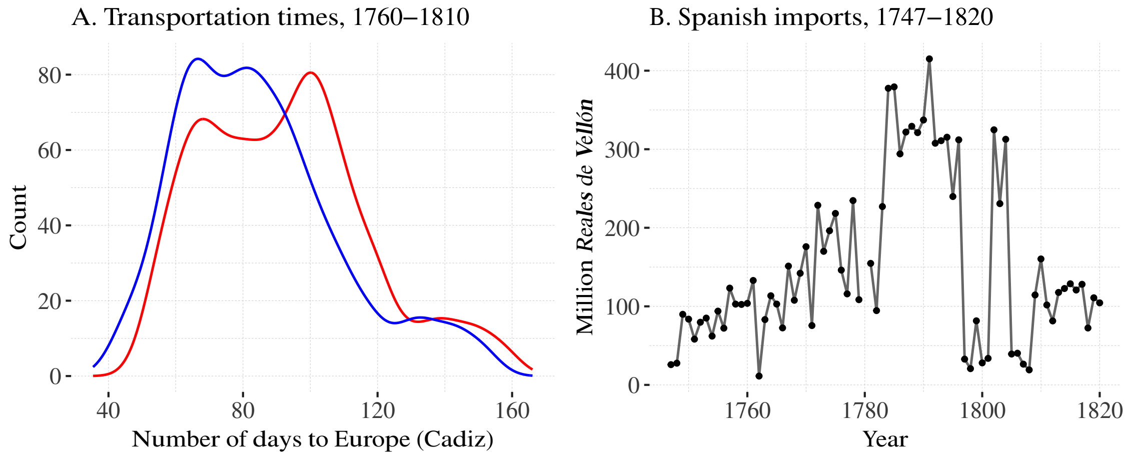

Figure 3: Panel A depicts the number of days travel from a grid cell to Europe in 1760 (red) and 1810 (blue) for the grid cells in the sample. Panel B depicts the value of private non-bullion imports to Spain from American ports between 1747 and 1820 at constant prices. The sharp decline from 1796 is due to the British blockade of Cadiz. Data for 1782 is missing in the original source. Data are from Cuenca-Esteban 2008 (Appendix table 5).

How was this increase in trade distributed across different ports? Let ΔT_{ie} denote the change in transportation time to Europe from port i (i.e. $\Delta T_{ie} = T_{ie1760} - T_{ie1800}$). Figure 4 displays the number of ships and the total value of imports to Spain originating from treated ($\Delta T_{ie} > 0$) and untreated ($\Delta T_{ie} = 0$) ports. As can be seen, the increase in Spanish imports from Spanish America is driven by both the treated and untreated ports. However, the *increase* is likely to be larger for the treated ports as trade with treated ports prior to the reform was more limited.[21] A concern is that imports from treated ports were underreported before the reform. However, this is less plausible when considering imports in Cadiz which was the port most closely monitored by the crown (Fisher, 1985,

[21]See e.g. Walker, 1979, p. 230, for the number of register ships arriving in Spanish America 1701-1740.

p. 32). Furthermore, the increase not only in the value of trade but also in the number of ships is not consistent with smuggling explaining the increased trade volume.

If lower transportation times drove the increase in trade with Europe, we might observe price convergence for traded goods in Spain and Spanish America. To explore this, I collect data on prices for various commodities (wine, salt, sugar, wheat) in Spain (New Castile) and various locations in Spanish America (Peru, Bolivia, Argentina, Chile, Colombia, Mexico) between 1700 and 1800. For each location, I construct a price index as the average price across the commodities for which there is data.[22] I then consider the ratio of the Spanish price index relative to the average American price index.

These results are presented in Panel D of 4. As can be seen, the prices measured in silver are lower in Spain. However, beginning in the second half of the century, the price differential declined. This is broadly consistent with the evidence presented in Gallo and Newland (2004).[23] While this is consistent with improved market integration, it is subject to important caveats. In particular, there are few commodities and several missing values are imputed. Moreover, there are confounding factors such as conflict that cannot be fully accounted for in a single time series. However, when considered jointly, the timing of the increase in trade, the increase in imports originating from treated ports, the reduction in

[22]Details on the variable construction can be found in the Appendix.

[23]Specifically, they find Table 1 shows a similar pattern for the commodities and regions they consider.

shipping times, and price convergence is consistent with lower transportation times promoting trade through market integration.

4.2 Transportation and Urban Growth

How did lower transportation times to Europe affect urban growth? To explore this question, I consider the following model,

$$\ln L_{it} = \lambda_i + \gamma_t + \beta T_{it} + X'_{it}\eta + u_{it}, \tag{4}$$

where L_{it} denotes the population and T_{it} the transportation time to Europe for city i at time t. The coefficient of interest β captures the percentage change in population for city i for a one-day change in T_{it}. λ_i denotes a city fixed-effect which controls for time-invariant unobserved location fundamentals such as agroclimatic characteristics, or the disease environment. I also include time-fixed effects γ_t, to capture all time-varying shocks that are common across cities. Given the long time dimension of the panel, it is likely that the influence of various location fundamentals changes over time. I therefore interact observable location fundamentals with year indicators in the vector X'_{it}.[24] u_{it} is an unobserved error term potentially correlated over time within cities. Standard errors are therefore

[24]The baseline controls are caloric potential, elevation, distance to the nearest coast, terrain ruggedness, distance to the nearest lake, distance to the nearest river, an indicator for a city being in the vicinity of a mine, maize suitability, and wheat suitability. To proxy for the disease environment, I construct an indicator variable that takes value 1 if the average elevation is above 1500m and control for distance to the coastline. Hong (2007) shows that the main predictors of deaths due to malaria in North American frontier forts in the 19th century are variables related to climate and elevation.

clustered at the city level in the baseline model.

The causal interpretation of β is based on the assumption that u_{it} is similar on average for cities, conditional on covariates. This is unlikely to hold if unobserved factors affect both urbanization and transportation times. For instance, if ports emerge in cities with favorable location fundamentals, urban development would be observed in port cities even in the absence of a port. However, city-fixed effects will absorb all time-invariant unobserved heterogeneity, including location fundamentals. A related concern is that the transportation network is shaped by urban growth, such as roads emerging to connect growing urban centers. This is also unlikely since the transportation times are constructed using pre-determined geographical characteristics only. A further possibility is that the reform targeted cities with high anticipated growth or commercial potential. However, as discussed in Section 2 this is also unlikely as there was reluctance to open the wealthiest ports for fear of diverting trade from smaller ports (Fisher, 1997, p.139). Furthermore, most settled areas were eventually subjected to the reform. I address these issues further in Section 4.5.

Table 3 reports the estimated effects of transportation times to Europe on the urban population size. Across all the specifications, I find a negative association between transportation times and urban population size. In the baseline specification in Column (1), containing both city and time fixed effects, I find that a one-day increase in the transportation time to Europe leads to an around 2.6 percent decrease in the urban population ($\hat{\beta}$ =-0.026). To put this in context, a

Table 3: Shipping time and urban population growth

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	−0.026	−0.018	−0.033	−0.030	−0.033
	(0.009)	(0.013)	(0.016)	(0.010)	(0.014)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.688	8.688	8.688	8.688	8.688
N	372	372	372	372	372
R^2	0.882	0.899	0.889	0.920	0.885

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The unit of observation is a city between 1600-1850. Regressions are based on a balanced panel of 6 time periods (outcomes measured every 50 years) × 62 cities = 372 observations. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level (62 clusters).

one-day increase in the transportation time to Europe constitutes a 1.5 percent increase for a city with an average transportation time in 1760. The estimates are precisely estimated across the various specifications. As one period in the panel constitutes 50 years, the estimates should be interpreted as capturing the long-term adjustment to a change in transportation times to Europe.

Did the reform also lead to the emergence of new settlements? I explore this by estimating Equation 4 as a linear probability model where the dependent variable is an indicator of whether a grid cell contains a settlement in a given decade. The model is estimated between 1710 and 1810 and the results are displayed in Table 4. Across the various specifications, the estimates are negative but small in magnitude. In the baseline specification in Column (1), I find that a ten-day increase in the transportation time to Europe reduced the probability of a grid cell containing a settlement by one percentage point. This is from a sample average of around 11 percent of cell year pairs containing a settlement. These findings suggest that lower transportation times to Europe primarily affected the location of economic activity through increasing the size of existing cities, rather than expanding the frontier of settlement to new areas.

4.3 Heterogenous Effects of Transportation Times

The cities in the sample differed in endowments, age, remoteness, and consequently size during the 18th century. Building on Henderson et al. (2018), I explore the heterogeneity of the estimates presented in Section 4.2 along these dimensions in two ways. First, I follow Mahoney (2010) and define macro-regions based on modern-day countries.[25] The *core* regions before the 18th century are defined as Mexico, Peru, and Bolivia which were the most important areas for Spanish settlement and economic activity (Mahoney, 2010, p. 50). The remaining countries are defined as the periphery or semi-periphery. I group these latter countries which I label the *fringe* regions to obtain two roughly equally sized groups of countries. Second, I split the sample into large and small cities, depending on whether the population size was above or below the median at the

[25]The colonial core consists of Mexico, Peru, and Bolivia, the colonial semiperiphery consists of Guatemala, Ecuador, and Colombia, while the periphery consists of Uruguay, Argentina, Chile, Paraguay, El Salvador, Honduras, Nicaragua, Costa Rica (Mahoney, 2010, p. 50)

beginning of the sample. I then proceed to estimate Equation 4 separately for the different samples.

The results are presented in Panels A and B of Table 5. In the preferred specification, the marginal impact of lower transportation times to Europe is more precisely estimated in the fringe region. While a one-day increase in the reduces the logarithm of the population size by ($\hat{\beta}$ =-0.018) in the baseline specification for the fringe region, the effect is indistinguishable from zero in the core region. The results for small and large cities are presented in Panels C and D of Table 5 and mirror these findings. Here the effects are larger and more precisely estimated for smaller cities. This further suggests that the average effect found in Section 4.2 is driven by the less economically developed fringe regions of Spanish America.

4.4 Persistence of Economic Activity

Did the permanent change in transportation times to Europe change the persistence of the pre-reform settlement pattern? I explore this question, by estimating the elasticity of the contemporary to the pre-reform population size across different locations. I consider the following model,

$$\ln L_{it} = \alpha + \rho \ln L_{it'} + \theta X_i' + \varepsilon_{it}, \tag{5}$$

where L_{it} denotes the population size of location i (a city or a province) in year 2000, $L_{it'}$ denotes the population size in year 1500 or 1750, X_i' again denotes a vector of location fundamentals, and ε_{it} is an unobserved error term. The parameter of interest, ρ is the elasticity of the contemporary population size to the pre-reform population size.

I estimate Equation 5 separately for locations that were differentially exposed to the reform. This assumes that locations that experienced different changes in shipping time would have had similar elasticities ρ in the absence of the reform, conditional on observable location fundamentals. Proxying historical location fundamentals with contemporary data requires additional assumptions. In particular, I assume that the location fundamentals change with the same factor across different cities and provinces within the same country. Measurement error that varies at the country or viceroyalty level is again absorbed by fixed effects. I explore these points in more detail in the Appendix. Finally, standard errors are clustered at the city/province level in the main specifications.

Table 6 displays the results. Panel A displays the elasticities for the sample of cities. The elasticity for the full sample is 0.584. Columns (3) and (4) display the elasticities for the cities with below-median changes in the transportation time to Europe. For this sample, the elasticity is larger, 0.897. For the sample with large changes in the transportation times, the elasticity is smaller (0.582). This association holds when controlling for location fundamentals, but is based on few observations and should therefore be interpreted with caution.

Panel B repeats this exercise by using data on provinces from Maloney and Valencia (2016). Consistent with their findings, there is a high degree of persistence of population density. However, this is again attenuated for the sample that experienced large changes in transportation times to Europe. Across the specifications, the differences between the samples are statistically significant. Moreover, following Maloney and Valencia (2016) by including country fixed-effects to control for differences in national institutions, I find that the pattern is robust to the inclusion of these additional controls. In sum, across both the samples the findings are consistent with changes in transportation times affecting urban growth which in turn attenuated the persistence of pre-reform settlement patterns. This provides further evidence that the location of economic activity adjusted to changes in the location of trading opportunities in the long run.

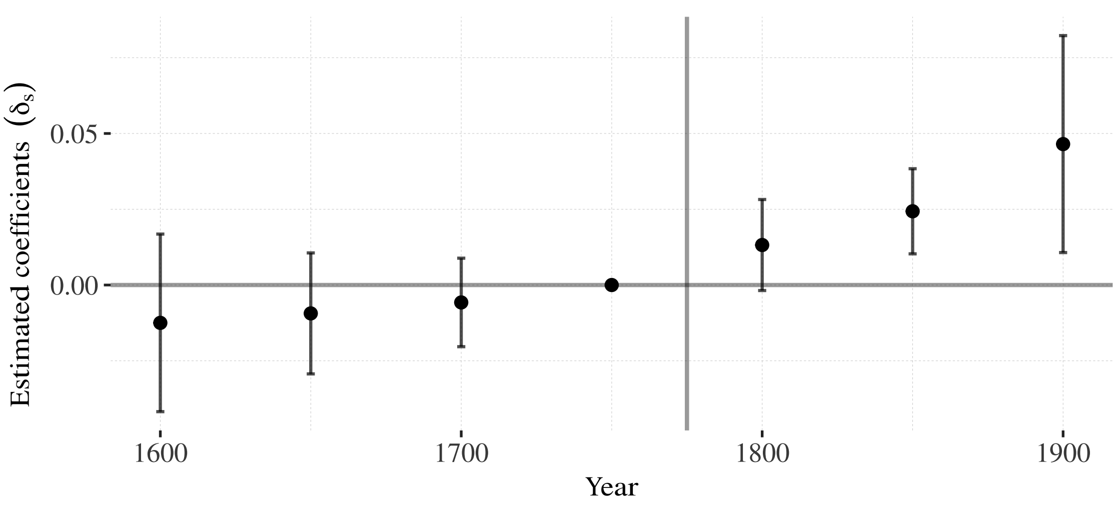

Figure 4: The figure depicts the estimated coefficients of the reduction in transportation times to Europe interacted with time indicators from Equation 6. *Dependent variable:* The log of the city population. *Observations:* 62 cities observed every 50 years. $62 \times 7 = 434$ observations. *Standard errors:* Clustered at the city level. 62 clusters.

4.5 Sensitivity Analysis

In this section, I assess the main identification assumption. I begin by considering a dynamic version of Equation 4 where I interact the decline in transportation time with time indicators. Specifically, I estimate the following model

$$\ln L_{it} = \mu_i + \theta_t + \sum_{s=1600}^{1900} \mathbb{1}[t = s]\Delta T_i \times \delta_s + \epsilon_{it}, \tag{6}$$

where the variables are defined as in Equation 4. The coefficients δ_s, denote the difference in population between differentially exposed cities in year s relative to the difference in 1750 (the last observation before the reform). The estimated coefficients and 95 percent confidence intervals are presented in Figure 4. Consistent with the identification assumption, Figure 4 shows no significant difference in population growth in areas with different exposures to the reform before 1750. This is consistent with the assumption that differentially exposed cities would have evolved similarly in the absence of the reform. Alternative specifications are presented in the Appendix, where I also show the estimates for the formation of settlements, and for the different sub-samples explored in Section 4.3, schowing little evidence of pre-trends. Further support of this assumption is also provided through an alternative research design based on the synthetic control method (Abadie, 2021) which is presented in the Appendix.

Even though all large ports were eventually allowed to trade directly with Europe, and even though the historical literature suggests otherwise, it cannot be ruled out that the timing with which ports opened was driven by their economic potential. While any time-invariant unobserved heterogeneity will be captured by city-fixed effects, a concern is if policymakers targeted ports in anticipation of higher future economic growth. To address this concern, I estimate Equation 4 for cities that were far away from ports (distance to a port greater than the sample median). Since these cities were unlikely to be directly targeted by the reform, it is reassuring that the estimates are similar. A further concern is the effect of other administrative, ecclesiastical, and military reforms that were conducted in Spanish America in the 18th century (see e.g. Valencia, 2019; Chiovelli et al., 2024). However, much of this time-variant heterogeneity is likely to be common across administrative regions and therefore captured by region (viceroyalty or country) times year fixed effects. A possible exception is the formation formation of two new viceroyalities in the 18th century, *Río de la Plata* and *Nueva Granada*. To assess this concern, I estimate the Equation 4 after dropping cities in these viceroyalties. I find that the coefficients are similar in these cases, although unsurprisingly less precisely estimated. These results are also reported in the Appendix. Finally, I consider the influence of independence from Spain by estimating the model only up to 1800. For the full sample I find similar point estimates, but again less precise. To increase precision I estimate the model for smaller cities, for which the effects are more precisely estimated in the main analsysis. For all the cases above, I find a similar and precisely estimated effect for smaller cities.

Here I briefly discuss the main additional sensitivity checks for the results in Table 3. First, I remove cities that are outliers in terms of pre-reform population growth. I also consider specification when observations are weighted by population size. Furthermore, I calculated standard errors accounting for spatial correlation in line with Conley (1999). To assess the stability of the coefficients in Table 3 when including controls, I implement the approach developed in Cinelli and Hazlett (2020). Taken together, these exercises support the causal interpretation of the estimates. Further details are reported in the Appendix.

4.6 Discussion

The findings above suggest that the location of economic activity adjusted to changes in transportation times to Europe. Yet, the average effect masks heterogeneity and the effect is primarily driven by smaller cities and cities located in the fringes of the Spanish Empire. Several possible mechanisms can explain this overall pattern.

First, the core and fringe regions differed level of urban development which might affected their reliance on long-distance trade. Specifically, location fundamentals that enabled high pre-colonial population density shaped the early colonial urban structure (Maloney and Valencia, 2016). Subsequent investment in durable and sunk factors, such as irrigation, canals, and roads, along with agglomeration economies further reinforced urban development in the core regions which was high by early modern standards (Arroyo Abad and van Zanden, 2016). Furthermore, the core regions were less remote also prior to the reform. While these areas were clearly favored by Spanish commercial policy, pre-colonial cities also emerged in locations with fundamentals that enabled interactions with its hinterland (see e.g. Hassig, 1993). Both these factors suggest that cities in the core regions had larger internal markets, reducing their reliance on long-distance trade (see e.g. Redding and Sturm, 2008).

Beyond initial conditions, the nature of the shock itself might have led to different effects in the core and fringe regions. For example, the initial system of trade was designed to channel trade through the core regions. As a result, the reform lowered transportation times more in the fringe regions with smaller cities. Additionally, while the reform promoted trade with Europe and did not differentially target migration costs in treated ports, improved commercial linkages might have facilitated migration. Specifically, lower transportation times for trade could for example have lowered migration frictions by facilitating the flow of information about new migration opportunities (Pérez, 2013). Although migration from Spain was limited in the 18th century, the importance of destinations like Argentina, Venezuela, and Cuba increased during the 18th century (Pérez-Artés, 2023). This learning channel might therefore have contributed to driving urban growth in the fringe regions.

To understand how the location of economic activity adapts to changes in transportation times over the long run, it is crucial to distinguish between the various channels. In the next section, I construct a dynamic spatial model that nests these channels. I then parameterize the model to match salient features of the data and simulate the reform, turning on and off the different mediating channels described above to shed light on potential mechanisms.

5 A Model of Trade and Persistence

In this section, I explore potential mechanisms and long-term implications through the lens of a dynamic spatial general equilibrium model that I calibrate to match the observed data. The model closely builds on Allen and Donaldson (2022).

5.1 Theoretical Framework

Geography, endowments, and timing. The model consists of R cities and T discrete time periods indexed by i and t respectively. Cities differ in their endowments of productivity $\mathcal{A} = \{\bar{A}_i\}_{i=1}^{R}$, arable land $\mathcal{H} = \{\bar{H}_i\}_{i=1}^{R}$, and their connections to other cities. Trade between cities is subject to iceberg trade costs captured by the matrix $\mathcal{T}_t = \{\tau_{ijt}\}_{i,j \in R}$ where $\tau_{ijt} \geq 1$. Migration costs between cities are given by the matrix $\mathcal{M}_t = \{m_{ijt}\}_{i,j \in R}$ where $m_{ijt} \geq 1$. Following Allen and Donaldson (2022), cities are inhabited by agents living for two periods of 50 years. There are L_{it} individuals in their second period of life (old) who supply one unit of labor inelastically, consume goods, give birth to one individual, and then die.[26] Individuals in the first period of life (young) choose where to live

[26]Fertility is exogenous as Malthusian forces likely operated at longer time horizons (see e.g. Chaney and Hornbeck, 2016; Bouscasse, Nakamura and Steinsson, 2021).

at the beginning of their second period. Finally, $\mathcal{L}_0 = \{L_{i0}\}_{i \in R}$ denotes the old population across the R cities at time 0.

Preferences. Preferences are defined over a composite of differentiated varieties C_{it} and a non-traded good f_{it},

$$u_{it} = \left(\frac{C_{it}}{\mu}\right)^{\mu} \left(\frac{f_{it}}{1-\mu}\right)^{1-\mu}, \tag{7}$$

where $C_{it} = \left(\sum_{j \in N} b_{ji}^{\frac{1}{\sigma}} c_{jit}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$. c_{jit} is the amount of the j variety consumed in city i and b_{ji} is an exogenous preference shifter that sums to one.[27] I assume that $b_{ij} = b$ if i or j are on different continents (Europe and America) and b' otherwise. The expenditure shares of C_{it}, f_{it} and c_{jit} are given by μ, $1-\mu$, and $\mu_{jit} = b_{ji}(p_{jit} \ / \ P_{it})^{1-\sigma}$ respectively where $P_{it} = \left(\sum_{j \in N} b_{ji} p_{jit}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ is the price index for the differentiated varieties. As a result, the real income in city i at time t is given by $V_{it} = w_{it} \ / \ \mu P_{it}^{\mu} r_{it}^{1-\mu}$.

Technology and market structure. Cities produce a unique variety q_{it} with a constant returns to scale technology where $q_{it} = A_{it} L_{it}$. A_{it} is given by $A_{it} = \bar{A}_i L_{it}^{\alpha_1} L_{it-1}^{\alpha_2}$ and captures dynamic and static agglomeration economies.[28] There is perfect competition in all goods and factor markets.[29] The price of the city i

[27] Long-distance trade during the 18th century was largely limited to non-competing goods (Findlay and O'Rourke, 2007) which is consistent with the assumption that each location produces a unique variety.

[28] A variety of channels such as knowledge spillovers, input sharing, and location-specific capital, might have induced static agglomeration economies in pre-industrial cities (Jedwab, Johnson and Koyama, 2022). Allen and Donaldson (2022) show that the dynamic structure can be micro-founded in different ways including the persistence of local knowledge or durable investment in local productivity.

[29] Allen, Murphy and Schneider (2012) provide evidence that in the long run, real wages

variety is therefore given by $p_{it} = w_{it} \ / \ A_{it}$. Furthermore, the non-traded good is produced using a linear technology using land $\bar{H}_i$ as the only input. Let F_{it} denote the aggregate supply of the non-traded good f_{it}. The market clearing implies that $F_{it} = f_{it} L_{it}$ and the rents derived from the non-traded good in equilibrium are given by $r_{it} = (1-\mu) Y_{it} \ / \ \bar{H}_i$ where Y_{it} denotes the total income of city i. These rents are distributed lump-sum to all inhabitants in the city.

Trade. Since traded varieties can be transported across cities subject to iceberg trade costs, the price faced by consumers in city i for good a good originating in j is given by $p_{jit} = \tau_{jit} w_{jt} \ / \ A_{jt}$. The value of goods transported from city j to i denoted X_{jit}, thus takes the standard gravity form given by

$$X_{jit} = b_{ji} \tau_{jit}^{1-\sigma} \left(\frac{w_{jt}}{A_{jt}} \right)^{1-\sigma} \mu Y_{it} P_{it}^{\sigma-1}, \tag{8}$$

where Y_{it} again denotes the aggregate income in city i at time t.

Migration. Young agents can migrate to other cities over which they have heterogeneous preferences.[30] This is captured by a preference shifter $\varepsilon_t = \{\varepsilon_i\}_{i=1}^{R}$ which scales the deterministic utility. ε_t is assumed to be *i.i.d.* and drawn from a multivariate Fréchet-distribution with shape parameter θ. At the beginning of the second period, young individuals choose locations to maximize utility. Consequently, the utility attained by an individual born in city i is given by

responded to changes in labor scarcity in the context of Spanish America.

[30] Legal restrictions on labor mobility and coercive labor institutions had diminished in importance by the end of the 18th century (Arroyo Abad and Maurer, 2019).

$\max_{j \in R} \frac{V_{jt}}{m_{ijt}} \varepsilon_{jt}$. The fraction of agents in city i moving to j in period t is therefore given by,

$$\pi_{ijt} = \frac{(V_{jt} \;/\; m_{ij})^{\theta}}{\sum_{k \in R} (V_{kt} \;/\; m_{ik})^{\theta}}. \tag{9}$$

The number of individuals moving from i to j is the $L_{ijt} = L_{it-1} V_{jt}^{\theta} \Pi_{it}^{-\theta} m_{ij}^{-\theta}$ where $\Pi_{it}^{\theta} = \sum_{j \in R} m_{ij}^{-\theta} V_{jt}^{\theta}$.

Equilibrium and steady state. For each city and in every period all firms and individuals optimize and markets clear. An equilibrium is given by the sequence $\{L_{it}, w_{it}, V_{it}, \Pi_{it}\}_{i \in R}$ such that goods markets clear ($w_{it} L_{it} = \sum_{k \in R} X_{ikt}$), trade is balanced ($\sum_{k \in R} X_{ikt} = \sum_{k \in R} X_{kit}$), the total population equals the population arriving at a location ($L_{it} = \sum_{k \in R} L_{jit}$), and the total population in the last period equals the number of people exiting a location between $t-1$ and t ($L_{it-1} = \sum_{k \in R} L_{ijt}$). A steady state is an allocation such that $L_{it} = L_{it-1}$ for all cities $i \in R$. The existence of the equilibrium and steady state depends on the strength of the static and dynamic agglomeration forces relative to the dispersion force which arises from the fixed availability of arable land. Using results in Allen and Donaldson (2022) and Allen, Arkolakis and Li (2024), I provide conditions for the existence and uniqueness of the equilibrium and steady state in part B of the Appendix.

5.2 Trade and persistence in partial equilibrium

The model can be used to interpret the reduced-form patterns results in Section 4. Iterating backward gives the following expression for the equilibrium city size,

$$\begin{aligned}\ln L_{it} = \psi + \left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^t \ln L_{i0} - \frac{\sigma}{\nu}\sum_{k=0}^{t-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln V_{it-k} \\ -\frac{\mu(2\sigma-1)}{\nu}\sum_{k=0}^{t-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln P_{it-k} + \tilde{A}_i + \tilde{H}_i,\end{aligned} \tag{10}$$

where $\tilde{A}_i = \ln \bar{A}_i\mu(\sigma-1)\sum_{k=0}^{t-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k$ and $\tilde{H}_i = \ln \bar{H}_i\sigma(1-\mu)\sum_{k=0}^{t-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k$. This equation gives the equilibrium population size of city i as a function of the city's path of productivity, endowment of land, population size (L_{i0}), and access to trading opportunities (P_{ik}). The price index summarizes the role of trade costs in city growth.

First consider the *direct* impact of a change in historical trade costs to Europe at time k, denoted by τ_{iek}, on the population size of the city i at time t while ignoring equilibrium spillovers. The elasticity of city size at time t to a change in the price index at time k is given by $-\left(\mu(2\sigma-1)\,/\,\nu\right)\left(\alpha_2\mu(\sigma-1)\,/\,\nu\right)^k$. Since the price index is increasing in the trade cost to Europe in period k, it follows that lower historical trade costs to Europe increases the population size in period t when $-\left(\mu(2\sigma-1)\,/\,\nu\right)\left(\alpha_2\mu(\sigma-1)\,/\,\nu\right)^k < 0$. Equation 10 also suggests that the impact of historical trade costs is attenuated by the city's size. If $\partial P_{ik}\,/\,\partial \bar{A}_{ik} < 0$, it follows that the impact of a change in τ_{iek} is attenuated in larger cities. Intuitively, external trade costs matter less for the price index in larger markets. As a result, the effect of changes in the location of trading opportunities has a smaller effect on the spatial pattern of growth in locations with larger cities.

Next, I consider the persistence of the pre-reform settlement patterns documented in 4.4. While the persistence elasticity in Equation 10, $\alpha_2 \mu(\sigma - 1) \;/\; \nu$, does not depend on trade costs, this might not be the case for the observed association between L_{i0} and L_{it}. In particular, the association might be weaker in locations that have experienced larger changes in trade costs. Furthermore, since the price index might be less sensitive to changes in trade costs for larger cities, L_{it} will to a larger extent resemble L_{i0} in cities that were larger at the time they experienced changes in the location of trading opportunities. As a result, the observed persistence between the pre and post-reform settlement pattern is weaker in locations that experienced changes in the location of trading opportunities and were less urbanized when these changes occurred. Naturally, except $\tilde{A}_i$ and $\tilde{H}_i$, the variables in Equation 10 are jointly determined in equilibrium. The effects will depend on the parameterization as well as interactions across cities. I explore these issues by simulating the model.

6 Quantitative Analysis

In this section, I discuss the parameters of the model and the main counterfactual exercises.

6.1 Taking the model to the data

There are six parameters, two vectors of fundamentals, the trade cost matrix, and the migration cost matrix given by,

$$\Lambda = \{\sigma, \theta, \mu, b, \alpha_1, \alpha_2, \mathcal{A}, \mathcal{H}, \mathcal{T}, \mathcal{M}\}. \tag{11}$$

The estimation of Λ proceeds in four steps. First, I select parameters from the literature and match the trade and migration costs to corresponding reduced-form estimates to recover $\mathcal{T}$ and $\mathcal{M}$. Second, I use the equilibrium conditions to calculate $\{p_{it}^{\sigma-1}, P_{it}^{\sigma-1}, V_{it}^{\theta}, \Pi_{it}^{\theta}\}_{i\in R}$ from observed population and nominal wages $\{L_{it}, w_{it}\}_{i\in R}$. Third, I estimate the structural version of the reduced-form equations to estimate α_2. In a final step, $\mathcal{A}$ and $\mathcal{H}$ are chosen such that the model equilibrium exactly matches the spatial distribution of population and nominal wages in 1750. I elaborate on the steps of this procedure as well as the underlying assumptions for identifying the parameters below.

Trade and migration costs. I make the following parametric assumptions about trade and migration costs. First, trade costs depend on transportation time with

Table 7: Baseline model parameters

Parameter	Value	Description
α_1	0.055	Productivity spillover
α_2	0.059	Historical productivity spillover
κ	0.513	Elasticity of trade wrt. time
λ	0.363	Elasticity of migration wrt. time
σ	5	Elasticity of substitution
b	0.295	Preference parameter
θ	3.18	Shape parameter
μ	0.5	Share of expenditure on traded goods

Note: The table reports the baseline model parameters. α_2, κ, λ, and b are estimated directly from the data. μ, σ, α_1, and θ are taken from the literature.

a constant elasticity where $\tau_{ijt} = T_{ijt}^{\kappa}$. Motivated by Equation 8, I estimate the transportation time elasticity of trade flows from a gravity model with viceroyalty fixed effects of imports to Spain from Spanish America by port of origin. I then match the estimated elasticity to $\kappa(\sigma - 1)$. A shortcoming of this analysis is that there is no data on trade between American ports, as a result, it is not possible to control for multilateral resistance terms. Similarly, migration costs are also assumed to depend on transportation time with a constant elasticity $m_{ijt} = T_{ijt}^{\lambda}$. Using Equation 9, I follow the same approach and match the migration elasticity of transportation time from a gravity model to $-\lambda\theta$. In both cases, the gravity models are estimated using the PPML estimator (Silva and Tenreyro, 2006).

Historical scale spillover. Given data on $\{L_{it}, L_{it-1}, w_{it}\}_{i \in R}$, I use the equilibrium conditions to solve for $\{p_{it}^{\sigma-1}, P_{it}^{\sigma-1}, V_{it}^{\theta}, \Pi_{it}^{\theta}\}_{i \in R}$. Combining the equilibrium conditions and taking logs gives,

$$\nu \ln L_{it} = \phi - \sigma \ln V_{it} - \mu(2\sigma - 1)\ln P_{it} + \alpha_2 \mu(\sigma - 1)\ln L_{it-1} + \eta_i, \quad (12)$$

where $\nu = \mu + \sigma(1-\mu) + \alpha_1\mu(1-\sigma)$, $\eta_i = \sigma(1-\mu)\bar{H}_i + \mu(\sigma-1)\bar{A}_i$, and ϕ is a constant term. Equation 12 highlights two key issues. First, the elasticity of contemporaneous population size with respect to the previous period's population size depends on the historical agglomeration spillover. Second, the contemporaneous population size directly depends on the location productivity and availability of land through η_i which is unobserved in the data. Moreover, since cities with favorable location fundamentals attract people also in the previous period, η_i can be correlated with the remaining explanatory variables. This highlights the importance of accounting for location fundamentals as well as institutional factors when examining the association between the contemporaneous and past city populations.

In light of these issues, I estimate the following regression model

$$\ln L_{it} = \phi_0 + \phi_1 \ln V_{it} + \phi_2 \ln P_{it} + \phi_3 \ln L_{it-1} + X_i'\omega + \mu_i, \quad (13)$$

where X_i' is the same vector of controls as in Equation 4.[31] ϕ_3 denotes the elasticity of the contemporary with respect to past population size and is the

[31] X_i' includes elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake.

parameter of interest. The identification assumption is that location fundamentals are accounted for by observable geographical determinants that were important in the context and regional fixed effects, that is $E[\mu_i | V_{it}, P_{it}, L_{it-1}, X_i'] = 0$. As in Section 4.2, the standard errors are clustered at the city level.

Model inversion. Finally, given a trade cost matrix, migration cost matrix, and the full set of parameters, $\mathcal{A}$ and $\mathcal{H}$ are calculated by inverting the model (see e.g. Redding and Rossi-Hansberg, 2017). Specifically, $\mathcal{A}$ and $\mathcal{H}$ are chosen to make the equilibrium nominal wages and city population sizes in 1750, exactly match these objects in the data. Further details are provided in Section B of the Appendix.

Parameters. Table 7 reports the resulting baseline model parameters. I begin by choosing parameters from the literature. μ is set to 0.5 which is the mid-range of the approximation of the share of GDP derived from land for colonial Mexico and Peru in (Arroyo Abad and van Zanden, 2016). I set σ equal to 5 which is consistent with findings in (Simonovska and Waugh, 2014). Using data at the port level between 1797 and 1820 from (Fisher, 1993) I find a transportation time elasticity of -2.05. This is somewhat larger than -0.8 which Pascali (2017) finds for the second half of the 19th century.[32] This gives a trade cost elasticity of transportation time of 0.513. b is chosen such the share of Spanish imports from the Americas in 1750 matches 25 percent (Prados de la Escosura and Casares, 1983). This results in b equal to 0.295. To my knowledge, there are no estimates for

[32] Using data on imports to Spain between 1782 and 1796 the estimate is imprecise.

how responsive migration flows are to differences in real wages across locations in this setting. I therefore set θ equal to 3.18 as found in Bryan and Morten (2019). I find that $-\lambda\theta$ equals -1.16. This results in a migration cost elasticity of 0.363. Estimates of α_1 typically fall between 0.04 and 0.07 (Combes and Gobillon, 2015). I choose a value in the mid-range of 0.055 as a baseline. Equipped with these parameter values, ϕ_3 identifies the historical scale elasticity α_2. In the preferred specification, containing controls for location fundamentals, this results in $\alpha_2 = 0.059$. This is somewhat smaller than what is found in Allen and Donaldson (2022). I explore the sensitivity of the counterfactual exercises to alternative parameter values below. For the baseline parameters described here, I find that there exists a unique equilibrium and steady state of the model.

6.2 Counterfactuals

Benchmark counterfactual. The counterfactual exercises compare the long-run equilibrium in two alternative scenarios. The first scenario keeps transportation times fixed at 1760 levels, while the second scenario considers the reductions in transportation costs described in Section 4. For each scenario, I simulate the model forward 300 years. The baseline simulation considers reductions in trade *and* migration costs, however, I also report the results when keeping migration costs fixed. These can be interpreted as upper and lower bounds on the influence of migration costs. The objects of interest are ΔP, ΔL, and ΔV which denote the percentage change in the traded variety price indices, population size, and real

Table 8: Counterfactuals

Scenario:	Benchmark		Fixed migration frictions	
	Mean	25th/75th perc.	Mean	25th/75th perc.
Panel A: All cities				
$\Delta P(\%)$	-0.62	[-0.71, 0.01]	-0.55	[-0.68, 0.01]
$\Delta L(\%)$	1.3	[-0.07, 1.34]	0.64	[-0.02, 0.77]
$\Delta V(\%)$	-0.13	[-0.09, 0.02]	0.16	[0, 0.2]
Panel B: Core region				
$\Delta P(\%)$	-0.12	[0, 0.01]	-0.11	[0.01, 0.01]
$\Delta L(\%)$	0.24	[-0.07, -0.03]	0.12	[-0.03, -0.01]
$\Delta V(\%)$	-0.02	[0.01, 0.02]	0.03	[0, 0.01]
Panel C: Fringe region				
$\Delta P(\%)$	-0.93	[-1.27, 0.01]	-0.83	[-0.96, 0.01]
$\Delta L(\%)$	1.97	[-0.07, 3.37]	0.97	[-0.01, 1.11]
$\Delta V(\%)$	-0.21	[-0.26, 0.02]	0.23	[0, 0.26]

Note: The table reports the results from the baseline counterfactual exercises. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The *Benchmark* assumes migration frictions change. *Fixed migration frictions* assume migration frictions remain fixed at 1760 values. The unit of observation is a city.

income for Spanish American cities across the two scenarios.

The results are presented in Panel A of Table 8. The reduction in transportation costs to Europe reduces the price index by -0.62 percent on average across all cities. This translates into a 1.3 percent increase in the population size and a small reduction in real wages on average of -0.13. While nominal wages increase and the price for traded varieties decline, the reduction in migration frictions induced by lower transportation costs increases the inflow of people from Europe which in turn drives up the prices of non-traded goods in many cities, thereby exerting downward pressure on real wages.

While the average effects are small, they again mask heterogeneity. The 25th and 75th percentiles changes in population size are given by -0.07 and 1.34 respectively and the maximum impact is 11.13. The most sizeable positive effects are concentrated in locations that experienced large changes in transportation costs (e.g. Buenos Aires) or locations that became relatively more central economically from the change in transportation times (e.g. the Caribbean). The biggest loss in population comes from locations where the economic centrality declined, e.g. Veracruz or Cartagena. Assuming that the reduction in transportation costs did not reduce migration frictions led to qualitatively similar but attenuated effects, as depicted in the third and fourth columns of Table 8.

The impact across macroregions. Panel B and C of Table 8 displays the effects of lower transportation costs to Europe across the macroregions defined in Section 4.3. The findings mirror the results in that section where the effects were larger in the fringe region than in the core region. While the average differences in the traded variety price index, population size, and real income were -0.12, 0.24, and -0.02 in the core region, it was -0.93, 1.97, and -0.21 percent in the fringe region. Furthermore, for changes in the population size, the 25th/75th percentiles are around -0.07 and 3.37 for the fringe region and only -0.07 and -0.03 for the core region. Again, the same pattern holds when considering the simulations where the migration frictions are kept fixed. Furthermore, when considering large and small cities separately, I find a similar pattern. The impacts then are larger among smaller cities than in large ones. What drives this heterogeneous impact? Below I explore differences in location fundamentals, dynamic agglomeration economies, and differences in the magnitude of the reduction of transportation costs between the core and fringe regions in mediating the long-term impact of the reform.

The role of location fundamentals. To what extent do differences in natural endowments mediate the impact of the changes in transportation costs? Natural endowments are captured by the location fundamentals $\mathcal{A}$ and $\mathcal{H}$. To isolate the role of differences in location fundamentals, I simulate the model after equalizing the location fundamentals across all cities. Specifically, I consider the vector of fundamentals $\mathcal{A}'$ where $A'_i = \sum_{i \in R} A_i / R$ and $\mathcal{H}'$ where $H'_i = \sum_{i \in R} \bar{H}_i / R$ for all i. I then repeat the simulations in Table 8. I find that equalizing the location fundamentals across all cities attenuates the impact in the fringe region.

While the difference in population growth between the core and fringe region is 1.73 on average for the baseline case, this falls to 1.16 after equalizing the location fundamentals. For the traded price index and real wages these differences are -0.81 and -0.19 before equalizing the location fundamentals and -0.51 and -0.16 after. The case without any changes in migration frictions again results in a similar pattern. These findings suggest that differences in location fundamentals play a role in driving the different impacts across the macroregions.

The role of pre-reform population size. Beyond natural endowments, the core and fringe regions differ in their level of urban development during the 18th century. For the cities in the full sample, the city size is almost twice as large in the core region than in the fringe. As highlighted by the model, a larger pre-reform population may have increased local productivity through dynamic agglomeration economies and could therefore play a similar role as differences in location fundamentals. This will be captured by the lagged agglomeration parameter α_2. I explore this issue by simulating the model after equalizing the pre-reform population shares across all cities. Specifically, I consider the vector of population shares at $t = 0$ of $\mathcal{L}'_0$ where $L'_{i0} = \sum_{i \in R} L_{i0}/R$ for all i. The contribution of dynamic agglomeration economies will therefore be similar in the core and fringe regions.

While the difference in population growth between the core and fringe region is again 1.73 on average for the baseline case and 1.74 after equalizing the pre-reform population size. For the traded price index and real wages these differences are -0.81 and -0.19 before equalizing the location fundamentals and -0.81 and -0.19 after. Again this holds across the scenarios where migration costs stay fixed and the ones where it changes. Taken together, this suggests that the uneven population distribution across the core and fringe regions contributes little in explaining the difference in the impact of the reform across macro-regions.

The spatial incidence of the reform. While the core and fringe regions differed greatly in initial conditions, they also differed in how much transportation costs changed as a result of the reform and independence. I explore this issue by again simulating the model forward, but now equalizing the reduction in transportation times across all cities. Specifically, I assume that $\Delta T'_{ie} = \sum_{i \in R} \Delta T_{ie}/R$ for all i. I find that equalizing the size of the shock also lowers the difference between the core and the fringe region. The difference in population growth between the core and the fringe region declines to 0.26 after equalizing the reduction in transportation times. For the price index and real wages this is -0.17 and 0 respectively. Consequently, part of the different impacts in the core and the fringe regions is driven by transportation times being more restricted in the fringe than in the core prior to the reform.

Trans-Atlantic migration. Across all the counterfactuals considered above, lower transportation times to Europe increase the urban population growth of affected cities by making them more attractive to settle. Is this effect driven by internal or trans-Atlantic migration or internal migration between cities in Spanish America? Mahoney (2010) suggests that the effect is driven by both intracolonial and trans-Atlantic migration.[33] If the effect is primarily driven by internal migration, then the effect of the reform should be largely unchanged when trans-Atlantic migration is made prohibitively expensive. I therefore explore this issue by simulating the model after increasing trans-Atlantic migration costs. Specifically, I set $m_{ijt} = T_{ijt}^{\lambda}$ if both i and j are not in Europe and $\xi > 0$ otherwise. When simulating the model for large ξ I find that the average impact of the reform is smaller. In particular, the average value is only 25.99 percent of the baseline case while for the largest value it is 13.2. While these findings suggest trans-Atlantic migration is an important mediating factor, there is also some heterogeneity in the extent to which cities grow due to intracolonial or trans-Atlantic migration.

[33]See Mahoney (2010) p. 48.

6.3 Sensitivity Analysis

In this section, I briefly discuss the main robustness checks. First, I consider the counterfactual scenarios with alternative parameter values. σ which governs the sensitivity of demand for traded varieties to changes in trade costs is taken from the literature. I consider alternative values ranging from 3 to 7. The findings are qualitatively similar, but larger elasticities attenuate the impact. I also consider different values of θ which affects the sensitivity of migration flows to differences in real incomes across cities. Considering θ in the range of 2 to 4, I find that the model-implied impact of lower transportation costs to Europe is not sensitive to plausible changes to this parameter. Furthermore, I consider other values for the share of consumption on land $(1 - \mu)$ which affects the strength of congestion forces. I consider values between 0.4 and 0.6. Reducing the strength of congestion forces in the model (lower μ) tends to attenuate the impact of lower transportation costs, however, the difference is rather small. I next consider alternative values for the contemporary and historical agglomeration externalities $\alpha_1 \in [0.04, 0.07]$ and $\alpha_2 \in [0.02, 0.07]$. In both these cases I find that the model implied impacts are similar to the baseline parameter values. Finally, I set $b_{ij} = 1$ for all i and j. This naturally results in an attenuated effect where the average change in population is half that of the baseline parameterization in 8. Taken together, these exercises suggest that the model implied impact of the reform is not sensitive to plausible alternative parameter values.

Next, I consider the sensitivity of the findings to changes in location productivity and transportation costs. First, I simulate the model while assuming a secular improvement in location productivity across all cities. Then I consider a scenario where there is higher growth in coastal cities. Furthermore, since there were improvements in transportation technology during the 19th century which resulted in lower trade costs, I explore whether the model-implied impact is sensitive to a secular decline in transportation costs. I assume a reduction in trade costs of 0.88 percent per year starting in 1800 (Harley, 1988). In both these cases, the average effect of the reform is larger than in the baseline counterfactuals.

Finally, I consider alternative elasticities of trade and migration costs with respect to transportation times. First, I consider an alternative transportation time elasticity following Baum-Snow et al. (2018). In particular, I assume that $\tau_{ij} = 1 + 0.004(T_{ij} \times 8)^{0.8}$. I also consider the emergence of national borders after the reform (see e.g. Arteaga, 2022), by incorporating an additional cost from crossing borders. Again following Baum-Snow et al. (2018), I assume that $\tau^*_{ij} = 1.15\tau_{ij}$ if i and j are in different countries and τ_{ij} otherwise. Finally, explore the sensitivity of the findings to changes in the transportation time elasticity of migration frictions. Specifically, I consider $-\lambda\theta = -0.717$ which is the distance elasticity of migration found in Bryan and Morten (2019). Again, I find similar, but somewhat larger impacts of lower transportation costs to Europe.

7 Conclusion

Historical patterns of trade can play a key role in shaping city location and growth. Do historical patterns of trade dictate the location and size of cities today despite the marked change in patterns of trade? Or does the location of economic activity adapt to changes in the location of trading opportunities if given enough time? This paper explores these questions by leveraging the reorganization of long-distance trade in the Spanish Empire. I combine a difference-in-differences design with a tractable dynamic spatial general equilibrium model that I calibrate to match the observed data.

The findings suggest that the location of economic activity adapted to the change in the location of trading opportunities in the long-run. However, this occurred to a greater extent in less populated cities and regions, suggesting the spatial distribution of economic activity was more malleable in the less populated fringes of Spanish America. The counterfactual exercises suggest that this adjustment was contingent on initial first and second-nature fundamentals, but that the spatial incidence of the shock also played an important role. Taken together, the findings are consistent with the view that the location of economic activity adapts to changes in the location of trading opportunities, but can persist when such changes are preceded by urban growth.

The empirical context provides a unique setting in which to study the long-term adjustment to changes in the location of trading opportunities, but it also has important limitations. First, the estimation relies on sizeable and abrupt changes in trade costs which may have led to different adjustment processes than more gradual changes. Furthermore, a lack of data on migration prevent a more detailed examination of the mechanisms. Finally, path dependence likely plays a more important role in persistence in industrialized contexts with stronger agglomeration economies. Exploring these issues is a potentially interesting avenue for future research.

References

Abadie, Alberto. 2021. "Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects." *Journal of Economic Literature* 59(2):391–425.

Acemoglu, Daron and James A. Robinson. 2000. "Political Losers as a Barrier to Economic Development." *American Economic Review* 90(2,):126– 130.

Acemoglu, Daron, Simon Johnson and James A Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91(5):229.

Acemoglu, Daron, Simon Johnson and James A. Robinson. 2002. "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution." *The Quarterly Journal of Economics* 117(4):1231–1294.

Acemoglu, Daron, Simon Johnson and James Robinson. 2005. "The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth." *American Economic Review* 95(3):62.

Alix-Garcia, Jennifer and Emily A. Sellars. 2020. "Locational Fundamentals, Trade, and the Changing Urban Landscape of Mexico." *Journal of Urban Economics* 116(103213).

Allen, Robert C. 2001. "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War." *Explorations in Economic History* 38(4):411–447.

Allen, Robert C., Tommy E. Murphy and Eric B. Schneider. 2012. "The Colonial Origins of the Divergence in the Americas: A Labor Market Approach." *The Journal of Economic History* 72(4):863–894.

Allen, Treb, Costas Arkolakis and Xiangliang Li. 2024. "On the Equilibrium Properties of Spatial Models." *American Economic Review: Insights* (forthcoming).

Allen, Treb and Dave Donaldson. 2022. "Persistence and Path Dependence in the Spatial Economy." *Manuscript* .

Alvarez-Villa, Daphne and Jenny Guardado. 2020. "The Long-Run Influence of Institutions Governing Trade: Evidence from Smuggling Ports in Colonial Mexico." *Journal of Development Economics* 144:102453.

Amante, C and B.W. Eakins. 2009. "ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis." *NOAA Technical Memorandum NESDIS NGDC-24*. (National Geophysical Data Center, NOAA).

Arkolakis, Costas, Arnaud Costinot and Andrés Rodríguez-Clare. 2012. "New Trade Models, Same Old Gains?" *American Economic Review* 102(1):94–130.

Arroyo Abad, Leticia, Elwyn Davies and Jan Luiten van Zanden. 2012. "Between Conquest and Independence: Real Wages and Demographic Change in Spanish America, 1530–1820." *Explorations in Economic History* 49(2):149–166.

Arroyo Abad, Leticia and Jan Luiten van Zanden. 2016. "Growth under Extractive Institutions? Latin American Per Capita GDP in Colonial Times." *The Journal of Economic History* 76(4):1182–1215.

Arroyo Abad, Leticia and Noel Maurer. 2019. "The Long Shadow of History? The Impact of Colonial Labor Institutions on Economic Development in Peru." *Manuscript* .

Arteaga, Fernando. 2022. "The Merchant Guilds and the Political Economy of the Spanish Empire on the Eve of Independence." *Journal of Historical Political Economy* 2(2):299–331.

Bairoch, P. 1988. *Cities and Economic Development: From the Dawn of History to the Present*. Chicago: University of Chicago Press.

Bakker, Jan David, Stephan Maurer, Jörn-Steffen Pischke and Ferdinand Rauch. 2021. "Of Mice and Merchants: Connectedness and the Location of Economic Activity in the Iron Age." *The Review of Economics and Statistics* 103(4):652–665.

Baskes, Jeremy. 2013. *Staying Afloat: Risk and Uncertainty in Spanish Atlantic World Trade, 1760-1820*. Stanford: Stanford University Press.

Baum-Snow, Nathaniel, J. Vernon Henderson, Matthew A. Turner, Qinghua Zhang and Loren Brandt. 2018. "Does investment in national highways help or hurt hinterland city growth?" *Journal of Urban Economics* 115(103124):1–19.

Bleakley, Hoyt and Jeffrey Lin. 2012. "Portage and Path Dependence." *The Quarterly Journal of Economics* 127(2):587–644.

Bolt, Jutta and Jan Luiten Van Zanden. 2024. "Maddison-Style Estimates of the Evolution of the World Economy: A New 2023 Update." *Journal of Economic Surveys* p. joes.12618.

Bouscasse, Paul, Emi Nakamura and Jón Steinsson. 2021. "When Did Growth Begin? New Estimates of Productivity Growth in England from 1250 to 1870." *NBER Working Paper* 28623.

Broadberry, S. N., B. M. S. Campbell, Alexander Klein, Mark Overton and Bas van

Leeuwen. 2015. *British Economic Growth, 1270-1870*. Cambridge: Cambridge University Press.

Bruhn, Miriam and Francisco A. Gallego. 2011. "Good, Bad, and Ugly Colonial Activities: Do They Matter for Economic Development?" *The Review of Economics and Statistics* 94(2):433–461.

Bryan, Gharad and Melanie Morten. 2019. "The Aggregate Productivity Effects of Internal Migration: Evidence from Indonesia." *Journal of Political Economy* 127(5):40.

Buringh, Eltjo. 2015. "The Clio-Infra Database on Urban Settlement Sizes: 1500-2000.".
URL: *http://www.cgeh.nl/urbanisation-hub: 27-4-2015*

Chaney, Eric and Richard Hornbeck. 2016. "Economic Dynamics in the Malthusian Era: Evidence from the 1609 Spanish Expulsion of the Moriscos." *The Economic Journal* 126(594):1404–1440.

Chiovelli, Giorgio, Leopoldo Fergusson, Luis R Martınez, Juan David Torres and Felipe Valencia Caicedo. 2024. "Bourbon Reforms and State Capacity in the Spanish Empire." *Manuscript* .

Cinelli, Carlos and Chad Hazlett. 2020. "Making Sense of Sensitivity: Extending Omitted Variable Bias." *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* 82(1):39–67.

Combes, Pierre-Philippe and Laurent Gobillon. 2015. The Empirics of Agglomeration Economies. In *Handbook of Regional and Urban Economics*. Vol. 5 Elsevier pp. 247–348.

Conley, T. G. 1999. "GMM Estimation with Cross Sectional Dependence." *Journal of Econometrics* 92(1):1–45.

Cuenca-Esteban, Javier. 2008. "Statistics of Spain's Colonial Trade, 1747–1820: New Estimates and Comparisons with Great Britain." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 26(3):323–354.

Davis, Donald R. and David E. Weinstein. 2002. "Bones, Bombs, and Break Points: The Geography of Economic Activity." *American Economic Review* 92(5):1269–1289.

Dell, Melissa. 2010. "The Persistent Effects of Peru's Mining Mita." *Econometrica* 78(6):1863–1903.

Denevan, William M. 1992. *The Native Population of the Americas in 1492*. Madison, Wisconsin: University of Wisconsin Press.

Diaz-Cayeros, Alberto. 2022. The Future of Latin American and Caribbean Cities: Urban Bias and Political Fragments in Place. In *The Routledge Handbook of Urban Studies in Latin America and the Caribbean*. Routledge.

Dijkstra, E.W. 1959. "A Note on Two Problems in Connexion with Graphs." *Numerische Matamatik* 1:269– 271.

Elliott, J. H. 2006. *Empires of the Atlantic World: Britain and Spain in America, 1492-1830*. New Haven: Yale University Press.

Engerman, S.L., K.L. Sokoloff, S. Haber, E.V. Mariscal and E.M. Zolt. 2012. *Economic Development in the Americas Since 1500: Endowments and Institutions*. Cambridge: Cambridge University Press.

Estevadeordal, Antoni, Brian Frantz and Alan M Taylor. 2003. "The Rise and Fall of World Trade, 1870-1939." *The Quarterly Journal of Economics* 118:50.

Feyrer, James. 2019. "Trade and Income—Exploiting Time Series in Geography." *American Economic Journal: Applied Economics* 11(4):1–35.

Findlay, Ronald and Kevin H. O'Rourke. 2007. *Power and Plenty: Trade, War, and the World Economy in the Second Millennium*. Princeton: Princeton University Press.

Fisher, John R. 1993. *El Comercio entre España e Hispanoamérica: 1797-1820*. Number 27 *in* "Estudios de historia económica" Madrid: Banco de España.

Fisher, John R. 1997. *The Economic Aspects of Spanish Imperialism in America, 1492-1810*. Liverpool: Liverpool University Press.

Fisher, John R. 1998. "Commerce and Imperial Decline: Spanish Trade with Spanish America, 1797–1820." *Journal of Latin American Studies* 30(3):459–479.

Fisher, J.R. 1985. *Commercial Relations Between Spain and Spanish America in the Era of Free Trade, 1778-1796*. Liverpool: Centre for Latin-American Studies, University of Liverpool.

Flückiger, Matthias, Erik Hornung, Mario Larch, Markus Ludwig and Allard Mees. 2022. "Roman Transport Network Connectivity and Economic Integration." *The Review of Economic Studies* 89(2):774–810.

Frankel, Jeffrey A and David Romer. 1999. "Does Trade Cause Growth?" *American Economic Review* 89(3):379–399.

GADM. 2024. "Global Administrative Areas (GADM).".

URL: *https://gadm.org/*

Gallo, Andrés and Carlos Newland. 2004. "Globalización y convergencia de precios en el Imperio Español 1660–1810." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 22(3):573–596.

Galor, Oded and Ömer Özak. 2015. "Land Productivity and Economic Development: Caloric Suitability vs. Agricultural Suitability." *Manuscript* .

Galor, Oded and Ömer Özak. 2016. "The Agricultural Origins of Time Preference." *American Economic Review* 106(10):3064–3103.

García-Herrera, R., G. P. Können, D. A. Wheeler, M. R. Prieto, P. D. Jones and F. B. Koek. 2005. "CLIWOC: A Climatological Database for the World's Oceans 1750–1854." *Climatic Change* 73(1):1–12.

Grafe, Regina and Alejandra Irigoin. 2012. "A Stakeholder Empire: The Political Economy of Spanish Imperial Rule in America." *The Economic History Review* 65(2):609–651.

Grossman, Gene and Elhanan Helpman. 1990. "Comparative Advantage and Long-Run Growth." *American Economic Review* 80(4):796– 815.

Hamilton, Earl Jefferson. 1947. *War and Prices in Spain, 1651-1800*. Cambridge: Harvard University Press.

Harley, C. Knick. 1988. "Ocean Freight Rates and Productivity, 1740–1913: The Primacy of Mechanical Invention Reaffirmed." *The Journal of Economic History* 48(4):851–876.

Hassig, Ross. 1993. *Trade, Tribute, and Transportation: The Sixteenth-century Political Economy of the Valley of Mexico*. Oklahoma: University of Oklahoma Press.

Henderson, J. Vernon, Tim Squires, Adam Storeygard and David Weil. 2018. "The Global Distribution of Economic Activity: Nature, History, and the Role of Trade." *The Quarterly Journal of Economics* 133(1):357–406.

Herzog, Irmela. 2014. "Least Cost Paths – Some Methodological Issues." *Internet Archaeol* 36.
URL: *https://intarch.ac.uk/journal/issue36/5/5-5.html*

Hong, Sok Chul. 2007. "The Burden of Early Exposure to Malaria in the United States, 1850–1860: Malnutrition and Immune Disorders." *The Journal of Economic History* 67(4):1001–1035.

Jedwab, Remi, Noel D. Johnson and Mark Koyama. 2022. "Medieval Cities Through the Lens of Urban Economics." *Regional Science and Urban Economics* 94:103598.

Juhász, Réka. 2018. "Temporary Protection and Technology Adoption: Evidence from the Napoleonic Blockade." *American Economic Review* 108(11):3339–3376.

Kelly, Morgan and Cormac Ó Gráda. 2019. "Speed Under Sail During the Early Industrial Revolution (c. 1750–1830)." *The Economic History Review* 72(2):459–480.

Krugman, Paul. 1991. "History Versus Expectations." *The Quarterly Journal of Economics* 106(2):651.

Kuethe, Allan J. and Kenneth J. Andrien. 2014. *The Spanish Atlantic World in the Eighteenth*

Century: War and the Bourbon Reforms, 1713–1796. New Approaches to the Americas Cambridge: Cambridge University Press.

Mahoney, James. 2010. *Colonialism and Postcolonial Development: Spanish America in a Comparative Perspective*. Cambridge: Cambridge University Press.

Maloney, William F. and Felipe Valencia. 2016. "The Persistence of (Subnational) Fortune." *The Economic Journal* 126(598):2363–2401.

Matsuyama, Kiminori. 1992. "Agricultural Productivity, Comparative Advantage, and Economic Growth." *Journal of Economic Theory* 58(2):317–334.

Maurer, Stephan and Ferdinand Rauch. 2023. "Economic Geography Aspects of the Panama Canal." *Oxford Economic Papers* 75(1):142–162.

Menard, Russell R. 1991. Transport Costs and Long-Range Trade, 1300–1800: Was There a European "Transport Revolution" in the Early Modern Era? In *The Political Economy of Merchant Empires: State Power and World Trade, 1350–1750*, ed. James D. Tracy. Cambridge: Cambridge University Press pp. 228–275.

Michaels, Guy and Ferdinand Rauch. 2018. "Resetting the Urban Network: 117-2012." *The Economic Journal* 128(608):378–412.

North, Douglass C. 1968. "Sources of Productivity Change in Ocean Shipping, 1600-1850." *Journal of Political Economy* 76(5):953–970.

O'Rourke, K. H. and J. G. Williamson. 2002. "When did Globalisation Begin?" *European Review of Economic History* 6(1):23–50.

O'Rourke, Kevin H. 2006. "The Worldwide Economic Impact of the French Revolutionary and Napoleonic Wars, 1793–1815." *Journal of Global History* 1(1):123–149.

Pascali, Luigi. 2017. "The Wind of Change: Maritime Technology, Trade, and Economic Development." *American Economic Review* 107(9):2821–2854.

Prados De La Escosura, Leandro. 2009. "Lost Decades? Economic Performance in Post-Independence Latin America." *Journal of Latin American Studies* 41(2):279–307.

Prados de la Escosura, Leandro and Gabriel Tortella Casares. 1983. "Tendencias a Largo Plazo del Comercio Exterior Español, 1714–1913." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 1(2):353–367.

Puga, Diego and Daniel Trefler. 2014. "International Trade and Institutional Change: Medieval Venice's Response to Globalization." *The Quarterly Journal of Economics* 129(2):753–821.

Pérez-Artés, María del Carmen. 2023. "Numeracy Selectivity of Spanish Migrants in Colonial America (Sixteenth–Eighteenth Centuries)." *The Economic History Review* 77(2).

Pérez, Mariana. 2013. "From Spain to the River Plate: Migratory Strategies of Spaniards in the Eighteenth Century." *Early American Studies* 11(1):55–71.

Rahn Phillips, Carla. 1990. The Growth and Composition of Trade in the Iberian Empires, 1450–1750. In *The Rise of Merchant Empires: Long-Distance Trade in the Early Modern World, 1350-1750*, ed. James D. Tracy. Cambridge: Cambridge University Press.

Ramankutty, Navin and Jonathan A. Foley. 1999. "Estimating Historical Changes in Global Land Cover: Croplands from 1700 to 1992." *Global Biogeochemical Cycles* 13(4):997–1027.

Redding, Stephen J and Daniel M Sturm. 2008. "The Costs of Remoteness: Evidence from German Division and Reunification." *American Economic Review* 98(5):1766–1797.

Redding, Stephen J., Daniel M. Sturm and Nikolaus Wolf. 2010. "History and Industry Location: Evidence from German Airports." *The Review of Economics and Statistics* 93(3):814–831.

Redding, Stephen J and Esteban Rossi-Hansberg. 2017. "Quantitative Spatial Economics." *Annual Review of Economics* (9):21–58.

Ridolfi, Leonardo and Alessandro Nuvolari. 2021. "L'histoire immobile? A Reappraisal of French Economic Growth Using the Demand-Side Approach, 1280–1850." *European Review of Economic History* 25(3):405–428.

Scobie, James R. 1971. *Argentina: A City and a Nation*. Oxford: Oxford University Press.

Silva, J. M. C. Santos and Silvana Tenreyro. 2006. "The Log of Gravity." *The Review of Economics and Statistics* 88(4):641–658.

Simonovska, Ina and Michael E. Waugh. 2014. "The elasticity of trade: Estimates and evidence." *Journal of International Economics* 92(1):34–50.

Stangl, Werner. 2018. "'The Empire Strikes Back' ?: HGIS de las Indias and the Postcolonial Death Star." *International Journal of Humanities and Arts Computing* 12(2):138–162.

Stangl, Werner. 2019*a*. "Data: Lago Texcoco, 18th century.".

URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DOT5EY*

Stangl, Werner. 2019*b*. "Data: Mail land routes of Spanish America, 1745-1808.".

URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/W4C9H7*

Stangl, Werner. 2019*c*. "Data: Places Gazetteer of Spanish America, 1701-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/FUSJD3*

Stangl, Werner. 2019*d*. "Data: Ports of Spanish America, 1701-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/UXDJLQ*

Stangl, Werner. 2019*e*. "Data: Routes of the flotas y galeones, 1564-1778.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/UGLWCR*

Stein, Stanley J. and Barbara H. Stein. 2003. *Apogee of Empire: Spain and New Spain in the Age of Charles III, 1759–1789*. Baltimore: Johns Hopkins University Press.

Valencia, Felipe. 2019. "The Mission: Human Capital Transmission, Economic Persistence, and Culture in South America." *The Quarterly Journal of Economics* 134(1):507–556.

Verhagen, Philip, Jamie Joyce and Mark R. Groenhuijzen, eds. 2019. *Finding the Limits of the Limes: Modelling Demography, Economy and Transport on the Edge of the Roman Empire*. Computational Social Sciences Cham: Springer International Publishing.

Walker, Geoffrey J. 1979. *Spanish Politics and Imperial Trade, 1700-1789*. London: Palgrave Macmillan.

Weiss, D. J., A. Nelson, H. S. Gibson, W. Temperley, S. Peedell, A. Lieber, M. Hancher, E. Poyart, S. Belchior, N. Fullman, B. Mappin, U. Dalrymple, J. Rozier, T. C. D. Lucas, R. E. Howes, L. S. Tusting, S. Y. Kang, E. Cameron, D. Bisanzio, K. E. Battle, S. Bhatt and P. W. Gething. 2018. "A global map of travel time to cities to assess inequalities in accessibility in 2015." *Nature* 553(7688):333–336.

Xu, Chenzi. 2022. "Reshaping Global Trade: The Immediate and Long-Run Effects of Bank Failures." *The Quarterly Journal of Economics* 137(4):2107–2161.

Álvarez-Nogal, Carlos and Leandro Prados De La Escosura. 2013. "The Rise and Fall of Spain (1270–1850)." *The Economic History Review* 66(1):1–37.

Özak, Ömer. 2018. "Distance to the Pre-Industrial Technological Frontier and Economic Development." *Journal of Economic Growth* 23(2):175–221.

9 Tables and Figures

Table 2: Summary statistics of the city-level dataset

Statistic	N	Mean	St. Dev.	Min	Median	Max
Shipping time 1760 (days)	372	68.35	16.13	41.96	65.95	121.09
Shipping time 1800 (days)	372	64.34	14.79	34.52	63.74	93.04
Δ Shipping time (days)	372	4.02	7.95	0.00	0.002	38.41
Elevation	372	0.37	0.48	0	0	1
Terrain ruggednes	372	320.74	220.08	3.21	268.56	855.98
Mining center	372	0.19	0.40	0	0	1
Tobacco	372	6.49	1.27	3.09	6.44	8.15
Cotton	372	6.52	1.52	2.61	6.87	8.15
Wheat	372	6.60	1.49	2.87	7.23	8.09
Maize	372	5.86	1.56	2.64	5.70	8.12
Sugar cane	372	6.97	1.27	2.45	7.62	8.15
Distand to coast (km)	372	2,129.93	1,285.23	0.79	1,782.47	4,867.55
Distand to river (km)	372	487.77	363.49	1.26	475.42	1,359.19
Distand to lake (km)	372	553.32	499.52	12.15	372.20	1,744.90
Distand to port in 1750 (km)	372	274.84	262.29	0.31	227.76	1,036.50
Year	372	1,725.00	85.51	1,600	1,725	1,850

Note: The table reports the main variables used in the analysis. The unit of analysis is at the city-level. The dataset is a balanced panel at a 50 year frequency for the period 1600-1850 for 62 cities ($62 \times 6 = 372$). *Elevation* is an indicator variable equal one if the elevation is above 1500m. *Mine* is an indicator variable taking the value one if the city is located less than 50 kilometer from a mine.

Table 1: List of ports in the sample

Port id.	Port name	Country	Direct trade	Longitude	Latitude
1	Cadiz	Spain	<1700	-6.3	36.5
2	Acapulco	Mexico	<1700	-99.9	16.8
3	Portobelo	Panama	<1700	-79.7	9.6
4	Panama	Panama	<1700	-79.5	9
5	El Callao	Peru	<1700	-77.1	-12.1
6	Cartagena de Indias	Colombia	<1700	-75.6	10.4
7	Batabano	Cuba	1765	-82.3	22.7
8	Isla de Trinidad	Trinidad and Tobago	1765	-61.5	10.7
9	Isla Margarita	Venezuela	1765	-63.9	11
10	La Habana	Cuba	1765	-82.4	23.1
11	Monte-Christi	Dominican Republic	1765	-71.6	19.9
12	San Juan de Puerto Rico	Puerto Rico	1765	-66.1	18.5
13	Santiago de Cuba	Cuba	1765	-75.8	20
14	Santo Domingo	Dominican Republic	1765	-69.9	18.5
15	Trinidad	Cuba	1765	-80	21.8
16	Campeche	Mexico	1770	-90.5	19.8
17	Riohacha	Colombia	1776	-72.9	11.6
18	Santa Marta	Colombia	1776	-74.2	11.2
19	Arica	Chile	1778	-70.3	-18.5
20	Buenos Aires	Argentina	1778	-58.4	-34.6
21	Chagres	Panama	1778	-80	9.3
22	Concepcion	Chile	1778	-73.1	-36.8
23	Guayaquil	Ecuador	1778	-79.9	-2.2
24	Montevideo	Uruguay	1778	-56.2	-34.9
25	Nuevitas	Cuba	1778	-77.3	21.5
26	Omoa	Honduras	1778	-88	15.8
27	Cumana	Venezuela	1788	-64.2	10.5
28	La Cruz	Venezuela	1788	-64.6	10.2
29	La Guaira	Venezuela	1788	-66.9	10.6
30	Veracruz	Mexico	1789	-96.1	19.2
31	San Blas	Colombia	1789	-105.3	21.5
32	Villahermosa	Mexico	1792	-92.9	18
33	Maracaibo	Venezuela	1793	-71.6	10.7
34	Matanzas	Cuba	1793	-81.6	23
35	Acajutla	El Salvador	1796	-89.8	13.6
36	Isla de Carmen	Mexico	1796	-91.8	18.7
37	Realejo	Nicaragua	1796	-87.2	12.5
38	Puerto Cabello	Venezuela	1798	-68	10.5
39	Rio San Juan	Nicaragua	1798	-84.8	11.1
40	San Andres	Colombia	1798	-81.7	12.6
41	Santo Tomas de Castilla	Guatemala	1798	-89	15.6
42	Valparaiso	Chile	1798	-71.6	-33
43	Baracoa	Cuba	1803	-74.5	20.4
44	Manzanillo	Cuba	1803	-77.1	20.3
45	Sisal	Mexico	1807	-90	21.2
46	San Bernardo	United States	1808	-96.6	28.6
47	Matina	Costa Rica	1811	-83.3	10.1
48	Trujillo	Peru	Independence	-79	-8.1
49	Paita	Peru	Independence	-81.1	-5.1
50	Maldonado	Uruguay	Independence	-55	-34.9
51	Trujillo	Honduras	Independence	-86	15.9

Table 4: Shipping time and the location of settlements

Dependent variable:	Settlements				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	-0.001	-0.0003	-0.002	-0.001	-0.002
	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0003)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty Trend					✓
Mean DV	0.11	0.11	0.11	0.11	0.11
N	53,581	53,581	53,548	53,581	53,548
R^2	0.873	0.877	0.874	0.878	0.874

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The unit of observation is a grid cell between 1710-1810. Regressions are based on a balanced panel of 11 time periods (outcomes measured every decade) $\times$ 4,871 cells = 53,581 observations. *Dependent variable:* Indicator for cell containing a settlement in a given decade. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the grid-cell level (4,871 clusters).

Table 5: Shipping time and urban population growth

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Panel A: Core region					
Transportation time (T_{it})	−0.074	−0.032	−0.047	−0.047	−0.042
	(0.059)	(0.053)	(0.057)	(0.057)	(0.054)
Mean DV	9.043	9.043	9.043	9.043	9.043
Cities	24	24	24	24	24
N	144	144	144	144	144
R^2	0.911	0.968	0.926	0.926	0.921
Panel B: Fringe region					
Transportation time (T_{it})	−0.018	−0.017	−0.022	−0.028	−0.023
	(0.008)	(0.022)	(0.013)	(0.009)	(0.009)
Mean DV	8.464	8.464	8.464	8.464	8.464
Cities	38	38	38	38	38
N	228	228	228	228	228
R^2	0.845	0.874	0.863	0.909	0.855
Panel C: Large cities					
Transportation time (T_{it})	−0.016	−0.014	−0.029	0.035	−0.031
	(0.008)	(0.026)	(0.020)	(0.026)	(0.017)
Mean DV	9.719	9.719	9.719	9.719	9.719
Cities	25	25	25	25	25
N	150	150	150	150	150
R^2	0.783	0.875	0.831	0.923	0.813
Panel D: Small cities					
Transportation time (T_{it})	−0.020	−0.027	−0.034	−0.038	−0.032
	(0.008)	(0.012)	(0.007)	(0.009)	(0.006)
Mean DV	7.992	7.992	7.992	7.992	7.992
Cities	37	37	37	37	37
N	222	222	222	222	222
R^2	0.834	0.878	0.858	0.892	0.850
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty Trend					✓

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The unit of observation is a city between 1600-1850. Regressions are based on a balanced panel of 6 time periods (outcomes measured every 50 years) × 62 cities = 372 observations. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level (62 clusters).

Table 6: Shipping time and urban population growth

Dependent variable:	Full sample		$\Delta T_i <$ Median		$\Delta T_i \geq$ Median	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Cities						
Pop. 1750 (log.)	0.529	0.584	0.512	0.897	0.538	0.582
	(0.142)	(0.173)	(0.213)	(0.227)	(0.188)	(0.263)
Mean DV	12.89	12.89	12.87	12.87	12.91	12.91
N	62	62	27	27	35	35
R^2	0.237	0.337	0.224	0.652	0.243	0.306
Panel B: Provinces						
Pop. density 1500 (log.)	0.362	0.312	0.575	0.303	0.252	0.136
	(0.047)	(0.046)	(0.055)	(0.062)	(0.068)	(0.078)
Mean DV	-1.003	-1.003	-0.699	-0.699	-0.28	-0.28
N	288	288	155	155	133	133
R^2	0.264	0.498	0.431	0.604	0.121	0.550
Controls		✓		✓		✓

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The unit of analysis in Panel A/B is a city/province. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city/province level (62/288 clusters).

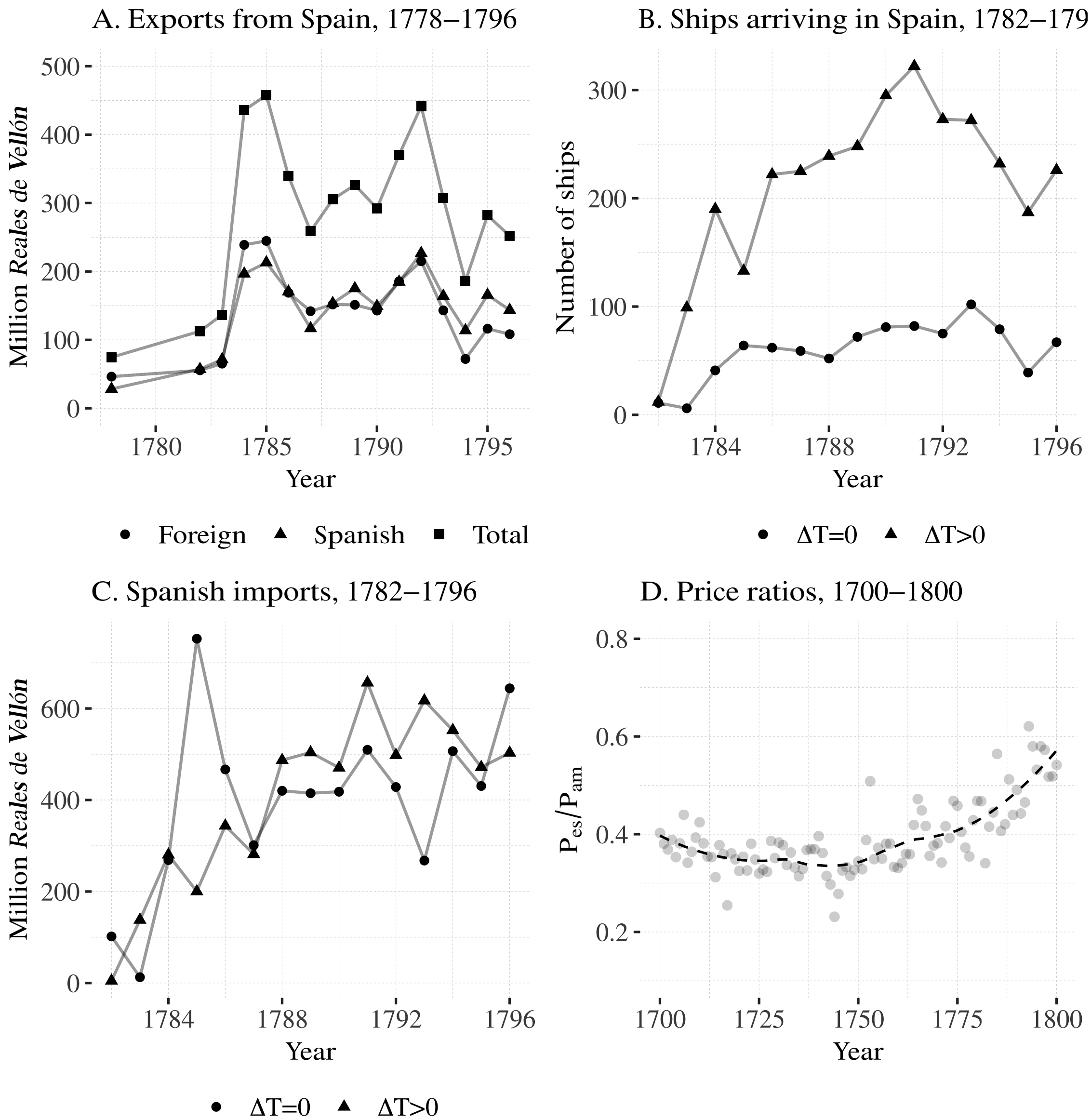

Figure 4: Panel A depicts exports from Spain to Spanish America between the years 1778 and 1796. Data for the years 1779, 1780, and 1781 is missing in the original source. *Spanish* denotes goods produced in Spain, *foreign* denotes goods produced abroad. *Total* denotes the sum of goods produced in Spain and abroad. Source: Fisher 1985 (Table VI, p. 46). Panel B displays the number of ships arriving in Cadiz from ports experiencing changes in shipping time as a result of the reform ($\Delta T > 0$) and ports without changes in the shipping time ($\Delta T = 0$) for the years between 1782 and 1796. Panel C displays the value of imports arriving in Cadiz (in million *reales de vellón*). Source B and C: Fisher 1985 (Appendix E). Panel D depicts the price ratio of the Spanish price index relative to the American price index. Sources: Hamilton (1947); Arroyo Abad, Davies and van Zanden (2012). Data construction and definitions are found in the Appendix.

Supplementary Appendix
(For online publication only)

Contents

A Data Details

A.1 Data Sources and Definitions

Ports: The port locations and trading statuses are from Stangl (2019*d*) and Fisher (1997). New Orleans is omitted since it's not in the study region. Guyana is omitted since it is inland. The list of ports is displayed in Table 1 in the paper.

Cities: The sample of cities is based on a historical reconstruction of the urban structure during the early colonial period by Diaz-Cayeros (2022). He constructs a historical GIS of major cities during the early colonial period based on primary sources. The georeferencing of the cities mentioned in these sources is based on maps in López de Velasco (1570) and López de Velasco (1575). I obtain the longitude and latitude of the historical center as well as the legal status of each city from a gazetteer of colonial Spanish America (Stangl, 2019*c*). The longitude and latitude of each city are typically the main town square, church, or cathedral. I then keep cities designated *city* or *villa* to obtain places that were centers of Spanish settlement, governance, and economic activity before the 18th century.

Population: I use data on urban populations from Buringh (2015) made available by the Centre for Global Economic History at Utrecht University. The basic criterion for inclusion in the database was the availability of historical population data between 1500 and 1800. The authors apply a threshold rule and collect data on cities with a population exceeding 5,000 inhabitants in 1850 or 20,000 inhabitants in 2000. If one of these criteria was met the city was included in the dataset. Following Arroyo Abad and van Zanden (2016), I supplement and extend this dataset by consulting various regional and national sources. These sources are largely based on population and urbanization studies, colonial censuses, and regional economic studies. Data on Mexico is from Gerhard (1993*a*,*b*,*c*). Data on Buenos Aires is from Johnson and Seibert (1979). Information on Colombia is from Pinzón, Mora and Mora (1994). For urban population numbers for larger cities across the Americas, I use Morse (1974). For periods where population data are missing or the recorded year does not coincide with the year in the dataset, I follow Buringh (2015) and impute the value by assuming a uniform growth rate between the two years for that specific city.

Settlements: Data on settlements comes from a territorial gazetteer of around 15,000 places in Bourbon Spanish America (Stangl, 2019*c*). The data come from a variety of sources. "Sources include archival material like census tables, mission reports, visitations of dioceses and provinces, but also more ephemeral documents like petitions of some city council which was mostly not written for giving geographic information but may touch one specific detail or incidentally exposes some relevant information. Non-archival contemporary sources include mostly highly systematic sources for information like so-called"Foreigner Guides" (printed calendar-manuals which included also lists of office holders of many parts of the Empire), maps, or geographical descriptions both printed and manuscripts." (Stangl, 2018).

Logbook data: The logbook data is from Cliwoc 2.1 (García-Herrera et al., 2005) and contains daily information on ship location, reported wind speed, and wind direction. Wind speed is measured in tenths of a meter per second. Wind direction measures the direction from which the wind is blowing in whole degrees. I restrict the sample to entries of sailing ships, that are not anchored, and not in coastal waters. I further restrict the sample to contain entries between 1750 and 1855. The dataset is available at: https://www.historicalclimatology.com/cliwoc.html.

Wind data: Wind speed and wind direction at 0.5×0.5 degrees resolution are from The Global Forecasting System (GFS) atmospheric model provided by the National Oceanic and Atmospheric Administration (NOAA) and National Centers for Environmental Prediction (NCEP). The data was downloaded using the RWind library in R (Fernández-López and Schliep, 2019). Wind direction is stored as velocity components $\vec{v}$ (northward) and $\vec{u}$ (eastward). I define wind direction as the direction of the origin of the wind relative to true north measured in degrees. The wind speed is measured in meters per second. For each cell, I download data for every 14th day between 03/09/2011 and 09/09/2017. The data used in the analysis is averaged by grid cell over the whole period.

Transportation times: Author's calculations. See section A.2 for details.

Trade flows: Data on the nominal value of imports and the number of ships arriving in Spain by origin in Spanish America for the period 1782 to 1796 is from Fisher (1985) (Appendix E). Data on the nominal value of exports from Spain to Spanish America by destination for the period 1797 to 1820 is from Fisher (1993) (Appendix E). Some origins/destinations list several ports of call. In these cases, I assign the origins/destinations to the first port mentioned. Data on total imports from Spanish America in constant prices is from Cuenca-Esteban (2008) (Appendix table 5).

Population flows: Data on the Argentinian population for 14 provinces distributed by province in 1869 is from the 1860 Argentinian census (Census, 1872). Available at: https://biblioteca.indec.gob.ar/bases/minde/1c1869_TU.pdf. Data on population by state in Mexico by state of birth is from the Mexican census of 1895 (Census, 1899). Available at: https://www.inegi.org.mx/app/publicaciones/?p=1681.

Wages: Annual wages in grams of silver for unskilled construction laborers or miners from Arroyo Abad, Davies and van Zanden (2012). The data is made available by the Global Price and Income History Group (UC Davis) and is available here: https://gpih.ucdavis.edu/Datafilelist.htm#Latam (under Living standards in Latin America).

Prices: Prices for wheat, wine, salt, and sugar for Spain (New Castile) between 1650 and 1800 are from Hamilton (1947). Prices for wheat, wine, salt, and sugar for Argentina, Bolivia, Chile, Colombia, Mexico, and Peru are from the Global Price and Income History Group (UC Davis) and are available here: https://gpih.ucdavis.edu/Datafilelist.htm#Latam. I convert the quantities into consistent units of measurement using the information provided in the Allen-Unger Global Commodity Prices Dataset (http://www.gcpdb.info/data.html). For Spain, I convert the monetary value into grams of silver using the conversion tables in Hamilton (1947). For each location i, the price index (P_i) is the average price across the available commodities. The price index for America is the average over all the locations: $P_{am} = \sum_{j \in am} P_j$. The measure depicted in the paper is P_{es}/P_{am}. Missing values are imputed using a multiple imputation procedure following Honaker and King (2010).

Province/state-level data: Province level population data is from Maloney and Valencia (2016). The data is primarily from Denevan (1992), Bruhn and Gallego (2011), and national censuses. See Maloney and Valencia (2016) for details.

Caloric yield: I use a measure of agricultural potential constructed by Galor and Özak (2015, 2016). The data measure the maximum attainable yield measured in calories that can be achieved for a variety of crops. Agricultural suitability measures are from the United Nations Food and Agricultural Organization Global Agro-Ecological Zones (GAEZ) dataset under rain-fed, low-input agriculture for six important staple and export crops. I consider wheat, maize, sugar cane, tobacco, and cocoa as the most important cash and staple crops.

Rivers, lakes, coastlines: Data on the location of rivers, lakes, and coastlines is from Natural Earth. I remove Lake Gatun which is artificial and created in the 20th century. I add shapefiles on the location of Lake Texcoco in the 18th century (Stangl, 2019*a*).

Mining centers: The location and type of the principal mining centers is from Figure 2 in Fisher (1997). The longitude and latitudes are found using Google Maps.

Post routes: Shapefiles of courier routes on land between 1745 and 1808 are from Stangl (2019*b*).

Potential vegetation: I use the Global Potential Vegetation Dataset dataset made available by the Center for Sustainability and the Global Environment at the University of Wisconsin-Madison to measure historical landcover. It measures 15 types of potential vegetation, that would exist in the absence of human intervention at the grid-cell level (Ramankutty and Foley, 1999). The data is available at https://sage.nelson.wisc.edu/data-and-models/datasets/.

Political borders: Viceroyalty and audiencia borders are from Stangl (2019*e*). Present-day province borders are from the Global Administrative Areas dataset GADM (2024). Present-day country borders are from Natural Earth.

Elevation: Data on elevation is from the ETOPO Global Relief Model (Amante and Eakins, 2009).

Terrain ruggedness: Calculated using ETOPO Global Relief Model with the method following Elliot, DeGloria and Riley (1999). Ranges from 0 (level terrain surface) to 959 (extremely rugged surface).

The European economy: Data for Europe is given by Spain and its most important trading partners, France and the United Kingdom. The population data for the 18th century is taken from Bolt and Van Zanden (2024). The source for Spain is Álvarez Nogal and De La Escosura (2013), for France Ridolfi and Nuvolari (2021), and Broadberry et al. (2015) for the United Kingdom. The nominal wages are averaged over cities in these countries for which data is available (London, S. Eng. towns, Paris, Strasbourg, Madrid, and Valencia). Nominal wages are measured in grams of silver per day for building laborers between 1700 and 1749. This data is from Allen (2001).

A.2 Estimating Transportation Times

In this section, I provide further detail on how I reconstruct transportation times.

A.2.1 Maritime transportation.

In the first step, I calculate the average travel speed for the voyages in the CLIWOC 2.1 dataset (García-Herrera et al., 2005). Using the information on the date of the logbook entry as well the longitude and latitude, I infer ship i's average speed between dates t and $t-1$, which is denoted s_{it}^{sea}. From the entries at time t and $t-1$, I calculate the direction of travel measured in degrees relative to true north. Using the information on the wind direction recorded in the logbook at time $t-1$, I calculate the difference in the direction of movement from the direction of the origin of the wind in degrees. I denote this θ_{it}. I also keep the recorded wind speed in $t-1$ measured in meters per second denoted w_{it}.

I then estimate the relationship between sailing speed s_{it}^{sea}, wind speed w_{it}, and the deviation of the wind direction and the direction of movement θ_{it} using the following regression model

$$s_{it}^{sea} = \alpha + \beta w_{it} + \omega \cos(\theta_{it}) + \lambda_{it}, \tag{A.1}$$

where λ_{it} is an unobserved error term. To evaluate the model fit, I split the sample into a training set ($N_{\text{train}} = 179{,}287$) and a validation set ($N_{\text{test}} = 9{,}436$). The model is estimated with ordinary least squares on the training set which gives the estimates presented in Table A1. As expected, there is a positive relation between sailing speed and wind speed. The findings are robust to including voyage fixed effects. Moreover, the coefficients are found to be precisely estimated. Finally, I evaluate the fitted model on the training sample. I find that the mean squared error is 2.21. In sum, this exercise confirms that wind speed and wind direction predict sailing speeds in this context.

In the final step, I construct a grid of 0.16×0.16 degrees resolution. For each cell, the average wind direction and wind speed over the 2011-2017 period is calculated. Based on this grid, I construct a directed graph where each node is a grid cell and each edge is a link to an adjacent cell. For any adjacent pair of nodes i, j, the predicted time to sail from i to j is calculated using the fitted model version of Equation A.1, denoted $\hat{s}_{it}^{sea}$. This results in a cost surface of predicted sailing times between any two nodes spanning the western hemisphere. I denote the sparse matrix containing the attained speed between all nodes $\mathbf{S}$.

A.2.2 Land transportation.

Mules were the most common means of bulk transportation for most of the colonial period and up to the second half of the 19th century. Furthermore, pack animals were

Table A1: Wind speed, direction, and sailing time.

Dependent variable:	Sailing speed (knots)	
	(1)	(2)
Wind speed	0.079	0.087
	(0.003)	(0.002)
Wind angle	−0.132	−0.122
	(0.012)	(0.010)
Constant	3.635	
	(0.028)	
Voyage FE		✓

Note: The table reports OLS estimates. The unit of observation is a daily logbook entry. There are 179, 287 observations. *Dependent variable:* Sailing speed in knots. *Standard errors:* Clustered at the voyage level. 4,832 clusters.

typically accompanied by humans on foot (Verhagen, Joyce and Groenhuijzen, 2019). I therefore model the shipping time with pack animals using geographical features, drawing on least-cost analysis tools from archaeology. The walking speed attained when traveling between two locations i and j will depend on whether travel occurs on road, the slope of the terrain, the elevation, and the landcover. I consider the following model of walking speed from Weiss et al. (2018),

$$s_{ij}^{land} = 6\kappa_i e^{-3.5|\text{slope}_{ij}+0.05|-\gamma \text{elev}_i} \tag{A.2}$$

where s_{ij}^{land} denotes the walking speed attained between locations i and j. slope_{ij} denotes the average slope between points i and j. elev_i denotes the elevation in meters above sea level. κ_i is a scalar that adjusts the walking speed to account for differences i landcover. The model closely resembles the Tobler hiking function (Tobler, 1993) but incorporates differences in elevation and landcover which could be important in pre-industrial contexts. It follows that the travel speed on flat terrain at sea level is approximately 5 kilometers per hour on road ($\kappa_i = 1$). I assume 8 hours of walking per day. As a result, 40 kilometers can be traveled in a day in this ideal case.

I approximate the travel time by combining Equation A.2 with a different data sources. I use a digital elevation model to calculate the average slope and elevation. Following Weiss et al. (2018), I set $\gamma = -0.0001072$ to account for lower mobility at high altitudes. I approximate the landcover using data on potential vegetation from Ramankutty and Foley (1999). This dataset gives a measure of the type of vegetation of a cell in the absence of human intervention. There are 15 types of potential vegetation in the data. I construct a mapping from the potential vegetation to the terrain coefficient κ_i using information on the speed of walking in various terrain types from Weiss et al. (2018). Five terrain types have a natural mapping between the potential vegetation data and the terrain coefficients. These are tropical forests, temperate forests, deserts, savanna, and shrubland. The terrain factors are 0.324 in a tropical forest, 0.648 in a temperate forest, 0.97 in a savanna, 0.6 in shrubland, and 0.6 in deserts. Inland water such as rivers and lakes can be traversed at half the speed (Herzog, 2014). I assume that travel on road is affected by the slope and elevation, but not the landcover κ_i. Finally, the location of roads is approximated with the location of postal routes using data from Stangl (2019*b*).

I again construct a measure of the travel time by setting up a grid of 0.16×0.16 degrees. For any adjacent pair of cells i, j, the predicted time to walk from i to j is calculated using Equation A.2 combined with the above data. This results in a matrix of approximated walking times between any two cells in North and South America. I denote the sparse matrix containing the attained speed between all nodes $\mathbf{L}$. The average speed of traversing a cell is 3.4 kilometers per hour.

A.3 Validation Exercises

Assessing the population data. I supplement and extend the city population data by consulting various regional and national sources. These sources are largely based on population and urbanization studies, colonial censuses, and regional economic studies and are discussed in Section A.1. In total, I adjust 70 population/city pairs. In this section, I use the national and regional sources to validate the data on cities in the Americas recorded in Buringh (2015). Reassuringly, there is a high correlation between the two datasets for the countries and period in question (ranging between 0.796 and 0.964). Furthermore, I re-estimate the models without the adjustments to the data as a robustness check. Unsurprisingly, I find very similar results as in the baseline case. Taken together, it is reassuring that the data sources coincide well.

Assessing the transportation times. I validate the estimated transportation times for both land and maritime transportation. For maritime transportation, I compare the estimated shipping times to measures of sailing times from a database of bilateral sailing

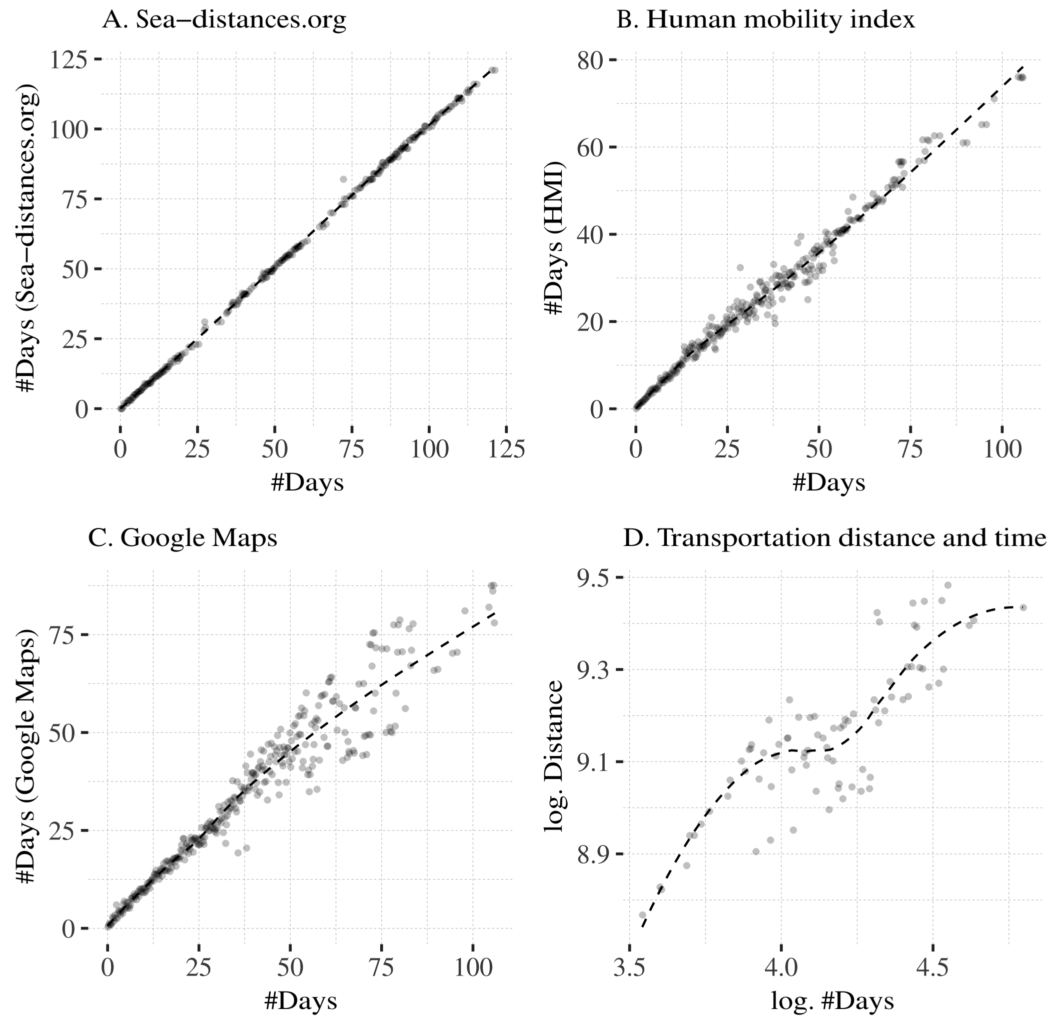

Figure A1: The figures depict the results from the main validation exercises. Panel A. depicts the relationship between estimated sailing times and sailing times from sea-distances.org for voyages between Cadiz and 21 ports in Spanish America. Panel B. depicts the relationship between the estimated travel times between large cities and travel times implied by the Human Mobility Index (Özak, 2010, 2018). Panel C. depicts the relationship between the estimated bilateral shipping times between major cities and google maps. Panel D. depicts the association between the number of days travel and distance between 1760 and 1810.

times.[1] For each port, I calculate the sailing time from Cadiz to all the ports in the dataset for which the website records information. The average speed of 4 knots is used, which is around the average speed of Spanish freight ships in 1750 (Kelly and Ó Gráda, 2019). For shipping on land, I compare the calculated shipping times with walking times using the Human Mobility Index (Özak, 2018) as well as Google Maps. Since there might be measurement error in the estimated transportation times, I consider

[1]A database of bilateral sailing times between major ports around the world. Data are available at `seadistances.org`.

an alternative approach where I calculate the least cost path on a cost surface without accounting for terrain or wind patterns. The association between the transportation time and resulting distance is provided in Panel D. Figure A1 shows that these alternative shipping time measures are correlated with the measure developed in this paper. Lastly, I assess the correlation between historical and contemporary wind patterns. There is a positive correlation between wind speed and direction in these two datasets (0.245 and 0.331).

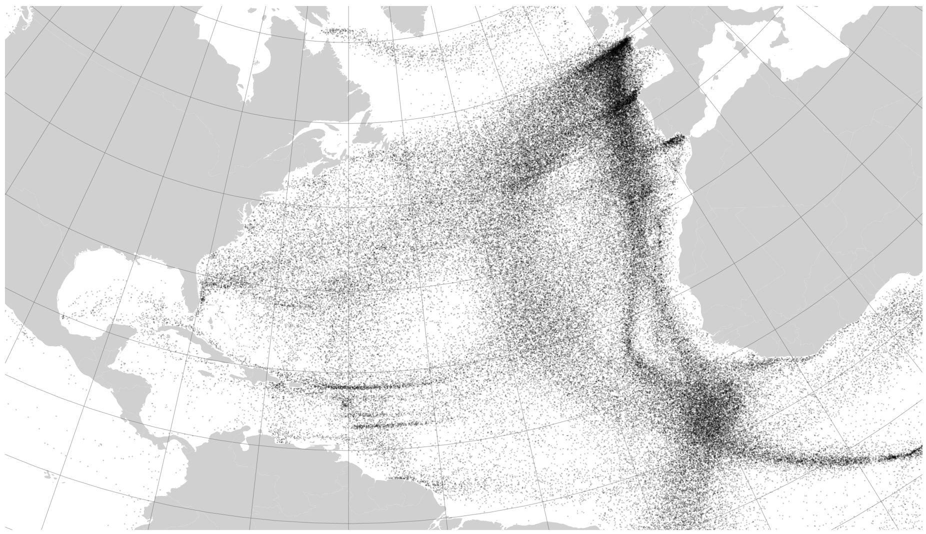

Figure A2: The figure depicts a snapshot of the logbook entries used to estimate the travel times in the main analysis. Each dot represents a logbook entry between 1750 and 1855. Source: CLIWOC 2.1.

B Model Details

This section provides a more complete description of the model, the equilibrium conditions, and the estimation strategy.

B.1 Model Ingredients

Geography and timing. The environment consists of R cities indexed by i or j. Each city differs in their location productivity $\mathcal{A} = \{\bar{A}_i\}_{i=1}^{R}$ and availability of land $\mathcal{H} = \{\bar{H}_i\}_{i=1}^{R}$. Locations also differ in their connections to other cities. Goods trade is subject to iceberg trade costs captured by the matrix $\mathcal{T}_t = \{\tau_{ijt}\}_{i,j \in R}$ where $\tau_{ijt} \geq 1$ for all i, j. Migration frictions are given by the matrix $\mathcal{M}_t = \{m_{ijt}\}_{i,j\in R}$. Both migration and trade costs are potentially time-varying. Finally, $\mathcal{L}_0 = \{L_{i0}\}_{i\in R}$ denotes the initial population across the R cities. Together, this defines the geography at time t, denoted $\mathcal{G}_t$. Following Allen and Donaldson (2022), each city is inhabited by young and old individuals. Old individuals supply labor and consume, give birth to one young individual, and then leave the model. Young individuals choose where to live when old to maximize their utility.

Preferences. The utility derived from consumption in city i at time t is defined over a composite of differentiated varieties C_{it} and a non-traded good f_{it}. The non-traded good can be thought of as food that is sourced from the city's immediate hinterland. The preferences are defined as follows,

$$u_{it} = \left(\frac{C_{it}}{\mu}\right)^{\mu}\left(\frac{f_{it}}{1-\mu}\right)^{1-\mu}, \tag{A.3}$$

where $C_{it} = \left(\sum_{j\in N} b_{ji}^{\frac{1}{\sigma}} c_{jit}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$. c_{jit} is the amount of the city j specific good consumed in city i and b_{ji} is am exogenous preference shifter. It follows that the expenditure shares on C_{it} and f_{it} are constant and given by μ and $1-\mu$ respectively. The demand functions are given by $f_{it} = (1-\mu)y_{it} \,/\, r_{it}$ and $C_{it} = \mu y_{it} \,/\, P_{it}$ where $P_{it} = \left(\sum_{j\in N} b_{ji} p_{jit}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ is the price index for traded varieties, r_{it} the price of the non-traded good, and y_{it} income per capita. Moreover, the share of expenditure devoted to traded varieties spent on any particular variety is given by $\mu_{jit} = b_{ji}(p_{jit} \,/\, P_{it})^{1-\sigma}$. As a result, the individual utility derived from consumption in equilibrium for in city i is given by the indirect utility function, $V_{it} = w_{it} \,/\, \mu P_{it}^{\mu} r_{it}^{1-\mu}$. Finally, every individual supplies one unit of labor inelastically.

Technology and market structure. Traded goods q_{it}, are produced with a constant returns to scale technology $q_{it} = A_{it}L_{it}$ where L_{it} is the number of workers in city i and A_{it} the productivity level given by $A_{it} = \bar{A}_i L_{it}^{\alpha_1} L_{it-1}^{\alpha_2}$. There is assumed to be perfect competition in goods and factor markets. Since a worker in city i can produce A_{it} units of a good and the nominal wage is w_{it}, the price of the good in city i is given by $p_{it} = w_{it} \,/\, A_{it}$. Let F_{it} denote the supply of the non-traded good. Then market clearing implies that $F_{it} = f_{it}L_{it}$. The non-traded good is produced using a linear technology where land is the only input. We therefore have that $F_i = \bar{H}_i$, where $\bar{H}_i$ denotes the availability of land in the city and the immediate hinterland. The price for the non-traded good in equilibrium is given by $r_{it} = (1-\mu)Y_{it} \,/\, \bar{H}_i$ where Y_{it} denotes the total income of city i.

Trade. The traded varieties can be transported across cities subject to iceberg trade costs. The price faced by consumers in city i for good a good originating in j is therefore given by $p_{jit} = \tau_{jit} w_{jt} \,/\, A_{jt}$. The value of goods transported from city j to city i denoted X_{jit}, takes the standard gravity form given by

$$X_{jit} = b_{ji} \tau_{jit}^{1-\sigma} \left(\frac{w_{jt}}{A_{jt}} \right)^{1-\sigma} \mu Y_{it} P_{it}^{\sigma-1} \tag{A.4}$$

Using the expression for the local productivity A_{it} and that $\mu Y_{it} = w_{it} L_{it}$ gives the expression in the derivations that follow.

Migration. The utility of an individual moving from city i to city j is given by $V_{ijt} = \frac{V_{jt}}{m_{ij}} \epsilon_{jt}$ where ϵ_{jt} represents individual-level heterogeneity in preferences over cities, assumed to be an *i.i.d.* draw from a multivariate Fréchet-distribution with shape parameter θ. The CDF is thus given by $F(x) = e^{-x^{-\theta}}$. m_{ij} captures bilateral migration costs. An individual chooses to move from i to j if the realized utility of that city is higher, which happens with probability $Pr\left(V_{ijt}\epsilon_{jt} \geq V_{ikt}\epsilon_{kt} \forall k \neq j \in R\right)$. Since the idiosyncratic location preferences are *i.i.d.* and there is a continuum of agents in each location this probability corresponds to the share of individuals in city i moving to j, denoted π_{ijt}. It follows that the conditional probability of moving is,

$$\pi_{ijt} | \epsilon_{jt} = Pr\left(\epsilon_{kt} \leq \frac{V_{ijt}\epsilon_{jt}}{V_{ikt}} \epsilon_{kt} \forall k \neq j \in R \right) = \prod_{k \neq j} Pr\left(\epsilon_{kt} \leq \frac{V_{ijt}\epsilon_{jt}}{V_{ikt}} \right). \tag{A.5}$$

As a result, the fraction of individuals moving from i to j is given by,

$$\pi_{ijt} = \frac{(V_{jt} \,/\, m_{ij})^{\theta}}{\sum_{k \in R} (V_{kt} \,/\, m_{ik})^{\theta}}. \tag{A.6}$$

The number of people moving from i to j is the $L_{ijt} = \pi_{ijt} L_{it-1} = L_{it-1} V_{jt}^{\theta} \Pi_{it}^{-\theta} m_{ij}^{-\theta}$ where $\Pi_{it}^{\theta} = \sum_{j \in R} m_{ij}^{-\theta} V_{jt}^{\theta}$. This gives the expression in the text.

Equilibrium and steady-state. The equilibrium for period t, given the geography $\mathcal{G}_t$, is characterized by the following four equations.

1. $w_{it} L_{it} = \sum_{k \in R} X_{ikt}$ (goods market clearing).

2. $\sum_{k \in R} X_{ikt} = \sum_{k \in R} X_{kit}$ (balanced trade).

3. $L_{it} = \sum_{k \in R} L_{jit}$ (total population equals the number arriving in the city).

4. $L_{it-1} = \sum_{k \in R} L_{ijt}$ (total population equals the number exiting the city).

Since trade is balanced and trade costs are quasi-symmetric, it follows that the origin and destination terms in the gravity equation are proportional (Allen and Arkolakis, 2014). Therefore $w_{it}^{1-\sigma} A_{it}^{\sigma-1} \propto w_{it} L_{it} P_{it}^{\sigma-1}$. Using the indirect utility, it follows that $P_{it}^{\sigma-1} \propto w_{it}^{\sigma-1} V_{it}^{\frac{1-\sigma}{\mu}} \bar{H}_i^{\frac{(1-\mu)(\sigma-1)}{\mu}} L_{it}^{\frac{(\mu-1)(\sigma-1)}{\mu}}$. Inserting this gives the following expression for the nominal wage,

$$w_{it} \propto A_{it}^{\tilde{\sigma}} L_{it}^{\tilde{\sigma}\left(\frac{1}{1-\sigma}+\frac{1-\mu}{\mu}\right)} V_{it}^{\frac{\tilde{\sigma}}{\mu}} \bar{H}_i^{\frac{(\mu-1)\tilde{\sigma}}{\mu}}, \tag{A.7}$$

where $\tilde{\sigma} = 1 - \sigma \ / \ 1 - 2\sigma$. Using the functional form of the agglomeration spillovers, the goods market clearing condition (1.) and the equilibrium restrictions on labor mobility (3. and 4.) then results in the following equations for the equilibrium of the model,

$$\begin{aligned} L_{it}^{\tilde{\sigma}\left(1-\sigma\frac{\mu-1}{\mu}-\alpha_1(\sigma-1)\right)} V_{it}^{\frac{\tilde{\sigma}\sigma}{\mu}} &= \phi \bar{A}_i^{\tilde{\sigma}(\sigma-1)} \bar{H}_i^{\frac{(1-\mu)\tilde{\sigma}\sigma}{\mu}} L_{it-1}^{\alpha_2\tilde{\sigma}(\sigma-1)} \times \\ \sum_{j \in R} b_{ij} \tau_{ijt}^{1-\sigma} \bar{A}_j^{\tilde{\sigma}\sigma} L_{jt}^{\tilde{\sigma}\left(1+\alpha_1\sigma+\frac{(1-\sigma)(1-\mu)}{\mu}\right)} & V_{jt}^{\frac{\tilde{\sigma}(1-\sigma)}{\mu}} \bar{H}_j^{\frac{\tilde{\sigma}(\mu-1)(1-\sigma)}{\mu}} L_{jt-1}^{\sigma\tilde{\sigma}\alpha_2}, \end{aligned} \tag{A.8}$$

$$\Pi_{it}^{\theta} = \sum_{j \in R} m_{ij}^{-\theta} V_{jt}^{\theta}, \tag{A.9}$$

$$L_{it} V_{it}^{-\theta} = \sum_{j \in R} m_{ij}^{-\theta} \Pi_{jt}^{-\theta} L_{jt-1}, \tag{A.10}$$

where ϕ is a constant that is pinned down by the total population size $\sum_{k \in R} L_{kt} = \bar{L}_t$. Next, consider the long-run steady state of the model. There will still be migration in the model in the steady-state, but bilateral flows will cancel out leaving the relative size of all cities fixed. The long-run steady state is characterized by $L_{it} = L_{it-1}$ for all i. Using this condition gives the following system of equations for the steady state of the model. It is also used to infer the location fundamentals.

$$\begin{aligned} L_{it}^{\tilde{\sigma}\left(1-\sigma\frac{\mu-1}{\mu}-(\alpha_1+\alpha_2)(\sigma-1)\right)} V_{it}^{\frac{\tilde{\sigma}\sigma}{\mu}} &= \bar{A}_i^{\tilde{\sigma}(\sigma-1)} \bar{H}_i^{\frac{(1-\mu)\tilde{\sigma}\sigma}{\mu}} \times \\ \sum_{j \in R} b_{ij} \tau_{ijt}^{1-\sigma} \bar{A}_j^{\tilde{\sigma}\sigma} L_{jt}^{\tilde{\sigma}\left(1+(\alpha_1+\alpha_2)\sigma+\frac{(1-\sigma)(1-\mu)}{\mu}\right)} & V_{jt}^{\frac{\tilde{\sigma}(1-\sigma)}{\mu}} \bar{H}_j^{\frac{\tilde{\sigma}(\mu-1)(1-\sigma)}{\mu}} \end{aligned} \tag{A.11}$$

$$\Pi_{it}^{\theta} = \sum_{j \in R} m_{ij}^{-\theta} V_{jt}^{\theta} \tag{A.12}$$

$$L_{it}V_{it}^{-\theta} = \sum_{j\in R} m_{ij}^{-\theta}\Pi_{jt}^{-\theta}L_{jt}. \tag{A.13}$$

B.2 Existence and Uniqueness

The existence and uniqueness of the equilibrium and steady state of the model can be characterized using the results in Allen and Donaldson (2022) and Allen, Arkolakis and Li (2024). The system in equations A.8, A.9, and A.10 contain $3 \times R$ endogenous variables for each period t. Ordering the endogenous variables as L, V, and Π gives the following matrices of coefficients,

$$\mathbf{B} = \begin{bmatrix} \tilde{\sigma}(1-\sigma\frac{\mu-1}{\mu} - \alpha_1(\sigma-1)) & \frac{\tilde{\sigma}\sigma}{\mu} & 0 \\ 0 & 0 & \theta \\ 1 & -\theta & 0 \end{bmatrix}, \tag{A.14}$$

$$\mathbf{\Gamma} = \begin{bmatrix} \tilde{\sigma}(1+\alpha_1\sigma + \frac{(1-\sigma)(1-\mu)}{\mu}) & \frac{\tilde{\sigma}(1-\sigma)}{\mu} & 0 \\ 0 & \theta & 0 \\ 0 & 0 & -\theta \end{bmatrix}. \tag{A.15}$$

Allen, Arkolakis and Li (2024) show that there exists a unique equilibrium if the largest eigenvalue of $\mathbf{A}$, where $\mathbf{A}_{hh'}$ is the absolute value of the corresponding element of $\mathbf{\Gamma}\mathbf{B}^{-1}$. As the equations pinning down the steady state are the same as for the equilibrium except for the parameters, the existence and uniqueness follow directly from the above condition where α_1 is replaced by $\alpha_1 + \alpha_2$. For the baseline calibration of the model, the spectral norm is approximately 0.9 in both cases. As a result, the equilibrium and steady state are both unique.

B.3 Comparative Statics

The deterministic component of indirect utility is given by $V_{it} = w_{it}P_{it}^{-\mu}r_{it}^{\mu-1} / \mu$ where again $r_{it} = (1-\mu)w_{it}L_{it} / \bar{H}_i$ and assuming quasi-symmetric trade costs $w_{it}^{1-\sigma}A_{it}^{\sigma-1} \propto w_{it}L_{it}P_{it}^{\sigma-1}$. As a result, $V_{it}^{-\sigma} = w_{it}^{-\mu\sigma}P_{it}^{\mu\sigma}L_{it}^{\sigma(1-\mu)}\bar{H}_i^{\sigma(\mu-1)}$ and $w_{it}^{-\sigma\mu} \propto A_{it}^{\mu(1-\sigma)}L_{it}^{\mu}P_{it}^{\mu(\sigma-1)}$. This gives,

$$L_{it}^{\mu+\sigma(1-\mu)+\alpha_1\mu(1-\sigma)} \propto V_{it}^{-\sigma}\bar{A}_i^{\mu(\sigma-1)}L_{it-1}^{\alpha_2\mu(\sigma-1)}P_{it}^{\mu(1-2\sigma)}\bar{H}_i^{\sigma(1-\mu)}, \tag{A.16}$$

which in turn gives,

$$\nu \ln L_{it} = \kappa - \sigma \ln V_{it} + \alpha_2 \mu(\sigma - 1) \ln L_{it-1} - \mu(2\sigma - 1) \ln P_{it} + \mu(\sigma - 1) \ln \bar{A}_i + \sigma(1 - \mu) \ln \bar{H}_i, \tag{A.17}$$

where $\nu = \mu + \sigma(1 - \mu) + \alpha_1 \mu(1 - \sigma)$ and κ is a constant. Next, the expression is used to solve for the current population as a function of the full path of endogenous and exogenous variables,

$$\ln L_{it} = \psi + \left(\frac{\alpha_2 \mu(\sigma - 1)}{\nu}\right)^t \ln L_{i0} - \frac{\sigma}{\nu} \sum_{k=0}^{t-1} \left(\frac{\alpha_2 \mu(\sigma - 1)}{\nu}\right)^k \ln V_{it-k} - \frac{\mu(2\sigma - 1)}{\nu} \sum_{k=0}^{t-1} \left(\frac{\alpha_2 \mu(\sigma - 1)}{\nu}\right)^k \ln P_{it-k} + \tilde{A}_i + \tilde{H}_i, \tag{A.18}$$

where $\tilde{A}_i = \ln \bar{A}_i \mu(\sigma - 1) \sum_{k=0}^{t-1} \left(\frac{\alpha_2 \mu(\sigma - 1)}{\nu}\right)^k$ and $\tilde{H}_i = \ln \bar{H}_i \sigma(1 - \mu) \sum_{k=0}^{t-1} \left(\frac{\alpha_2 \mu(\sigma - 1)}{\nu}\right)^k$.

To analyze the comparative statics underlying the reduced form exercise consider the above equation, I consider the direct effect of a reduction in the trade cost to Europe in period k for city i (that is a change in τ_{eik}), while ignoring general equilibrium effects. First note that the elasticity of the city's population size today with respect to the price index in period k is given by

$$\frac{\partial \ln L_{it}}{\partial \ln P_{ik}} = -\frac{\mu(2\sigma - 1)}{v} \left(\frac{\alpha_2 \mu(\sigma - 1)}{v}\right)^k < 0. \tag{A.19}$$

Next, lower trade costs to Europe in period k lead to a lower price index for city i.

$$\frac{\partial P_{ik}}{\partial \tau_{eik}} = P_{ik}^{\sigma} \tau_{eik} b_{ei} \left(\frac{w_{ek}}{A_{ek}}\right)^{1-\sigma}. \tag{A.20}$$

As a result, a lower trade cost to Europe has a persistent and positive effect on the population size in location i, that is $\frac{\partial \ln L_{it}}{\partial \tau_{eik}} < 0$. Moreover, when $\alpha_2 \mu(\sigma - 1) / \nu < 1$, it follows that $\lim_{l \to \infty} \partial \ln L_{it} / \partial \tau_{iel} = 0$. Finally, consider the effect of changes in trade for cities differing in initial market size (captured by A_{ik}). Since $\partial P_{ik} / \partial A_{ik} < 0$, it follows that the marginal impact of τ_{eik} declines as A_{ik} becomes larger.

C Further Historical Background

This section provides an extended discussion about the historical background for the analysis. As in the main body of the text, I discuss the background and the motivation for the trade reform as well as the historical relationship between trade and economic development within the Spanish Empire.

A central aim of commercial policy in the 18th century was to promote state wealth acquisition through trade surpluses (Findlay and O'Rourke, 2007). In the Spanish context, this was achieved through a range of policies restricting trade. First, trade was limited to four ports in the Americas (Cartagena de Indias, El Callao, Portobello/Nombre de Dios, and Veracruz) and only Seville/Cádiz in Europe. Further, the frequency of travel and the routes were restricted. Typically, only two fleets left Spain every year: the New Spain *flota* destined for Veracruz, and the *Tierra Firme galeones* destined for Cartagena and Portobello. In the Pacific, shipping was conducted by *Armada del Sur*, which carried goods from the trade fairs in Portobello to Pacific ports in South America (Walker, 1979). Moreover, the Manilla galleon would sail between Acapulco and Manilla. Official information was carried by *aviso* ships, which were light carriers operating separately from the commercial system and were not permitted or equipped to carry freight. Third, participation in Atlantic trade was restricted to Spanish merchants. Finally, there were high tax rates on imports and exports. The duties typically depended on the origin of the goods, with lower rates on goods originating from Spain. These measures effectively monopolized trade in the merchant guilds in Seville (later Cadiz), Mexico City, and Lima, and only the merchant guilds of these cities were allowed to buy and sell goods at the trade fairs at Veracruz and Portobelo. These locations then in turn managed trade with other locations in their respective viceroyalties, typically transported by third parties using mule trains or wagons depending on road conditions. The system limited trade with Europe across large parts of the Spanish empire in America, however, there was still some maritime communication and trade occurring in locations too remote relative to the large trade routes. In addition to dispatch ships (*avisos*), ships sailing under special permission of the crown (*registros*) occasionally supplied ports that were too remote relative to the large trade routes. However, this was never done at a sufficiently large scale (Walker, 1979) and increased the reliance on contraband trade which was sizeable (Christelow, 1942). While as a rule, there were no restrictions on inter-regional trade (Elliott, 2006, p. 111), there were cases where inter-regional was discouraged. For example, there were policies in place to limit trade between the Viceroyalties of Peru and New Spain to reduce the demand for the goods of the Manilla Galleon in Peru. Another example is the erection of a customs barrier in Córdoba (Argentina) in 1618 (Scobie, 1971, p. 53).

Mercantilist restrictions and high trade costs ensured that trade was limited to non-competing goods with a high value-to-weight ratio. Important exports during the period beyond precious metals were hides, tallow, sugar, indigo, and cochineal (Rahn Phillips, 1990). The slave trade was subject to different rules. Trade of slaves was allowed for British ships from the early to the mid-18th century as a result of the treaty of Utrecht, the *asiento* (Walker, 1979). These measures facilitated the naval defense of convoys and limited imports to the Americas, thus limiting the flow of bullion to other places than the Iberian Peninsula while keeping prices for Spanish exports artificially high. It also facilitated the managing of risk in a context where long shipping times and costly communication made it difficult to predict demand (Baskes, 2013). As a result, in addition to remittances directly controlled by the crown, private remittances to Spain were substantial (Cuenca-Esteban, 2008). However, a likely consequence of Spanish mercantilist policies before the liberalization in the late 18th century was the underdevelopment of peripheral areas in America (Fisher, 1997, p. 73). There were few changes to this system until the second half of the 18th century but there were some notable changes. In return for the support of France during the War of the Spanish Succession, French ships were allowed to trade along the Pacific coast for some time. Moreover, as part of the treaty of Utrecht, the English were granted the right to send a ship of 500 tons to the trade fairs. Finally, the trade fair at Veracruz was moved inland to Jalapa.

Reforming transatlantic trade. Beginning in the 18th century, Spanish policymakers were induced by geopolitical considerations, originating mainly in Europe, to overhaul the external trading system (Elliott, 2006). In the immediate aftermath of Spain's defeat in the Seven Years' War, a special *junta* was appointed under Charles III to "review ways to address the backwardness of Spain's commerce with its colonies and foreign nations" Stein and Stein (2003). Drawing on ideas for reforming the system of government in America that had been circulating for a long time, the *junta* proposed the abolition of the Cádiz monopoly as well as the fleet system. Further, it proposed opening 14 ports on the Iberian Peninsula as well as 35 ports in the Americas (Fisher, 1997). The ports that were opened on the Iberian peninsula in this period were Malaga, Almería, Cartagena, Alicante, Tortosa, Barcelona, Santander, Gijón, La Coruña, Palma de Mallorca, Santa Cruz de Tenerife. While the reform is believed to have a role in promoting the rise of the Barcelona textile industry, in the early 19th century, around 80 percent of Spanish trade with the Americas still went through the port of Cádiz (Fisher, 1997). Several ports in the Caribbean were opened already in 1765. Santo Domingo, Puerto Rico, Margarita, and Trinidad were opened for direct trade with Spain in 1765. Further, reform was slowed by the Esquilache riots in 1766 and the liberalization measures culminated in the decree of free trade in 1778, which opened several of the remaining ports. This was except Venezuela (Caracas), where it was believed the Caracas company's tobacco monopoly was worth protecting, and New Spain. Even so, especially Veracruz was affected by the changes before the late 1780s due to the abolition of the convoy system and the increased prevalence of register ships. In the 1780s, the remaining ports followed. Spanish communication with the Americas was disrupted during the Napoleonic wars (O'Rourke, 2006). Out of necessity, trade with neutral nations was therefore allowed. This marked the end of Spain's ability to enforce protected trade with the colonies. By the beginning of the 19th century, Spanish America enjoyed *de facto* although not *de jure* unrestricted trade with foreigners (Fisher, 1998). As a result, direct trade with Britain, not mediated through Spain, grew in importance (Prados de la Escosura and Casares, 1983). Independence was mostly followed by high tariffs, mainly driven by the revenue needs of post-independence governments (Coatsworth and Williamson, 2004).

The historical literature emphasizes the role of European interstate competition and the resulting increased need for a modernized imperial defense as motivating the reform. Thus, the drive to reform the Spanish commercial system can be understood as being motivated by the intense interstate competition between the European states of the 18th century (Kuethe and Andrien, 2014). Highlighted in the historical literature as an important impetus for the reform was the "humiliating" capture of Havana and Manila by the British during the Seven Years' War. This opened a window of opportunity for reform-minded policymakers in Spain who now could justify reforming the commercial system with concerns about the territorial integrity of the empire in what has been described in the historical literature as a "defensive modernization" (Stein and Stein, 2003). Furthermore, the commercial expansion of Havana during the British occupation showcased the economic potential of the Spanish colonies.

The reform was therefore implemented rapidly after the Seven Years' War (Fisher, 1997). As a result, the timing of the reform is mainly driven by intensified interstate competition in Europe, rather than economic development in the Americas directly. Moreover, the reform was implemented from above, and no significant ports in which the policies were applied were excluded. This is also apparent from the fact that the policies were resisted by powerful interests in the Spanish Empire (Baskes, 2013). Finally, the selection of ports is unlikely to be driven by the perceived commercial potential of its hinterland. This is apparent when considering the case of New Spain. As the most important colony of the Spanish empire in America, it was believed New Spain would have diverted too much trade away from other regions (Fisher, 1997). Moreover, avoiding confrontation with merchants in New Spain whose resources were a key source of revenue for the crown. As a result, New Spain was not subject to the reform until the late 1780s.

It is generally agreed upon that the reform increased trade. This was recognized by contemporaries as well as in the historical literature. Floridablanca (minister under Charles III) wrote about a fortunate revolution (*feliz revolución*) when referring to Spanish export growth after 1778. When referring to Veracruz, went from "gloomy and ugly" to "elegant and growing" (Stein and Stein, 2003). The magnitudes in the economic history literature are contested (Cuenca-Esteban, 2008). Colonial imports to Spain increased tenfold and exports from Spain to the colonies fourfold according to Fisher (1985), while more modest estimates are found in Cuenca-Esteban (2008), also suggesting large effects. Fisher (1993) provides data on the composition of Spanish imports from Spanish America between 1782 and 1796 for the ports of Cadiz and Barcelona (which accounted for around 88 percent of imports from Spanish America). Precious metals still accounted for 56.4 percent of imports through this period. The other commodities were typically high-value agricultural commodities (tobacco 13.6, cacao 7.8, sugar 5.5, indigo 5.2, cochineal 4.2, hides 3.4 and cotton 0.4 percent) (Fisher, 1993). Cadiz remained the dominant port for trade with Spanish America between 1778 and 1796 (76.4 percent of total exports and 84.2 percent of imports). The remaining important ports were Barcelona (9.6 and 3.8 percent), Malaga (4.8 and 1.3 percent), Santander (3.3 and 2.6 percent), and La Coruña (3 and 6.8 percent) (Fisher (1993) p.20 and p.25).

Some accounts highlight that the lower trade costs induced by the reform promoted agricultural development. "...for the first time, the metropolis succeeded in unleashing the agricultural potential of its American possessions whilst also promoting the continued expansion of mining production. The relationship between this economic growth and the liberalization of trade is abundantly clear", (Fisher, 1997, p. 197). Moreover, lower trade costs induced by unrestricted sailing potentially allowed for specialization in a wider range of commodities, such as more perishable goods. However, bullion remained an important export commodity (Fisher (1997), p. 38). Moreover, it has been argued that the population and economies of previously stagnant peripheral colonies in Spanish America grew rapidly (Mahoney, 2010). In summary, the historical literature suggests the restrictions imposed on trade in goods with the Americas stunted economic development, and efforts induced by European interstate competition to relax these marked the beginning of a process that would have important effects on trade and economic development in the second half of the 18th century.

D Additional Results

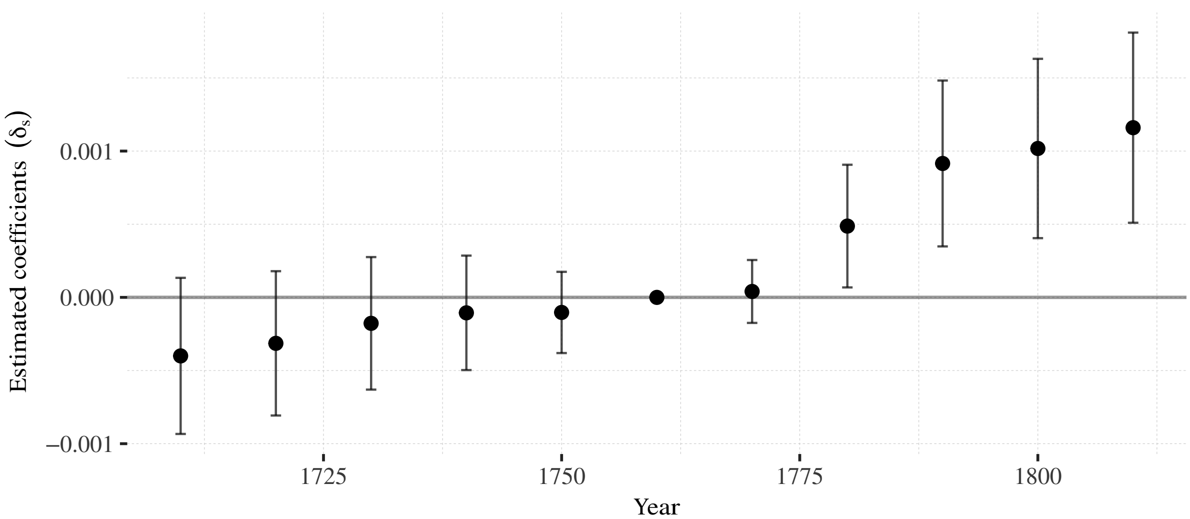

Figure A3: The figure depicts the estimated coefficients of the reduction in transportation times to Europe interacted with time indicators from Equation 6. *Dependent variable:* Indiciator variable taking the value one if the grid cell contains a settlement. *Observations:* 5,3581 cells observed every decade between 1710 and 1810. $5,3581 \times 11 = 58,9391$ observations. *Standard errors:* Clustered at the grid-cell level. 5,3581 clusters.

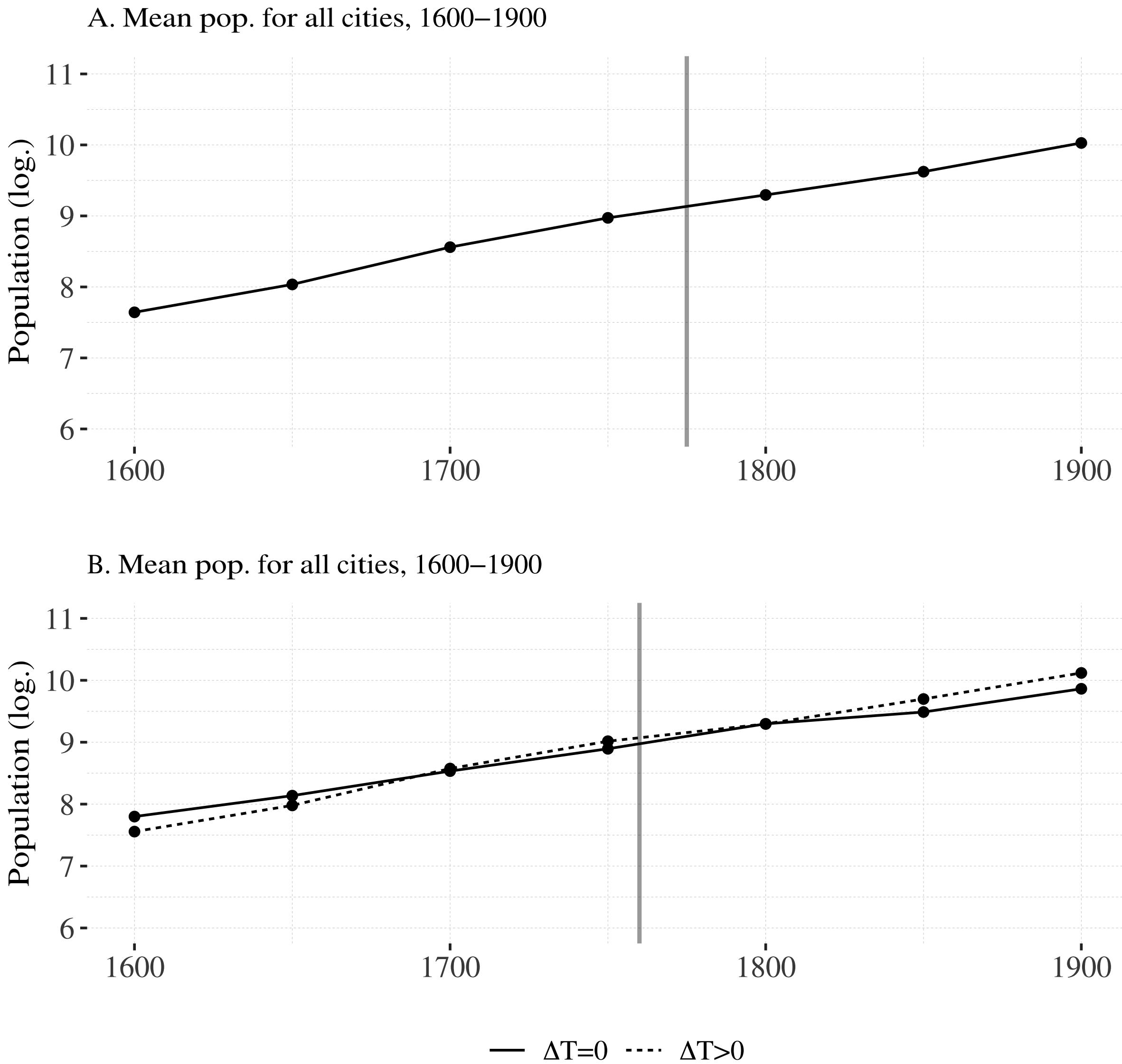

Figure A4: The figure depicts the average population across the cities in the full sample. Panel A. depicts the average population (log.) across all the cities. Panel B. depicts the average population (log.) by treatment status. $\Delta T_i > 0$ denotes cities that experienced changes in transportation times to Europe due to the reform. $\Delta T_i = 0$ denotes cities that did not experience changes in transportation times to Europe due to the reform.

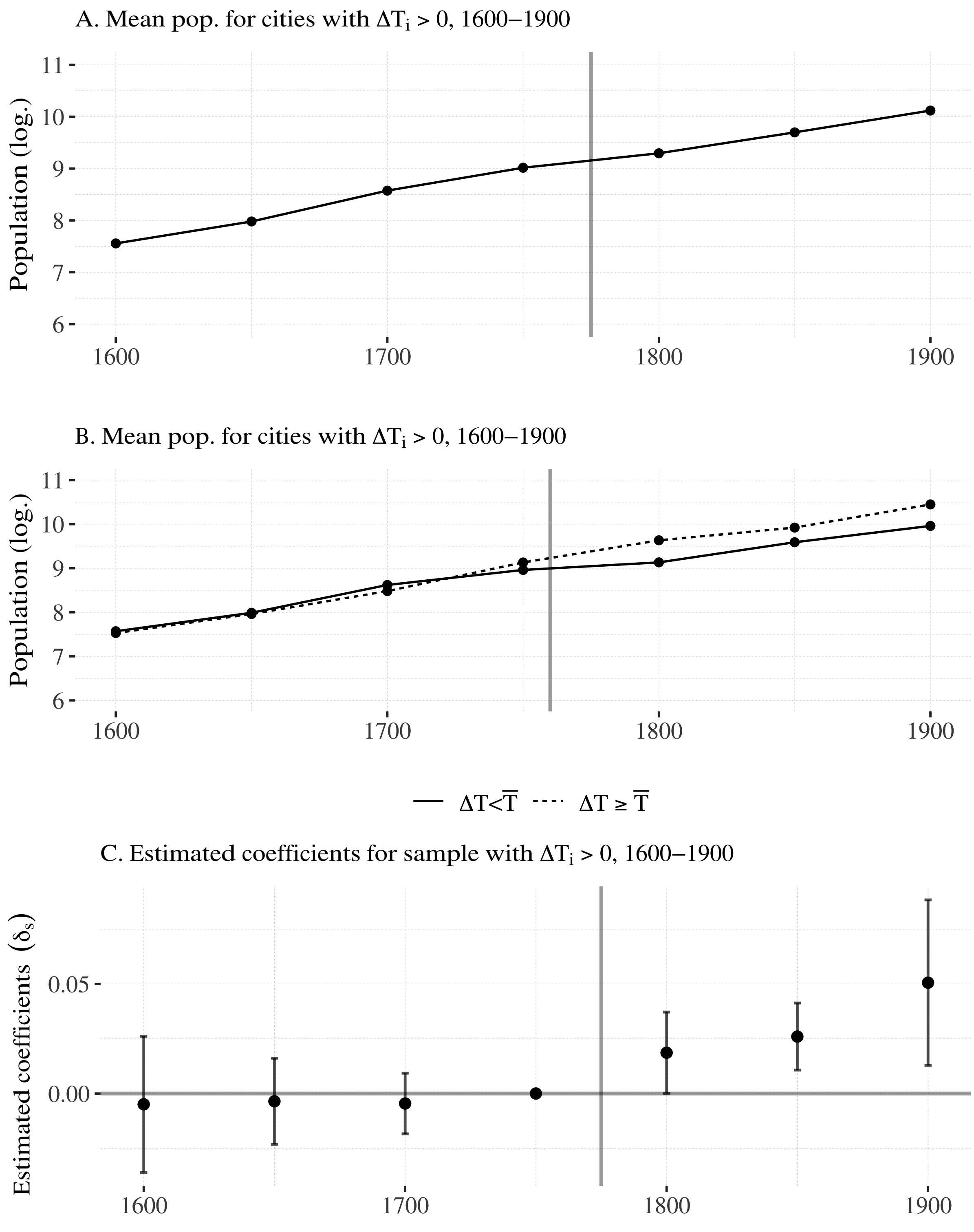

Figure A5: Panel A. depicts the mean population for cities. Panel B. depicts the average population by treatment intensity. $\bar{T}$ denotes the average change in transportation times. Panel C. depicts the estimated coefficients of the reduction in transportation times to Europe interacted with time indicators from Equation 6. The sample is restricted to cities with $\Delta T_i > 0$.

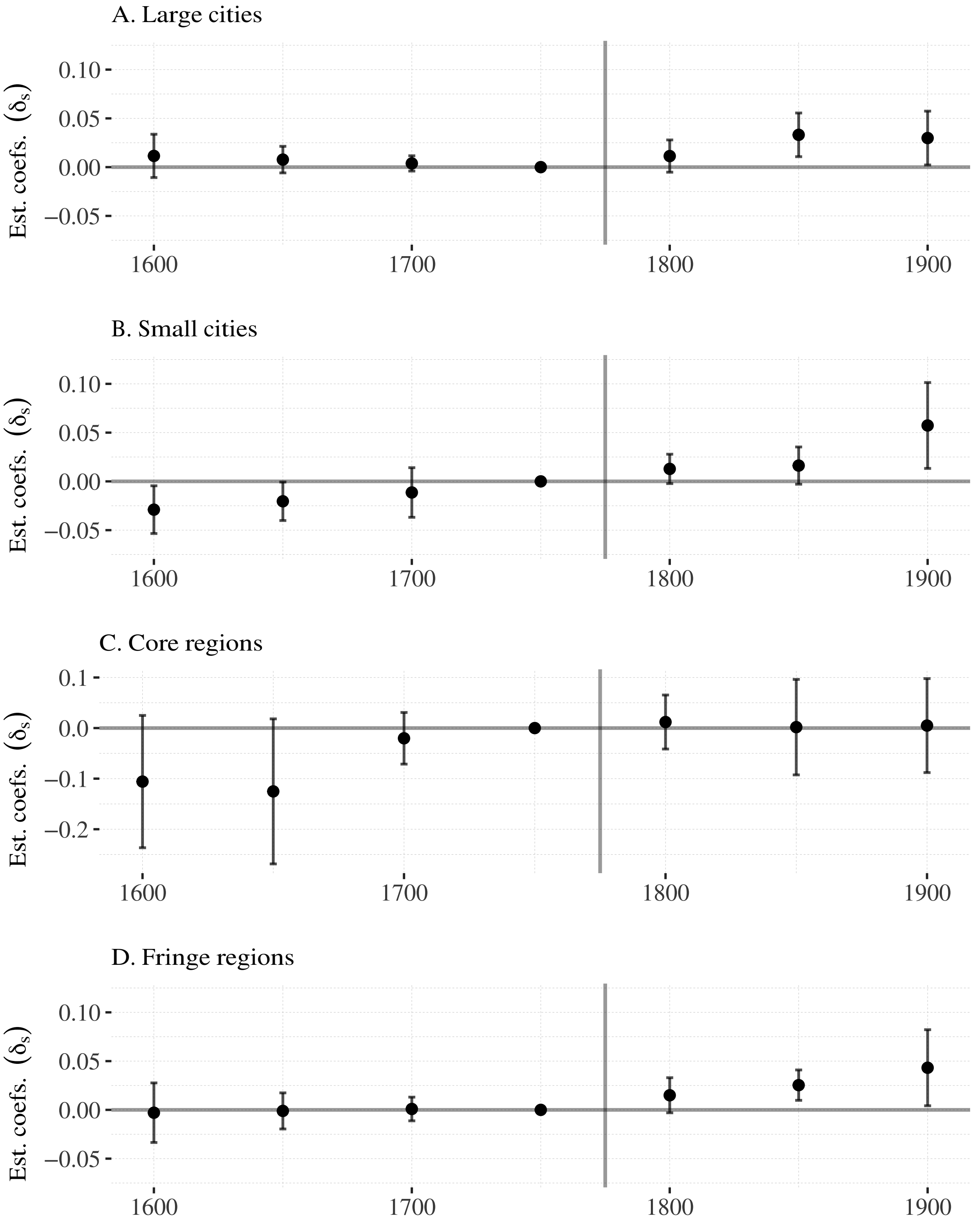

Figure A6: The figure depicts the estimated coefficients of the reduction in transportation times to Europe interacted with time indicators from Equation 6. Panel A./B. is estimated on the sample of cities with a population above/below the median in 1750. Panel A./B. is estimated on the sample of cities in the core/fringe regions.

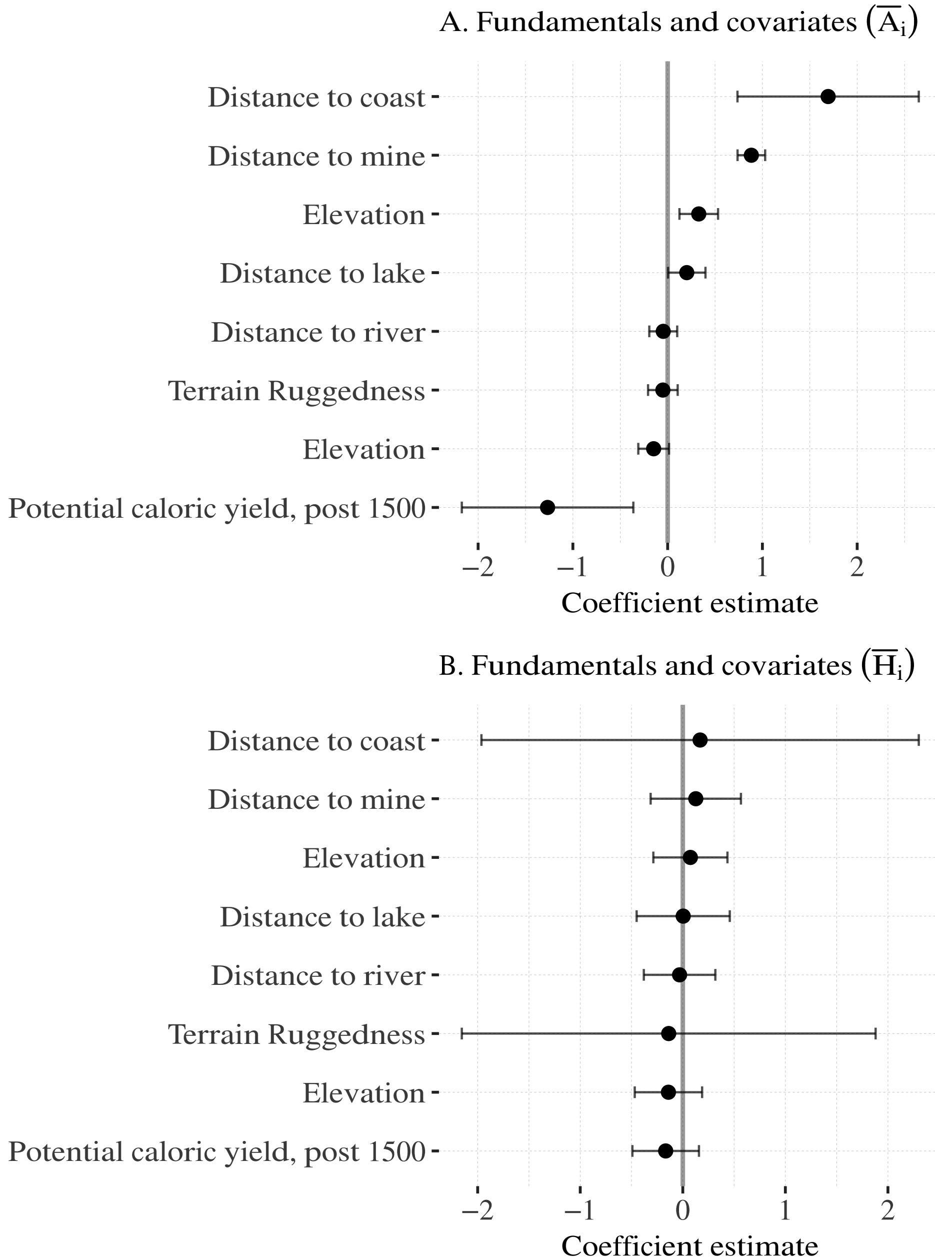

Figure A7: The figure depicts the correlates of the locational fundamentals implied by the model ($\bar{A}$ and $\bar{H}$) and 95 percent confidence intervals. The variables are standardized.

Table A2: Historical agglomeration spillovers

Dependent variable:	City population in 1800 (log.)				
	(1)	(2)	(3)	(4)	(5)
Hist. prod. spillover (α_2)	0.069	0.020	0.022	0.024	0.019
	(0.026)	(0.016)	(0.017)	(0.019)	(0.014)
Controls		✓		✓	✓
Country FE			✓	✓	
Viceroyalty FE					✓
Mean DV	9.296	9.296	9.296	9.296	9.296
N	62	62	62	62	62
R^2	0.974	0.993	0.995	0.997	0.994

Note: The table reports OLS estimates. The unit of observation is a city between 1750-1800. Regressions are based on 62 cities. *Dependent variable:* The natural logarithm of the population size in 1800. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A3: Counterfactuals (fundamentals equalized)

Scenario:	Benchmark		Fixed migration frictions	
	Mean	25th/75th perc.	Mean	25th/75th perc.
Panel A: All cities				
$\Delta P(\%)$	-0.41	[-0.25, 0]	-0.35	[-0.2, 0.01]
$\Delta L(\%)$	0.97	[0.04, 0.67]	0.39	[-0.03, 0.22]
$\Delta V(\%)$	-0.15	[-0.11, -0.02]	0.1	[0.01, 0.06]
Panel B: Core region				
$\Delta P(\%)$	-0.1	[-0.01, 0]	-0.08	[0.01, 0.01]
$\Delta L(\%)$	0.26	[0.04, 0.06]	0.06	[-0.04, -0.03]
$\Delta V(\%)$	-0.05	[-0.02, -0.02]	0.03	[0.01, 0.01]
Panel C: Fringe region				
$\Delta P(\%)$	-0.61	[-0.8, 0]	-0.52	[-0.62, 0.01]
$\Delta L(\%)$	1.42	[0.05, 2.22]	0.6	[-0.03, 0.71]
$\Delta V(\%)$	-0.21	[-0.37, -0.02]	0.15	[0.01, 0.17]

Note: The table reports the results from the baseline counterfactual exercises. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The *Benchmark* assumes migration frictions change. *Fixed migration frictions* assume migration frictions remain fixed at 1760 values. The unit of observation is a city.

Table A4: Counterfactuals (pre-reform population equalized)

Scenario:	Benchmark		Fixed migration frictions	
	Mean	25th/75th perc.	Mean	25th/75th perc.
Panel A: All cities				
$\Delta P(\%)$	-0.62	[-0.72, 0.01]	-0.55	[-0.69, 0.01]
$\Delta L(\%)$	1.3	[-0.07, 1.34]	0.65	[-0.01, 0.78]
$\Delta V(\%)$	-0.14	[-0.1, 0.02]	0.15	[0, 0.2]
Panel A: Core region				
$\Delta P(\%)$	-0.12	[0.01, 0.01]	-0.11	[0, 0.01]
$\Delta L(\%)$	0.24	[-0.07, -0.03]	0.12	[-0.02, 0]
$\Delta V(\%)$	-0.02	[0.01, 0.02]	0.03	[0, 0.01]
Panel A: Fringe region				
$\Delta P(\%)$	-0.93	[-1.27, 0.01]	-0.83	[-0.96, 0.01]
$\Delta L(\%)$	1.98	[-0.07, 3.39]	0.98	[-0.01, 1.11]
$\Delta V(\%)$	-0.21	[-0.27, 0.02]	0.23	[0, 0.26]

Note: The table reports the results from the baseline counterfactual exercises. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The *Benchmark* assumes migration frictions change. *Fixed migration frictions* assume migration frictions remain fixed at 1760 values. The unit of observation is a city.

Table A5: Counterfactuals (size of shock equalized)

Scenario:	Benchmark		Fixed migration frictions	
	Mean	25th/75th perc.	Mean	25th/75th perc.
Panel A: All cities				
$\Delta P(\%)$	-0.63	[-0.74, -0.37]	-0.57	[-0.68, -0.32]
$\Delta L(\%)$	1.24	[0.84, 1.52]	0.65	[0.37, 0.78]
$\Delta V(\%)$	-0.11	[-0.14, -0.07]	0.16	[0.08, 0.19]
Panel B: Core region				
$\Delta P(\%)$	-0.53	[-0.72, -0.35]	-0.47	[-0.66, -0.3]
$\Delta L(\%)$	1.08	[0.79, 1.47]	0.53	[0.35, 0.74]
$\Delta V(\%)$	-0.11	[-0.14, -0.09]	0.13	[0.08, 0.18]
Panel C: Fringe region				
$\Delta P(\%)$	-0.7	[-0.83, -0.49]	-0.64	[-0.75, -0.42]
$\Delta L(\%)$	1.34	[1.01, 1.68]	0.72	[0.48, 0.86]
$\Delta V(\%)$	-0.11	[-0.13, -0.06]	0.18	[0.11, 0.21]

Note: The table reports the results from the baseline counterfactual exercises. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The *Benchmark* assumes migration frictions change. *Fixed migration frictions* assume migration frictions remain fixed at 1760 values. The unit of observation is a city.

Table A6: Counterfactuals (no trans-Atlantic migration)

Scenario:	Benchmark		Fixed migration frictions	
	Mean	25th/75th perc.	Mean	25th/75th perc.
Panel A: All cities				
$\Delta P(\%)$	-0.61	[-0.74, -0.32]	-0.61	[-0.74, -0.32]
$\Delta L(\%)$	0.34	[0.01, 0.5]	0.34	[0.01, 0.5]
$\Delta V(\%)$	0.37	[0.29, 0.4]	0.37	[0.29, 0.4]
Panel B: Core region				
$\Delta P(\%)$	-0.5	[-0.72, -0.29]	-0.5	[-0.72, -0.29]
$\Delta L(\%)$	0.2	[-0.03, 0.46]	0.2	[-0.03, 0.46]
$\Delta V(\%)$	0.34	[0.28, 0.39]	0.34	[0.28, 0.39]
Panel C: Fringe region				
$\Delta P(\%)$	-0.69	[-0.84, -0.45]	-0.69	[-0.84, -0.45]
$\Delta L(\%)$	0.42	[0.16, 0.61]	0.42	[0.16, 0.61]
$\Delta V(\%)$	0.39	[0.32, 0.42]	0.39	[0.32, 0.42]

Note: The table reports the results from the baseline counterfactual exercises. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The *Benchmark* assumes migration frictions change. *Fixed migration frictions* assume migration frictions remain fixed at 1760 values. The unit of observation is a city.

E Sensitivity Analysis

E.1 Synthetic Control Design

In this section, I explore an alternative approach by implementing a synthetic control design (SCM) (Abadie, 2021). Specifically, I compare the growth in population size between cities that were directly affected by the reform ($\Delta T_i > 0$) and cities that were not ($\Delta T_i = 0$). I first average the population size across all treated cities and compare this to "never-treated" cities. The 22 never-treated cities constitute the donor pool. The synthetic group is constructed as a weighted average of cities in the donor pool, with weights chosen to minimize the mean squared error before 1750. The covariates chosen are the controls in the baseline model (caloric yield, distance to the coast, terrain ruggedness, distance to nearest lake, distance to nearest river, and maize and wheat suitability) as well as log. population size in 1600.

Panel A. Figure A8 displays the SCM results. First, one can see that the pre-reform population is closely matched between the synthetic and control and treated cities. The gap between the two groups began diverging in 1800. The treatment effect is given by 0.192, suggesting a treatment effect of approximately 19 percent over the course of one century.

I assess the robustness of the estimates by constructing placebo SCMs by re-estimating the synthetic control after assigning each city in the donor pool to the treatment. I then calculate the ratio of the pre and post-RMSE for each placebo treatment group. Reassuringly, I find that the largest ratio of pre to post-RSME is obtained for the true treatment. This suggests that the reform promoted the growth of cities that experienced reductions in their transportation times as a result of the reform and independence from Spain in the 19th century. However, there are two important shortcomings of the analysis. First, there are relatively few pre and post-intervention periods for which data is available. Second, even locations that are not directly affected by lower transportation times might experience equilibrium spillovers as highlighted by the quantitative framework. Nevertheless, it is reassuring that the findings with this alternative approach are qualitatively similar to the findings in the main analysis.

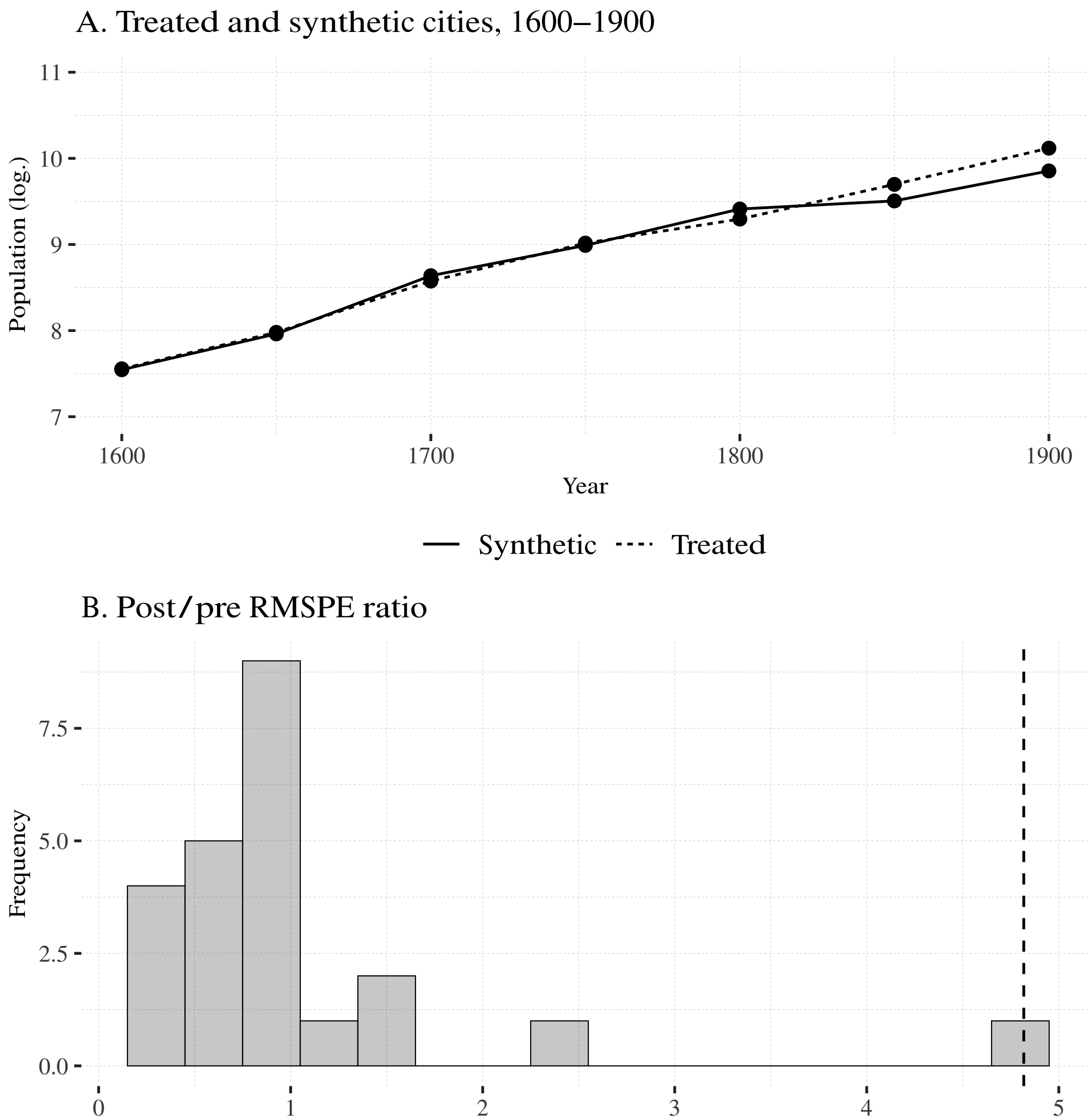

Figure A8: Panel A depicts the the results from the synthetic control design. The treatment group is the average population size for the cities in this group that experienced reductions in their transportation times to Europe. Panel B depicts a placebo exercise where each city in the donor pool is assigned the treatment.

E.2 Robustness Value

I consider the stability of the estimates in the baseline specification when including covariates. It is reassuring that the estimated effect is stable with the inclusion of these covariates. Moreover, the increase in the R^2 shows that the variables explain variation in the decline in shipping times and urban growth. A more systematic approach to sensitivity analysis is developed in Cinelli and Hazlett (2020). In this section, I estimate the sensitivity of the estimated impact of transportation times to Europe on population growth to unobserved confounders. Specifically, I follow the procedure developed in Cinelli and Hazlett (2020) and calculate the robustness value which quantifies the strength required by any unobserved confounder to account for the estimates in the baseline model. Alternatively, the strength needed from an unobserved confounder to render the coefficient statistically insignificant.

I find that a robustness value of 19.1 to account for a true effect of zero, and 9.5 to account for a true effect that is statistically insignificant. In other words, if there exists a confounder that explains 19.1 of the outcome and the treatment, then controlling for this confounder would make the effect of declining shipping time zero. Unfortunately, there are few time-varying covariates available that could serve as a benchmark for the magnitude of this effect. However, it should be noted that this is larger than the combined R^2 of the observable location fundamentals. This suggests that the estimated impact of the decline in shipping time is unlikely to be driven by an unobserved confounder.

E.3 Sensitivity Analysis

Table A7: Shipping time and urban population growth (interior cities)

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	−0.023	−0.019	−0.028	−0.026	−0.031
	(0.011)	(0.016)	(0.022)	(0.020)	(0.019)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.58	8.58	8.58	8.58	8.58
N	186	186	186	186	186
R^2	0.907	0.938	0.917	0.935	0.910

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The sample contains cities more than 228km from a port in 1750. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A8: Shipping time and urban population growth (removing outliers)

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	-0.020	-0.019	-0.018	-0.028	-0.021
	(0.009)	(0.011)	(0.010)	(0.010)	(0.008)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.502	8.502	8.502	8.502	8.502
N	306	306	306	306	306
R^2	0.901	0.919	0.908	0.935	0.902

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The sample contains 51 cities with population growth rates within the 5th and 95th percentiles. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A9: Shipping time and urban population growth, 1600-1800

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	-0.020	-0.015	-0.031	-0.031	-0.030
	(0.013)	(0.016)	(0.017)	(0.010)	(0.014)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.501	8.501	8.501	8.501	8.501
N	310	310	310	310	310
R^2	0.889	0.906	0.897	0.926	0.894

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A10: Shipping time and urban population growth (restricted samples)

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Panel A: Dropping Nueva Granada					
Transportation time (T_{it})	-0.025	-0.004	-0.033	-0.032	-0.032
	(0.010)	(0.016)	(0.017)	(0.010)	(0.014)
Mean DV	8.78	8.78	8.78	8.78	8.78
N	258	258	258	258	258
R^2	0.894	0.915	0.900	0.933	0.897
Panel B: Dropping Rio de la Plata					
Transportation time (T_{it})	-0.034	-0.057	-0.035	-0.033	-0.030
	(0.020)	(0.032)	(0.021)	(0.042)	(0.020)
Mean DV	8.78	8.78	8.78	8.78	8.78
N	318	318	318	318	318
R^2	0.894	0.909	0.897	0.927	0.895
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓

Note: The table reports OLS estimates. T_{it} denotes transportation time to Europe measured in days. The unit of observation is a city between 1550-1850. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A11: Shipping time and urban population growth (weighted by population)

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Transportation time (T_{it})	-0.027	-0.020	-0.035	-0.029	-0.035
	(0.009)	(0.014)	(0.016)	(0.009)	(0.014)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.688	8.688	8.688	8.688	8.688
N	372	372	372	372	372
R^2	0.878	0.897	0.886	0.920	0.882

Note: The table reports OLS estimates weighted by population size. T_{it} denotes transportation time to Europe measured in days. The unit of observation is a city between 1550-1850. Regressions are based on a balanced panel of 7 time periods (outcomes measured every 50 years) × 59 cities = 413 observations. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A12: Distance and urban population growth

Dependent variable:	City population (log.)				
	(1)	(2)	(3)	(4)	(5)
Distance (D_{it})	−0.299	−0.180	−0.344	−0.275	−0.386
	(0.160)	(0.179)	(0.177)	(0.302)	(0.164)
City & Year FE	✓	✓	✓	✓	✓
Controls × Year FE		✓			
Viceroyalty × Year FE			✓		
Country × Year FE				✓	
Viceroyalty × Time trend					✓
Mean DV	8.688	8.688	8.688	8.688	8.688
N	372	372	372	372	372
R^2	0.880	0.899	0.886	0.919	0.882

Note: The table reports OLS estimates. Distance$_{it}$ denotes the distance to Europe measured in kilometers (standardized). The unit of observation is a city between 1550-1850. Regressions are based on a balanced panel of 7 time periods (outcomes measured every 50 years) × 59 cities = 413 observations. *Dependent variable:* The natural logarithm of the population size. *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the city level.

Table A13: Dynamic regression model (cities)

Dependent variable:	City population (ln)			
	(1)	(2)	(3)	(4)
Δ T $\times$ $\mathbb{1}$ (*year* = 1600)	−0.012	−0.012	−0.020	−0.029
	(0.011)	(0.025)	(0.027)	(0.045)
Δ T $\times$ $\mathbb{1}$ (*year* = 1650)	−0.009	0.007	0.005	0.010
	(0.009)	(0.019)	(0.019)	(0.040)
Δ T $\times$ $\mathbb{1}$ (*year* = 1700)	−0.006	0.004	0.006	0.020
	(0.011)	(0.012)	(0.012)	(0.028)
Δ T $\times$ $\mathbb{1}$ (*year* = 1800)	0.013	0.014	0.013	−0.003
	(0.004)	(0.014)	(0.014)	(0.022)
Δ T $\times$ $\mathbb{1}$ (*year* = 1850)	0.024	0.022	0.029	0.008
	(0.009)	(0.018)	(0.020)	(0.031)
City FE	✓	✓	✓	✓
Controls $\times$ Year FE		✓	✓	✓
Viceroyalty $\times$ Year FE			✓	
Country $\times$ Year FE				✓
N	372	372	372	372
R^2	0.871	0.900	0.907	0.936

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit is a city in a certain year. The omitted year is 1750 (the last period before the reform). *Dependent variable:* log of city population size. *Controls:* Elevation, crop suitability, terrain ruggedness, the location of active mines, and distance to the coastline. *Standard errors:* Clustered at the city-level.

Table A14: Dynamic regression model (settlements)

Dependent variable:	Indicator for cell containing a settlement			
	(1)	(2)	(3)	(4)
Δ T $\times$ $\mathbb{1}$ $(year = 1710)$	−0.0004	0.001	0.0003	0.002
	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Δ T $\times$ $\mathbb{1}$ $(year = 1720)$	−0.0003	0.001	0.0004	0.002
	(0.0003)	(0.0004)	(0.0003)	(0.0004)
Δ T $\times$ $\mathbb{1}$ $(year = 1730)$	−0.0002	0.001	0.0004	0.001
	(0.0002)	(0.0003)	(0.0003)	(0.0004)
Δ T $\times$ $\mathbb{1}$ $(year = 1740)$	−0.0001	0.001	0.0003	0.001
	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Δ T $\times$ $\mathbb{1}$ $(year = 1750)$	−0.0001	0.0003	0.0001	0.001
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Δ T $\times$ $\mathbb{1}$ $(year = 1770)$	0.00004	−0.00004	0.00003	−0.0002
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Δ T $\times$ $\mathbb{1}$ $(year = 1780)$	0.0005	0.0003	0.0002	−0.0001
	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Δ T $\times$ $\mathbb{1}$ $(year = 1790)$	0.001	0.001	0.001	−0.0001
	(0.0003)	(0.0003)	(0.0003)	(0.0004)
Δ T $\times$ $\mathbb{1}$ $(year = 1800)$	0.001	0.001	0.001	0.00004
	(0.0003)	(0.0004)	(0.0004)	(0.0004)
Δ T $\times$ $\mathbb{1}$ $(year = 1810)$	0.001	0.001	0.001	0.0002
	(0.0003)	(0.0004)	(0.0004)	(0.0004)
City FE	✓	✓	✓	✓
Controls × Year FE		✓	✓	✓
Viceroyalty × Year FE			✓	
Country × Year FE				✓
N	53,581	53,581	53,548	53,581

Notes: The table reports OLS estimates. The unit of analysis is at a $0.5° \times 0.5°$ grid-cell. The omitted year is the last decade prior to the treatment (1760). *Controls:* Elevation, caloric yield pre-1500, crop suitability (wheat, maize), terrain ruggedness, the distance to the nearest mine, distance to the nearest coastline, distance to the nearest major river, and distance to the nearest lake. *Standard errors:* Clustered at the grid-level.

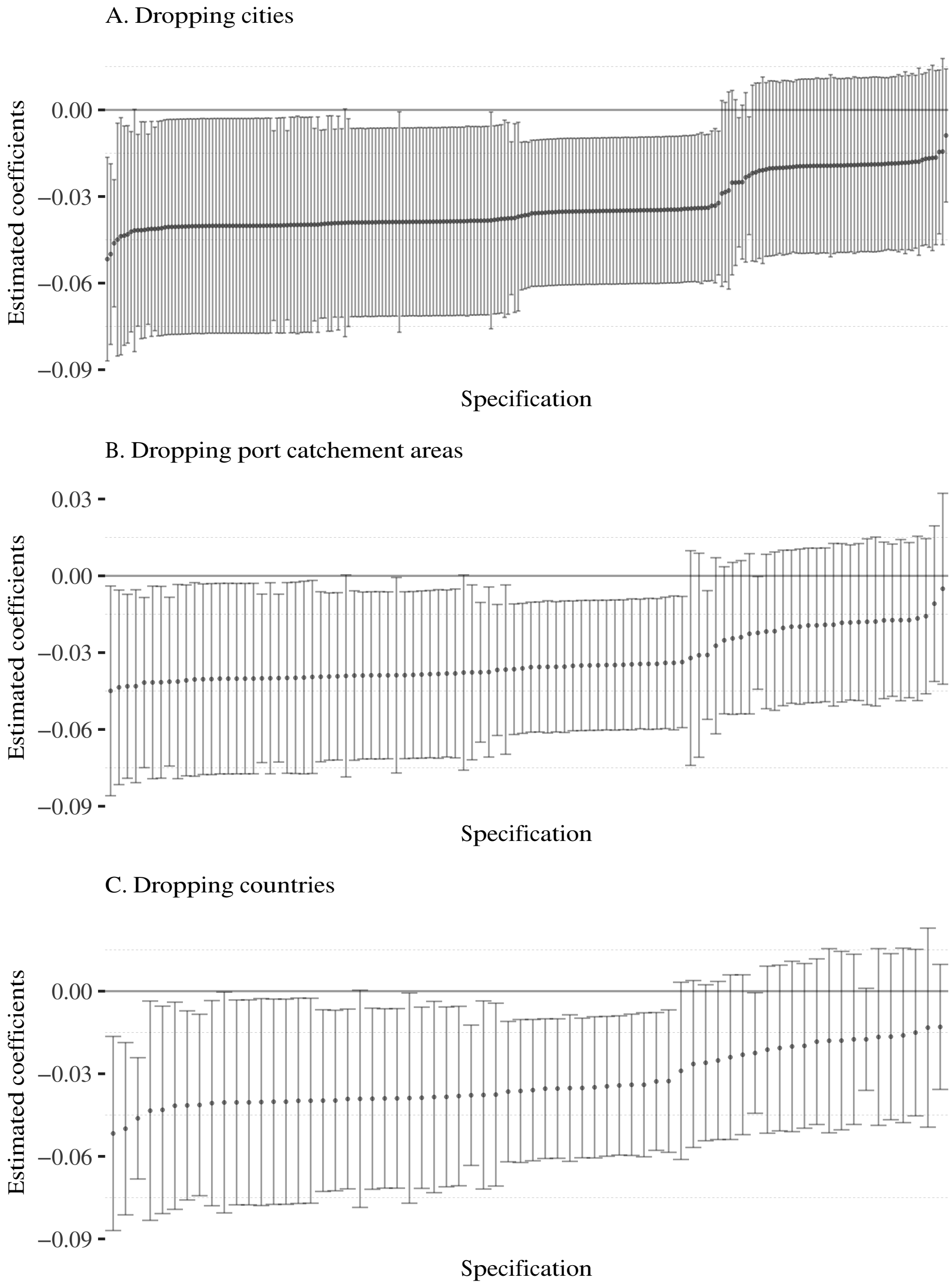

Figure A9: The figure shows the estimates in Table 3 for different subsamples. Panel A displays the model re-estimated after removing each port catchment area. Panel B displays the model re-estimated after removing each country. Panel C displays the model re-estimated after removing each viceroyalty.

Table A15: Counterfactuals (parameter sensitivity)

	(1)	(2)	(3)
Panel A: Elasticity of substitution	$\sigma = 3$	$\sigma = 5$	$\sigma = 7$
$\Delta P(\%)$	-1.33	-0.61	-0.39
$\Delta L(\%)$	1.88	1.28	1.08
$\Delta V(\%)$	0.01	-0.13	-0.17
Panel B: Shape parameter	$\theta = 2$	$\theta = 3$	$\theta = 4$
$\Delta P(\%)$	-0.62	-0.61	-0.61
$\Delta L(\%)$	1.45	1.3	1.23
$\Delta V(\%)$	-0.21	-0.13	-0.1
Panel C: Exp. share traded goods	$\mu = 0.4$	$\mu = 0.5$	$\mu = 0.6$
$\Delta P(\%)$	-0.59	-0.61	-0.64
$\Delta L(\%)$	0.98	1.28	1.71
$\Delta V(\%)$	-0.18	-0.13	-0.06
Panel D: Prod. spillover	$\alpha_1 = 0.04$	$\alpha_1 = 0.055$	$\alpha_1 = 0.07$
$\Delta P(\%)$	-0.61	-0.61	-0.61
$\Delta L(\%)$	1.27	1.28	1.3
$\Delta V(\%)$	-0.13	-0.13	-0.12
Panel E: Historical prod. spillover	$\alpha_2 = 0.02$	$\alpha_2 = 0.045$	$\alpha_2 = 0.07$
$\Delta P(\%)$	-0.62	-0.61	-0.61
$\Delta L(\%)$	1.25	1.27	1.28
$\Delta V(\%)$	-0.13	-0.13	-0.13

Note: The table reports the results from the benchmark counterfactual exercises under alternative parameter values. The percentage difference (mesured from 0-100) across the various outcomes for the two scenarios is reported. The counterfactuals assume migration frictions change. The unit of observation is a city.

References for the Online Appendix

Abadie, Alberto. 2021. "Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects." *Journal of Economic Literature* 59(2):391–425.

Allen, Robert C. 2001. "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War." *Explorations in Economic History* 38(4):411–447.

Allen, Treb and Costas Arkolakis. 2014. "Trade and the Topography of the Spatial Economy." *The Quarterly Journal of Economics* 129(3):1085–1140.

Allen, Treb, Costas Arkolakis and Xiangliang Li. 2024. "On the Equilibrium Properties of Spatial Models." *American Economic Review: Insights* (forthcoming).

Allen, Treb and Dave Donaldson. 2022. "Persistence and Path Dependence in the Spatial Economy." *Manuscript* .

Amante, C and B.W. Eakins. 2009. "ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis." *NOAA Technical Memorandum NESDIS NGDC-24.* (National Geophysical Data Center, NOAA).

Arroyo Abad, Leticia, Elwyn Davies and Jan Luiten van Zanden. 2012. "Between Conquest and Independence: Real Wages and Demographic Change in Spanish America, 1530–1820." *Explorations in Economic History* 49(2):149–166.

Arroyo Abad, Leticia and Jan Luiten van Zanden. 2016. "Growth under Extractive Institutions? Latin American Per Capita GDP in Colonial Times." *The Journal of Economic History* 76(4):1182–1215.

Baskes, Jeremy. 2013. *Staying Afloat: Risk and Uncertainty in Spanish Atlantic World Trade, 1760-1820*. Stanford: Stanford University Press.

Bolt, Jutta and Jan Luiten Van Zanden. 2024. "Maddison-Style Estimates of the Evolution of the World Economy: A New 2023 Update." *Journal of Economic Surveys* p. joes.12618.

Broadberry, S. N., B. M. S. Campbell, Alexander Klein, Mark Overton and Bas van Leeuwen. 2015. *British Economic Growth, 1270-1870*. Cambridge: Cambridge University Press.

Bruhn, Miriam and Francisco A. Gallego. 2011. "Good, Bad, and Ugly Colonial Activities: Do They Matter for Economic Development?" *The Review of Economics and Statistics* 94(2):433–461.

Buringh, Eltjo. 2015. "The Clio-Infra Database on Urban Settlement Sizes: 1500-2000.".
URL: *http://www.cgeh.nl/urbanisation-hub: 27-4-2015*

Census, Argentina. 1872. *Primer Censo de la República Argentina (1869). Resultados.* Buenos Aires: Imprenta del Porvenir.
URL: *https://biblioteca.indec.gob.ar/bases/minde/1c1869_TU.pdf*

Census, Mexico. 1899. *Censo General de la República Mexicana (1895). Resumen General.* Mexico: Oficina Tip. de la Secretaria de Fomento.
URL: *https://www.inegi.org.mx/app/biblioteca/ficha.html?upc=702825410100*

Christelow, Allan. 1942. "Contraband Trade between Jamaica and the Spanish Main, and the Three Port Act of 1766." *The Hispanic American Historical Review* 22(2):309.

Cinelli, Carlos and Chad Hazlett. 2020. "Making Sense of Sensitivity: Extending Omitted Variable Bias." *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* 82(1):39–67.

Coatsworth, John H and Jeffrey G Williamson. 2004. "Always Protectionist? Latin American Tariffs from Independence to Great Depression." *Journal of Latin American Studies* 36(2):205–232.

Cuenca-Esteban, Javier. 2008. "Statistics of Spain's Colonial Trade, 1747–1820: New Estimates and Comparisons with Great Britain." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 26(3):323–354.

Denevan, William M. 1992. *The Native Population of the Americas in 1492*. Madison, Wisconsin: University of Wisconsin Press.

Diaz-Cayeros, Alberto. 2022. The Future of Latin American and Caribbean Cities: Urban Bias and Political Fragments in Place. In *The Routledge Handbook of Urban Studies in Latin America and the Caribbean*. Routledge.

Elliot, Robert, Stephen DeGloria and Shawn Riley. 1999. "A terrain ruggedness index that quantifies topographic heterogeneity." *Intermountain Journal of Sciences* 5(1-4):23–27.

Elliott, J. H. 2006. *Empires of the Atlantic World: Britain and Spain in America, 1492-1830*. New Haven: Yale University Press.

Fernández-López, Javier and Klaus Schliep. 2019. "rWind: download, edit and include wind data in ecological and evolutionary analysis." *Ecography* 42(4):804–810.

Findlay, Ronald and Kevin H. O'Rourke. 2007. *Power and Plenty: Trade, War, and the World Economy in the Second Millennium*. Princeton: Princeton University Press.

Fisher, John R. 1993. *El Comercio entre España e Hispanoamérica: 1797-1820*. Number 27 *in* "Estudios de historia económica" Madrid: Banco de España.

Fisher, John R. 1997. *The Economic Aspects of Spanish Imperialism in America, 1492-1810*. Liverpool: Liverpool University Press.

Fisher, John R. 1998. "Commerce and Imperial Decline: Spanish Trade with Spanish America, 1797–1820." *Journal of Latin American Studies* 30(3):459–479.

Fisher, J.R. 1985. *Commercial Relations Between Spain and Spanish America in the Era of Free Trade, 1778-1796*. Liverpool: Centre for Latin-American Studies, University of Liverpool.

GADM. 2024. "Global Administrative Areas (GADM).".
URL: *https://gadm.org/*

Galor, Oded and Ömer Özak. 2015. "Land Productivity and Economic Development: Caloric Suitability vs. Agricultural Suitability." *Manuscript* .

Galor, Oded and Ömer Özak. 2016. "The Agricultural Origins of Time Preference." *American Economic Review* 106(10):3064–3103.

García-Herrera, R., G. P. Können, D. A. Wheeler, M. R. Prieto, P. D. Jones and F. B. Koek. 2005. "CLIWOC: A Climatological Database for the World's Oceans 1750–1854." *Climatic Change* 73(1):1–12.

Gerhard, Peter. 1993*a*. *A Guide to the Historical Geography of New Spain*. Oklahoma: University of Oklahoma Press.

Gerhard, Peter. 1993*b*. *The North Frontier of New Spain*. Oklahoma: University of Oklahoma Press.

Gerhard, Peter. 1993*c*. *The Southeast Frontier of New Spain*. Oklahoma: University of Oklahoma Press.

Hamilton, Earl Jefferson. 1947. *War and Prices in Spain, 1651-1800*. Cambridge: Harvard University Press.

Herzog, Irmela. 2014. "Least Cost Paths – Some Methodological Issues." *Internet Archaeol* 36.
URL: *https://intarch.ac.uk/journal/issue36/5/5-5.html*

Honaker, James and Gary King. 2010. "What to Do about Missing Values in Time-Series Cross-Section Data." *American Journal of Political Science* 54(2):561–581.

Johnson, Lyman L. and Sibila Seibert. 1979. "Estimaciones de la población de Buenos Aires en 1744, 1778 y 1810." *Desarrollo Económico* 19(73):107–119.

Kelly, Morgan and Cormac Ó Gráda. 2019. "Speed Under Sail During the Early Industrial Revolution (c. 1750–1830)." *The Economic History Review* 72(2):459–480.

Kuethe, Allan J. and Kenneth J. Andrien. 2014. *The Spanish Atlantic World in the Eighteenth Century: War and the Bourbon Reforms, 1713–1796*. Cambridge: Cambridge University Press.

López de Velasco, Juan. 1570. "Demarcación y división de las Indias [Manuscrito].".
URL: *https://bdh.bne.es/bnesearch/detalle/3427025*

López de Velasco, Juan. 1575. "Demarcacion y nauegaciones de Yndias.".
URL: *https://jcb.lunaimaging.com/luna/servlet/detail/JCBMAPS 1 1 1100 102700001:-Demarcacion-y-nauegaciones-de-Yndi*

Mahoney, James. 2010. *Colonialism and Postcolonial Development: Spanish America in a Comparative Perspective*. Cambridge: Cambridge University Press.

Maloney, William F. and Felipe Valencia. 2016. "The Persistence of (Subnational) Fortune." *The Economic Journal* 126(598):2363–2401.

Morse, Richard M. 1974. "Trends and Patterns of Latin American Urbanization, 1750–1920." *Comparative Studies in Society and History* 16(4):416–447.

O'Rourke, Kevin H. 2006. "The Worldwide Economic Impact of the French Revolutionary and Napoleonic Wars, 1793–1815." *Journal of Global History* 1(1):123–149.

Pinzón, H.T., J.A.T. Mora and C.E.T. Mora. 1994. *Convocatoria al poder del número: censos y estadísticas de la Nueva Granada, 1750-1830*. Serie Historia Bogotá, Colombia: Archivo General de la Nación.

Prados de la Escosura, Leandro and Gabriel Tortella Casares. 1983. "Tendencias a Largo Plazo del Comercio Exterior Español, 1714–1913." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 1(2):353–367.

Rahn Phillips, Carla. 1990. The Growth and Composition of Trade in the Iberian Empires, 1450–1750. In *The Rise of Merchant Empires: Long-Distance Trade in the Early Modern World, 1350-1750*, ed. James D. Tracy. Cambridge: Cambridge University Press.

Ramankutty, Navin and Jonathan A. Foley. 1999. "Estimating Historical Changes in Global Land Cover: Croplands from 1700 to 1992." *Global Biogeochemical Cycles* 13(4):997–1027.

Ridolfi, Leonardo and Alessandro Nuvolari. 2021. "L'histoire immobile? A Reappraisal of French Economic Growth Using the Demand-Side Approach, 1280–1850." *European Review of Economic History* 25(3):405–428.

Scobie, James R. 1971. *Argentina: A City and a Nation*. Oxford: Oxford University Press.

Stangl, Werner. 2018. "'The Empire Strikes Back' ?: HGIS de las Indias and the Postcolonial Death Star." *International Journal of Humanities and Arts Computing* 12(2):138–162.

Stangl, Werner. 2019*a*. "Data: Lago Texcoco, 18th century.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DOT5EY*

Stangl, Werner. 2019*b*. "Data: Mail land routes of Spanish America, 1745-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/W4C9H7*

Stangl, Werner. 2019*c*. "Data: Places Gazetteer of Spanish America, 1701-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/FUSJD3*

Stangl, Werner. 2019*d*. "Data: Ports of Spanish America, 1701-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/UXDJLQ*

Stangl, Werner. 2019*e*. "Data: Territorial Gazetteer for Spanish America, 1701-1808.".
URL: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/YPEU5E*

Stein, Stanley J. and Barbara H. Stein. 2003. *Apogee of Empire: Spain and New Spain in the Age of Charles III, 1759–1789*. Baltimore: Johns Hopkins University Press.

Tobler, Waldo. 1993. "Three Presentations on Geographical Analysis and Modeling." *Technical Report* .

Verhagen, Philip, Jamie Joyce and Mark R. Groenhuijzen, eds. 2019. *Finding the Limits of the Limes: Modelling Demography, Economy and Transport on the Edge of the Roman Empire*. Computational Social Sciences Cham: Springer International Publishing.

Walker, Geoffrey J. 1979. *Spanish Politics and Imperial Trade, 1700-1789*. London: Palgrave Macmillan.

Weiss, D. J., A. Nelson, H. S. Gibson, W. Temperley, S. Peedell, A. Lieber, M. Hancher, E. Poyart, S. Belchior, N. Fullman, B. Mappin, U. Dalrymple, J. Rozier, T. C. D. Lucas, R. E. Howes, L. S. Tusting, S. Y. Kang, E. Cameron, D. Bisanzio, K. E. Battle, S. Bhatt and P. W. Gething. 2018. "A global map of travel time to cities to assess inequalities in accessibility in 2015." *Nature* 553(7688):333–336.

Álvarez Nogal, Carlos and Leandro Prados De La Escosura. 2013. "The rise and fall of Spain (1270–1850)." *The Economic History Review* 66(1):1–37.

Özak, Ömer. 2010. "The Voyage of Homo-œconomicus: Some Economic Measures of Distance." *Manuscript* .

Özak, Ömer. 2018. "Distance to the Pre-Industrial Technological Frontier and Economic Development." *Journal of Economic Growth* 23(2):175–221.