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.

JEL Codes: F6, 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 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 45 by the beginning of the 19th century. By this time, no major ports in the empire were subject to restrictions on the direct trade of goods 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 trade cost matrices between all locations in the sample, which I validate using historical and contemporary sources. These time-varying measures of bilateral shipping 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 trade costs 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, it enables me to control for unobserved locational factors that determine both the location of trading opportunities and urban growth. Second, the reform primarily changed trade costs, not migration or communication costs more broadly. Furthermore, the setting enables comparison across a large geographic area while keeping other determinants of long-run growth, such as formal institutions and legal origins, fixed. Finally, the large geographic scope of this setting is compelling in terms of 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 standard deviation reduction in the shipping time (6.5 days) increases the urban population growth rate between 1750 and 1800 by around 8 percentage points. Third, I show that the effects are concentrated in less populous cities and 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 locations with smaller internal markets, thus weakening the persistence of the pre-reform settlement pattern.

To explore potential mechanisms and long-term implications, I interpret the findings through the lens of a dynamic spatial general equilibrium model that I calibrate to match the historical data. The model is consistent with key features of the historical context and accounts for potential changes in migration costs induced by increased trade. In the model, the population can move freely among 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 slow convergence 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 (2020).

The main counterfactual exercises consist of simulating the long-term impact of changes in the location of trading opportunities while keeping the local productivity and land availability fixed. I then explore how historical conditions, as summarized by the pre-reform population distribution, mediate the long-term impact of the trade reform. I find that lower trade costs to Europe increased population growth in affected cities by lowering the price of traded goods, but due to the lower reliance on external

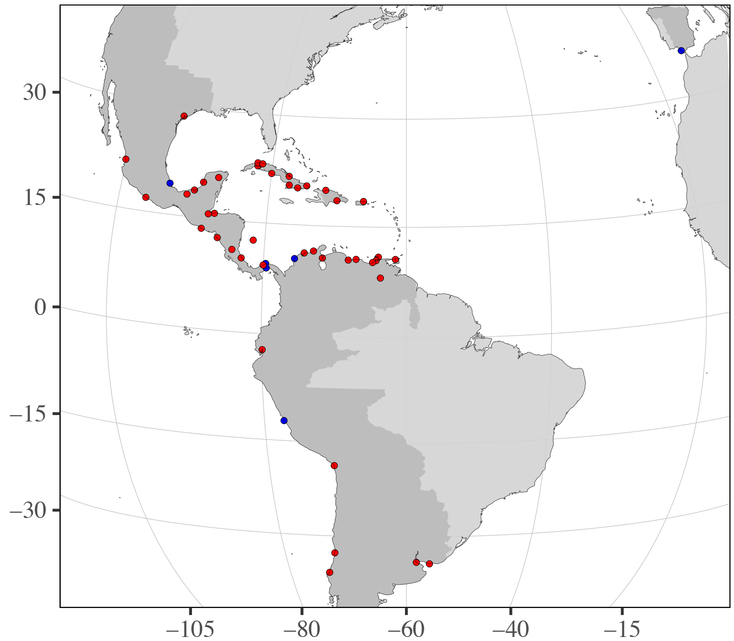

Figure 1: This map depicts the extent of the territory claimed by the Spanish Empire in 1790 with its ports marked according to status. Ports marked in blue were licensed for direct trade with Europe before 1765 (Callao, Cartagena, Veracruz, and Panama), while those marked in red were licensed to trade with Europe in 1810.

trade in larger home markets, this effect was muted in larger cities. The reform therefore attenuated the persistence of the pre-reform settlement pattern by disproportionally increasing urban growth in smaller cities. As such, the findings suggest 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.

My paper contributes to the literature on history dependence in economic geography and international trade. 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 Lin, 2012; Michaels and Rauch, 2018). History dependence also shapes patterns of international trade. Historical patterns of trade can persist through learning by doing externalities (Juhász, 2018), sunk costs in forming relationships (Xu, 2022), or by convergence in preferences (Flückiger et al., 2022). However, the importance of historical patterns of trade for the location of economic activity differs greatly across countries (Henderson et al., 2018). My findings shed light on these differences by exploring to what extent and under what conditions historical patterns of trade shape the location of economic activity.

I also contribute to the literature on the effects of international trade on economic growth. Reduced-form approaches have documented sizeable impacts of trade on national income (Frankel and Romer, 1999; Feyrer, 2019; Maurer and Rauch, 2019), while structural approaches uncover smaller effects (Arkolakis, Costinot and Rodríguez-Clare, 2012). However, studying the diffusion of steamship technology in the late 19th century, Pascali (2017) finds little evidence that trade integration promoted economic development, except in countries with inclusive institutions. This is consistent with increased access to trade inducing some countries to specialize in sectors that have fewer growth-enhancing externalities (Grossman and Helpman, 1990), have weaker economies of scale (Matsuyama, 1992), or have adverse effects on institutions (Acemoglu, Johnson and Robinson, 2005; Puga and Trefler, 2014). This paper sheds light on when reductions in trade costs affect long run economic growth *within* countries. The findings show that trade can promote growth also in contexts with extractive institutions, but highlight the importance of the home market size in mediating the long-run impact.

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 a lower pre-industrial population density necessitated institutions that enabled broader participation in the economy. These institutions were in turn conducive to sustained economic growth and therefore contributed to a divergence between areas with different pre-industrial densities, starting in the second half of the 18th century. I complement these findings by highlighting the role of trade-related institutions. The results 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 geography.

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 directly test this relationship 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 controlling long-distance trade for urban growth and market integration.

The remainder of the paper is structured as follows. Section 2 presents the historical background. Section 3 presents the data sources. Section 4 provides details on the calculation of trade costs. Section 5 elaborates on the reduced-form results. Section 6 presents the model and Section 7 the counterfactual exercises. Section 8 concludes.

2 Historical 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.[1] 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 instances where inter-regional trade was discouraged.[2]

The system limited trade with Europe across large parts of Spanish America, however, there was still some communication and trade with locations that were remote to 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), which increased the reliance on contraband (Christelow, 1942). Restrictions on trade and high trade costs ensured that trade was limited to non-competing goods with a high value-to-weight

[1] 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.

[2] 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)

ratio. Beyond precious metals, hides, tallow, sugar, indigo, and cochineal were important exports (Rahn Phillips, 1990).[3]

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 proved difficult. In part, this was due to the limited ability of the Spanish crown to commit to compensating the stakeholders of the old system (see e.g. Acemoglu and Robinson, 2000).

Reforming transatlantic trade. Beginning in the 18th century, geopolitical tensions originating in Europe prompted 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 already in 1765 (see Table 2). 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.[4] In the 1780s, the remaining 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 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

[3] 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).

[4] 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.

(Prados de la Escosura and Casares, 1983). Independence was mostly followed by high tariffs, often driven by the revenue needs of post-independence governments.

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 resulting 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 of 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 the most important colony, a concern was 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) (see Figure 2). This was recognized by contemporaries as well as in the historical literature.[5] Between 1782 and 1796 Fisher (1993), precious metals still accounted for 56.4 percent of imports. Also high-value agricultural commodities (Fisher, 1993) were important. 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).

[5] 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 quantitatively assess the impact of the reform, 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 that were claimed by Spain throughout the period.[6] Summary statistics are reported in Table 1.

Population. I use city-level population data from Buringh (2013) made available by the Centre for Global Economic History at Utrecht University. The dataset presents the best available estimates for all 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. I further restrict the sample to cities that existed in 1750, the last entry before the reform. This constitutes 297 cities. Following Arroyo Abad and van Zanden (2016), I supplement and corroborate this database by consulting a range of national and regional sources. These sources are largely based on population and urbanization studies, colonial censuses, and regional economic studies. Overall, there is a strong relation between Buringh (2013) and the sources consulted for the period covered by this study. I elaborate on the sources consulted and this exercise in the Appendix.

Data on pre-colonial population density is from Denevan (1992), which combines the most recent available geographical, anthropological, and archaeological findings (Maloney and Valencia, 2016).[7] For New Spain and Peru, more detailed data is available for the early colonial period. For these locations, I digitize data on population and tributary counts from Gerhard (1993*a*,*b*,*c*) and Cook (1981). Finally, I include data on contemporary population density from the Gridded Population of the World.

Settlements. I further supplement the dataset with a territorial gazetteer of around 15,000 places that existed in the Spanish Empire during the 18th and early 19th century (Stangl, 2019*b*). The dataset is based on various primary and secondary sources.[8] It

[6] 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, Louisiana, and Florida. These locations had limited trade with Spain throughout the period.

[7] This dataset has been made available by Maloney and Valencia (2016).

[8] "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

contains the founding, 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.[9] Altogether, the final dataset contains 2,125 places. I refer to these as settlements.

Sailing and trade. I use logbooks from the CLIWOC database (García-Herrera et al., 2005). The data was originally compiled for studying historical oceanic climate conditions 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 several voyage-level characteristics such as the ship name, origin, destination, captain name, and ship type. Information on the average speed and direction of the sea-surface winds by $0.5° \times 0.5°$ cells for each week between 2011 and 2017 is from the US National Oceanic and Atmospheric Administration (NOAA).

I digitized data on trade between Spain and America at the port-level primarily from Fisher (1985) and Fisher (1993). These data have been compiled from primary sources, mainly from the General Archive of the Indies in Seville. It contains data on the total value of Spanish imports and exports to 19 ports in the Americas (measured in *reales de vellón* in constant prices). Moreover, it contains data on the composition of trade and the number of ships arriving at Cadiz from a range of American ports. I also digitized data on prices in Spain (Castille) from Hamilton (1947) and combined this with price data from GPIH.[10] Data on the slave trade is from Behrendt et al. (1999).

Geography and infrastructure. I use agricultural suitability measures from FAO's Global Agro-Ecological Zones under rain-fed, low-input agriculture for six important staple and export crops. The staple food in Mexico and the Andean countries was maize while wheat was the important staple in Chile and Argentina. Important export crops were cotton, tobacco, sugarcane, and cacao which constituted around 27.3 percent of total exports from Spanish America to Spain in this period (Fisher, 1993). I supplement these data with the maximum attainable caloric yield using data from Galor and Özak

holders of many parts of the Empire), maps, or geographical descriptions both printed and manuscripts." (Stangl, 2018).

[9]This avoids common pitfalls associated with using population thresholds for defining a settlement. The status of city was the highest legal status afforded a population center in Spanish America and was typically granted by the crown. Below the city in the hierarchy was the town (*villa*). In some cases, settlements were abandoned (such as Buenos Aires) or moved (such as Guatemala). In these cases, the date of founding is the founding of the first city in both cases. The location of the place is determined by the functional center. For example, a place served as a marketplace, the dataset includes the location of the marketplace. A place with a primarily religious function records the location of the church and so on.

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

(2015, 2016).[11] Information on urban nominal wages (measured in grams of silver) is from Arroyo Abad, Davies and van Zanden (2012). Furthermore, I calculate the terrain ruggedness index, average slope, and elevation. Information on climatic variation is from Hijmans et al. (2005).

I collect data on the location and trading status of each port from the decree *Reglamento y aranceles reales para el comercio libre de España a Indias de 12. de octubre de 1778* (Ramíres Bibiano and Ortíz de la Tabla, 1978), as well as Fisher (1997). I validate the data with various secondary sources. The list of ports can be found in Table 2. I also include the location of the principal mining centers (*Reales de Minas*) in the 18th century from Fisher (1997). Together, mining, cotton, tobacco, sugarcane, and cacao exports make up around 83.7 percent of all exports from Spanish America to Spain in the period. Viceregal and *audiencia* borders are from Stangl (2019*b*).[12] I use mail routes to proxy for the location of roads (Stangl, 2019*a*). I include data on potential vegetation to control for various geographical fundamentals and to calculate travel speeds (Ramankutty and Foley, 1999). Finally, data on the location of rivers and lakes is from Natural Earth.

4 Shipping Times and Trade Costs

In this section, I construct a directed graph, where nodes denote localities and edges the shipping times between all adjacent nodes.

Maritime transportation. I estimate the sailing speed using information from maritime logbooks in the 18th and early 19th centuries. From each logbook entry, I extract information on recorded wind speed, wind direction, and travel direction. I follow Kelly and Ó Gráda (2019) and remove observations for which either the inferred speed is implausibly high (above 10 knots), or are located in coastal areas. To estimate the relationship between wind direction, wind speed, and sailing speed, I consider the following model,

$$S_{ij} = e^{f(\theta_{ij}, ws_i) + \varepsilon_{ij}}, \tag{1}$$

where ws_i measures the wind speed in grid-cell i, θ_{ij} measures the deviation of the angle between the wind direction and direction of travel, S_{ij} denotes the sailing speed obtained

[11] 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.

[12] 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).

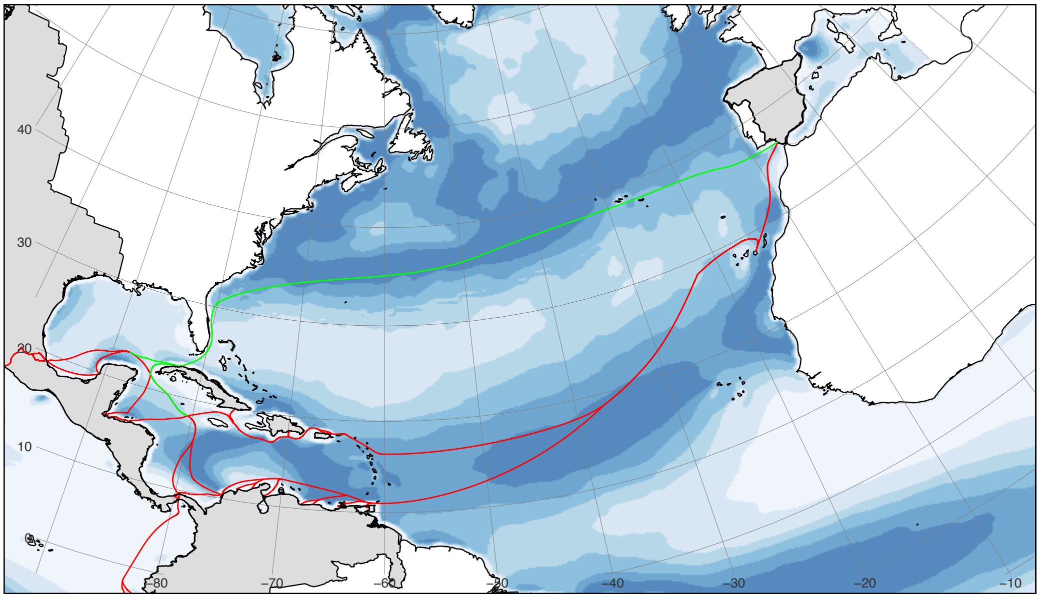

Figure 3: The figure depicts the cost surface of maritime travel between 1750 and 1850. The map plots the average cost for each 1°×1° grid-cell where darker colors indicate higher predicted sailing speed. Grey areas denote territory claimed by the Spanish Empire in 1790. The cost surface is calculated 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 worlds oceans. The red and green lines denote historical trade routes. Red denotes the westward journey while green denotes the eastward journey. Source: NOAA and CLIWOC.

between nodes i and j and ε_{ij} is an error term. Given a large number of features, Equation 1 is estimated using an elastic net where tuning parameters are chosen optimally using 10-fold cross-validation. The full sample ($N = 37,141$) is then split into a training sample (80 percent of the sample) and a validation sample. The model predicts sailing speed accurately (with a mean absolute error of 1.48 in the preferred model). Next, I average weekly high-resolution data on wind speed and wind direction from NOAA over the period 2011-2017. For every node in the graph, I then predict the sailing times between all adjacent nodes using the estimated model denoted $\hat{S}_{ij}(\cdot)$.[13]

Overland 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 the costs faced by shipping with pack animals using geographical features, drawing on least-cost analysis tools from archaeology. The pace will depend on whether travel occurs on road, the slope of the terrain, the elevation, and the landcover. The predicted speed of travel between node i and j is given by W_{ij} and based on the following

[13]The graph is weighted again to account for the fact that the distance between the nodes varies due to their relative position as well as the curvature of the earth.

model,

$$W_{ij} = \kappa_i \times 6.096 \times e^{-3.5|\mathrm{sl}_{ij}+0.05|-\gamma \mathrm{elev}_i} \tag{2}$$

where sl_{ij} measures the slope between cells i and j, κ_i is a coefficient determined by the landcover in cell i, and elev_i denotes the elevation in meters ($\gamma = -0.0001072$).[14] It follows that the travel speed on flat terrain at sea level is around 5 kilometers per hour. To adjust for differences in landcover, I rely on coefficients from Weiss et al. (2018). [15] Travel on a road is affected by the slope and elevation, but not the landcover.

Least-cost path. Once the duration of passing between all adjacent nodes is known, I calculate the bilateral shipping time between all cities by searching for the cost-minimizing route along the graph using the Dijkstra algorithm (Dijkstra, 1959). Beyond sailing speed, the turnaround time in port shapes the total shipping time of a route. Since it is not clear whether turnaround times improved over time (Rönnbäck, 2012), I assume these are constant at zero as a starting point. Moreover, I model Europe as a point-like country centered on Cadiz since the majority of legal trade with Europe was channeled through this port over the period. This approach results in an asymmetric $R \times R$ dimensional matrix of bilateral shipping times between all the locations, $\mathbf{T}_t[T_{ijt} \geq 0]$, where R denotes the number of cities. I calculate one matrix for every decade, accounting for which ports were open to direct trade with Europe.

Assessing the shipping times. I validate the estimated shipping times both qualitatively and quantitatively. First, I find a close correspondence between predicted trade routes and the location of known historical trade routes. An example is illustrated in Figure 3. Second, I find a strong relation between the estimated travel times and various measures of historical travel times. Furthermore, comparing data on wind patterns in the logbooks with contemporary sources, I also find a strong correlation. I elaborate on these validation checks in the Appendix. Finally, a concern is that changes in maritime technology changed shipping 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). As a result, measurement error in travel times is unlikely to be changing over time. Taken together,

[14] 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).

[15] Five terrain types have a natural mapping between historical landcover data and the terrain coefficients. These are tropical forests, temperate forests, desert, 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).

these exercises show that the determinants of trade costs emphasized in the estimation were important in the context.

Shipping time elasticity. Finally, I estimate the elasticity of the value of trade to shipping time. Consider the following model,

$$\ln X_{ejt} = \theta_r + \alpha_r \times \gamma_t + \beta \ln \mathrm{T}_{ejt} + \epsilon_{ejt}, \tag{3}$$

where X_{ejt} is the value of exports and T_{ejt} the shipping time from Spain to port j in year t. θ_r accounts for unobserved regional heterogeneity, such as weather variability or piracy.[16] Finally, $\alpha_r \times \gamma_t$ accounts for region times year-specific factors, such as interstate conflict. ϵ_{ejt} is a potentially serially correlated error term. β denotes the elasticity of exports from Spain with respect to shipping time. Missing data on bilateral trade between American ports prevents me from fully accounting for multilateral resistance terms. As a result, β does not have a structural interpretation.

5 Reduced-Form Results

In this section, I use the calculated changes in trade costs to examine the effects of the reform on market integration and urban growth.

5.1 Results

Fact 1: *The reform promoted trade through market integration.* Figure 4a shows the value of Spanish non-bullion imports from the Americas. While there is 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.[17] Exports from Spain exhibit similar patterns as is depicted in Figure 2c. The timing of the increase is consistent with the reform promoting trade, but it could be driven by other time-variant factors.

[16] The decline in piracy and privateering has been highlighted as an important source of productivity growth in shipping in the first half of the 18th century (North, 1968). These factors had become less important towards the end of the 18th century (Hillmann and Gathmann, 2011). While risk undoubtedly played an important role, it presumably affected the timing of departures more than choices between different routes.

[17] 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.

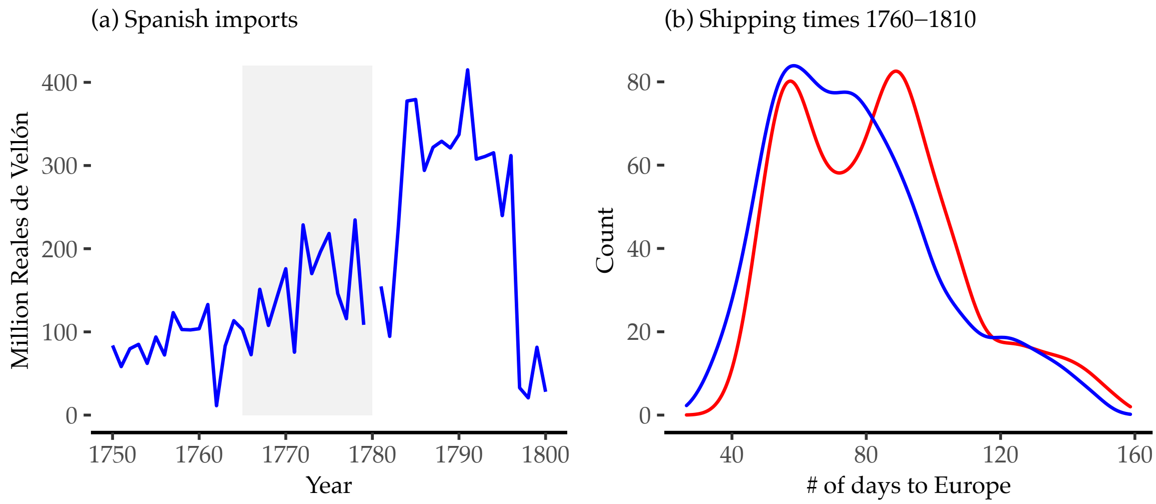

Figure 4: Panel (a) depicts the value of private non-bullion imports to Spain from American ports between 1750 and 1800 at constant prices. The shaded area denotes the main reform period. The sharp decline from 1796 is due to the British blockade of Cadiz. Data for 1782 is missing in the original source. Data are from Cuenca-Esteban (2008). Panel (b) 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.

ΔT_i denotes the decline in shipping time induced by the reform for port i measured in days ($\Delta T_i = T_{i1760} - T_{i1810}$). Figure 5 displays the number of ships and the total value of imports to Spain originating from treated ($\Delta T_i > 0$) and untreated ($\Delta T_i = 0$) ports. Although there is an increase in the number of ships and the value of imports originating from both treated and untreated ports, the increase is larger for the treated ports. Before the reform, the number of ships arriving in the treated ports was limited.[18] The effects are unlikely to be driven by smuggling for three reasons. First, smuggling is less likely to be an issue when considering imports to Cadiz which was the port most closely monitored by the crown (Fisher, 1985, p. 32). Second, estimates of the extent of smuggling are too small to account for the large increase in trade. Lastly, 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.

The growth in trade may be partly driven by income or productivity shocks that coincided with the reform in treated ports. To explore this further, Figure 4b presents the change in shipping time between 1760 and 1810 caused by the opening of ports. The red curve denotes the shipping times in 1760, while the blue curve denotes the distribution of shipping times in 1810. The figure shows a leftward shift in the distribution of shipping times. The reduction in shipping time ranges from 0 to 27 days and is 6 days lower on average. Since the pre-reform average is around 83 days, this reduction is economically

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

significant.[19] Table 3 and Figure 7 show there is a negative relationship between the shipping times and the value of exports from Spain between 1797 and 1820, suggesting lower shipping times promoted trade.

To further corroborate that market integration was a key driver for the trade growth, I consider data on price differences for commodities (wine, salt, sugar, cinnamon) between Spain (Castile) and major cities in Spanish America. Figure 8 shows the average price difference over the 18th century. For these commodities, there is a reduction in the price differential in the second half of the 18th century. The change in the price differential is significant under a range of specifications (more detail is provided in the Appendix). In sum, the timing of the increase in trade, the disproportional increase in imports originating from treated ports, the reduction in shipping times, and price convergence provide evidence that the reform promoted trade through market integration.

Fact 2: *Improved market integration induced urban growth.* How did market integration with Europe affect urban population growth? I consider the following model,

$$\ln L_{it} - \ln L_{it'} = \gamma_v + \beta \Delta T_i + \phi x'_{it} + \varepsilon_{it}, \tag{4}$$

where L_{it} is the population in city i at time t, ΔT_i again measures the decline in the number of days of shipping to Cadiz, and x'_{it} is a vector controlling for geography, agroclimatic characteristics, disease environment, and historical resource availability. To account for mean reversion and growth differences depending on city size (Duranton and Puga, 2014), I also control for the initial population size.[20] ε_{it} is an error term potentially correlated across nearby locations. Standard errors are clustered at the level of the closest port. ΔT_i is the preferred measure of openness since richer multilateral measures raise concerns about measurement error.

The coefficient β captures the effect of a one standard deviation change in ΔT_i on the population growth in city i. The key identification assumption is that, in the absence of the reform, population growth would have been similar across areas that, under the reform, experienced different reductions in shipping costs. Additional assumptions are needed to proxy 18th and 19th-century geography with contemporary data. I assume that the variables have remained fixed or changed with the same factor across different locations. Classical measurement error leads to attenuation bias. If measurement error

[19] Figure 6 shows the spatial distribution of the changes in trade costs.

[20] To proxy for the disease environment, I construct an indicator variable that takes value 1 if the average elevation is below 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, which I do control for in a flexible manner.

Table 4: Shipping time and urban population growth

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it'}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	0.116^{***}	0.114^{***}	0.122^{***}	0.079^{**}
	(0.034)	(0.040)	(0.041)	(0.035)
N	297	297	297	297
R^2	0.048	0.065	0.073	0.248
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.222^{***}	0.194^{***}	0.201^{***}	0.130^{***}
	(0.045)	(0.053)	(0.058)	(0.046)
N	297	297	297	297
R^2	0.076	0.097	0.123	0.327
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.035	0.012	0.008	0.008
	(0.036)	(0.040)	(0.036)	(0.035)
N	245	245	245	245
R^2	0.006	0.038	0.059	0.059
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Population in 1750				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** The change in the natural logarithm of the city population. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

varies across time and location this is partly captured by the region fixed-effects.

Panel (a) of Table 4 reports the effect of changes in shipping time on population growth between 1750 and 1800. It shows a positive relationship between declining shipping times and population growth. In the preferred specification in Column (4), containing both viceroyalty fixed effects and the full set of controls, I find that a one standard deviation larger reduction in the shipping time to Europe (6.5 days) leads to an around 8 percentage point increase in urban population growth ($\beta = 0.079$). For a city with a median growth rate between 1750 and 1800 (0.667), this corresponds to a 12 percent increase in the growth rate. Panel (b) shows the estimates for the 1750 to 1850 period for which the estimates are nearly twice as large. Reassuringly, the estimates for 1700 to 1750 are substantially smaller and statistically insignificant.

Did the reform also lead to the emergence of new settlements? To explore this, I estimate Equation 4 with the number of settlements per grid cell as the dependent variable. Panel (a) of Table 5 reports the results estimated between 1750 and 1800. The estimates are positive and significant but smaller in magnitude than the effect on population growth. A one standard deviation higher reduction in the shipping time increases the number of settlements in a grid cell by 0.044 in the baseline specification. Again, it is reassuring that the change between 1700 and 1750 is unrelated to the decline in shipping time which is consistent with the identification assumption.

These findings are unlikely to be driven by the reform reducing migration costs from Europe. In particular, the reform facilitated trade with Europe, not maritime communication more broadly. There was maritime communication between newly opened ports and Europe also before the reform. Moreover, relative to the substantial costs of international migration during the 18th century, the reduction in shipping time induced by the reform (around 6 days on average), is unlikely to have been decisive for the decision to migrate. Migration during the period remained modest compared to the second half of the 19th century. I explore this issue further through the lens of the model in Section 7. Taken together, the above estimates are consistent with cheaper access to traded goods inducing urban growth.

Fact 3: *The reform had a smaller effect on urban growth in larger markets.* In smaller cities, the home market can be less important compared to markets in other cities and as a result, a change in external trade cost can have a larger impact in smaller cities (Redding and Sturm, 2008). With the bilateral measure of openness ΔT_i, this effect would result in different estimates of β in larger and smaller cities. I therefore interact the initial population size with the change in trade costs in Equation 4.

The results are presented in in Table 6. Across all specifications, the interaction between changes in shipping time and the pre-reform city population is negative. A one standard deviation increase in the city size in 1750, reduces the marginal effect of a 6.5 days decline by 0.231 percentage points in the preferred specification. This constitutes a 0.144 percent reduction in the growth rate for a city with a median growth rate between 1750 and 1850.[21] For average-sized cities, the effect of a change is positive or zero.

To further explore the role of the own market size in mediating the effect, I split the sample into different macroregions (a core, semiperiphery, and periphery) following Mahoney (2010).[22] The core and semiperiphery had the largest internal markets. The results are reported in Table 7 and show that the average effect is driven by cities in the

[21] I find no effect of the interaction with growth on the extensive margin.

[22] 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)

periphery, further suggesting that the effect is mediated by the pre-reform market size.

An alternative interpretation is that larger cities are closer to their urban carrying capacity, which in turn limits how much the population size adjusts to lower trade costs. However, the estimates are similar when controlling for the local resource availability in Columns (2) and (3). I explore this issue further in the counterfactual exercises in Section 7. Measurement error in a city's population size is a concern when population size enters as an explanatory variable. Moreover, while there is a positive correlation between the size of the shock ΔT and the initial population size, this is not the case within *audiencia*. For both these reasons, it is reassuring that the estimates are robust to controlling for time-variant heterogeneity at the *audiencia* level. It is also reassuring that there is no effect on population growth, for the period 1700 to 1750. The results are therefore consistent with the pre-reform market size being important in mediating the effect of the change in trade costs.

Fact 4: *There is persistence in the pre-reform settlement pattern, but it is lower in areas exposed to the reform.* To explore the persistence of the pre-reform settlement pattern, I estimate the elasticity of the contemporary population size to the pre-reform population size. In particular, I estimate the following model,

$$\ln L_{it} = \alpha_c + \beta \ln L_{it'} + \phi x_i' + \varepsilon_{it}, \tag{5}$$

where L_{it} denotes the population size of location i in year 2000, $L_{it'}$ denotes the population size in year 1500 or 1750, x_i' is a vector of pre-determined control variables, and ε_{it} is an error term potentially correlated across nearby locations. Standard errors are clustered at the country level in the main specifications and α_c denotes country fixed-effects. β 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 β in the absence of the reform, conditional on the set of controls.

Table 8 shows the results for the baseline sample of cities. In the preferred specification in Column (4), the elasticity for the full sample is 0.34. The elasticity for the sample with an above-median decline in shipping time is 0.28 while it is 0.44 for the below-median sample. This pattern is mirrored in data from Denevan (1992). Figure 10a shows the relation for all regions in the sample. Consistent with Maloney and Valencia (2016), there is a strong persistence between pre-colonial population density and population density in 2000. Figure 10b shows the relation for the sample of provinces

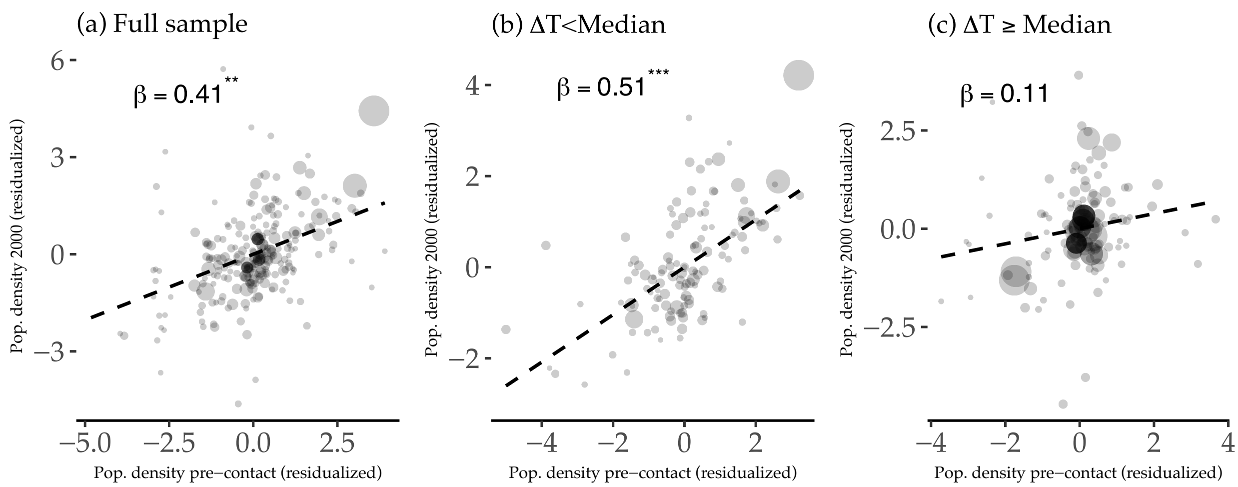

Figure 10: The figure depicts the relationship between pre-contact population density and the population density in the year 2000 at the province level. Panel (a) depicts the relationship for the full sample. Panel (b) depicts the relationship for provinces with below-median change in the distance to Europe between 1760 and 1810. Panel (c) depicts the relationship for the sample above-median reduction in shipping time to Europe between 1760 and 1810. Pre-colonial population density is the number of people per square kilometer pre-contact. The dependent variable is the log of people per square km in 2000. The full sample contains 340 observations. **Geographical controls:** Altitude, ruggedness, rainfall, and inverse distance to the coast (see Maloney and Valencia (2016) for details). **Standard errors:** Clustered at the country-level.

that experienced low changes in shipping costs ($\Delta T <$Median). The figure shows that persistence is more pronounced for this subsample. Finally, Figure 10c shows that the relationship attenuates in the subsample of provinces that experienced large changes ($\Delta T \geq$Median). Table 9 shows that this pattern is robust across several specifications. When using the data from Denevan (1992) the differences between the groups are highly statistically significant, however, for the city-level data the difference is less precisely estimated. In sum, the results suggest that the changes in trade costs increased urban growth and attenuated the persistence of pre-reform settlement patterns.

5.2 Assessing the Research Design

I assess the identification assumption by considering a dynamic version of Equation 4 where the decline in shipping time is interacted with time indicators. I estimate the following model

$$\ln L_{it} = \alpha_i + \tau_t + \sum_{s=1710}^{1810} \mathbb{1}[t = s]\Delta T_i \times \delta_s + \phi x_{it} + \epsilon_{it}, \tag{6}$$

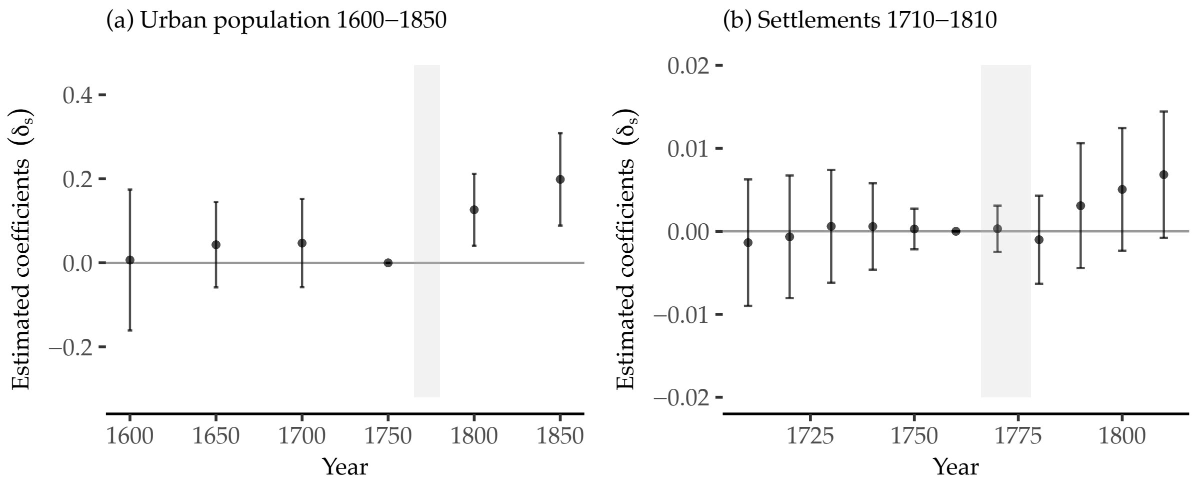

Figure 11: The figure depicts the estimated coefficients of the difference in population growth and the number of settlements according to the reduction in shipping times to Europe induced by the reform. **Dependent variable:** In Panel (a) the log of city population. In Panel (b) the number of settlements per grid-cell. **Observations:** In Panel (a) 297 cities for the period 1600-1850 totalling 1,782 observations. In Panel (b) 5,014 0.5°×0.5° grid-cells for the period 1710-1810 totalling 55,154 observations (11 × 5,014 = 55,154). **Controls:** Elevation, crop suitability, the location of active mines, distance to the coastline, and terrain ruggedness. **Standard errors:** Clustered at the port-level. 51 clusters.

where the variables are defined as in Equation 4. The coefficients (δ_s) denote the estimated difference between differentially exposed locations in year s relative to 1760 (the last year before the reform). Figure 11 depicts the estimated coefficients for both the urban population growth and the formation of settlements. Consistent with the identification assumption, Figure 11 shows that there is no significant difference in population growth in areas with different exposures to the reform before 1750.[23] This pattern can also be seen in Figure 12. Alternative specifications are 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 at which ports opened was driven by their economic potential. To mitigate this concern, I restrict the sample to only include areas far away from ports in the estimation. While these were unlikely to be directly targeted by the reform, 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. A particularly important reform in this regard was the separation of the Viceroyalty of *Rio de la Plata* from the Viceroyalty of Peru in the second half of the 18th century. However, when dropping cities in the Viceroyalty of *Rio de la Plata* or the whole of Argentina the

[23] I conduct a formal test of the joint significance. In all specifications, the hypothesis that the pre-trend coefficients are zero cannot be rejected.

estimated coefficients are similar. These results are reported in the Appendix.

Here I briefly discuss the main additional robustness checks. First, I remove cities that are outliers in terms of population growth. I also calculated standard errors accounting for spatial correlation in line with Conley (1999). To assess the stability of the coefficients in Table 4 when including controls, I implement the approach developed in Cinelli and Hazlett (2020). Lastly, I control for viceroyalty and *audiencia* fixed effects using 1710 and 1750 borders. Taken together, these exercises support the causal interpretation of the estimates. Further details are reported in the Appendix.

6 A Model of Trade and Persistence

I next 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.

6.1 Theoretical Framework

Setup. The model consists of cities indexed by $i, j \in R$. Cities differ in their productivity A_{it}, their hinterland's availability of arable land $\bar{H}_i$, and their connections to other cities through the transport network. A_{it} determines the city's productivity and $\bar{H}_i$ determines the urban carrying capacity.[24] Europe enters the model as a point-like country centered on Cadiz and contains the population mass of Western Europe.

Time is discrete and each period t corresponds to 50 years. Each individual lives for two periods. In the first period, the individual is born where the parent lives and choses where to live. In the second period the individuals move, consumes, supplies labor inelastically, gives birth to one child and dies. L_{it} denotes the number of inhabitants in city i at time t and $\bar{L}_t = \sum_{i=1}^{R} L_{it}$ denotes the total population.

Preferences. Individuals have Cobb-Douglas utility functions defined over a composite of traded differentiated varieties and a non-traded good. The ex-post welfare of an individual living in location i at time t is given by,

$$V_{it} = \epsilon_{it} w_{it} \ / \ \mu P_{it}^{\mu} r_{it}^{1-\mu}, \tag{7}$$

[24] For Mesoamerican cities relying on tlameme transportation the urban hinterland spanned between 21 to 28 kilometers. With the introduction of European modes of transportation this increased (Hassig, 1993).

where μ is the share of expenditure of the traded good, P_{it} is the price index for the traded goods, w_{it} is the nominal wage, and r_{it} is the price of the non-traded good. Each household supplies labor inelastically. Fertility is exogenous as Malthusian forces likely operated at longer time horizons.[25] Finally, inhabitants have heterogeneous preferences over all cities which is modeled as a draw ϵ_{it} from a Fréchet-distribution with shape parameter θ.

Production. There are two sectors in each city, a sector producing the location-specific variety and a sector producing food that is non-traded. Historical evidence has shown that in the long-run, real wages responded to changes in labor markets in the context of Spanish America (Allen, Murphy and Schneider, 2012). Motivated by this I assume that factor markets are competitive over the 50 year periods. The price of a variety produced in location i is therefore given by $p_{it} = w_{it} \ / \ A_{it}$. The agricultural sector features constant returns to scale where one unit of land produces one unit of food. The price of the non-traded good is therefore $r_{it} = (1-\mu)Y_{it} \ / \ \bar{H}_i$. Income from land is allocated in lump-sum to all inhabitants of the location.

Trade. Long-distance trade during the 18th century was limited to non-competing goods (Findlay and O'Rourke, 2007). I therefore assume that each city produces a unique variety that can be sold to all other cities subject to iceberg trade costs. As a result, the price faced by an individual in city j for a good produced in i is given by $p_{ijt} = \tau_{ijt} p_{it}$. The value of trade from location j to location i is given by

$$X_{jit} = p_{jit}^{1-\sigma} w_{it} L_{it} P_{it}^{\sigma-1}, \tag{8}$$

which is the structural gravity equation of trade.

Migration. 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). In the context of Spanish America, Mahoney (2010) notes that new areas were being populated after the 1760s, both through international and intra-national migration.[26] Motivated by this, I assume that individuals choose cities to maximize indirect utility

[25] See e.g. Chaney and Hornbeck (2016); Bouscasse, Nakamura and Steinsson (2021).

[26] The exact magnitude of migration from Europe is contested. Estimates range between 50,000 and 190,000 immigrants in the 18th century (Mahoney, 2010). Cook (1981) writes that migration in colonial Peru was extensive, covered large distances, and was mainly directed to large cities and mining centers. For 1613 numbers on origins of the population of Lima are provided in Cook (1981) and show a significant fraction born outside Lima. 271,000 victims of the transatlantic slave trade disembarked in Spanish America between 1700 and 1760 (Eltis, 2000, p. 9)

subject to migration costs. [27] The utility of an individual moving from region i to region j is given by $V_{ijt} = V_{jt}\epsilon_{jt} \ / \ m_{ijt}$ where ϵ_{jt} is a draw from a Fréchet-distribution and m_{ijt} denotes migration costs. The share of inhabitants in city i moving to j is then given by,

$$L_{ijt} = L_{it-1} V_j^{\theta} \Pi_i^{-\theta} m_{ij}^{-\theta} \tag{9}$$

where $\Pi_i = \left(\sum_{j=1}^{R} \left(V_{jt} / m_{ijt} \right) \right)^{\frac{1}{\theta}}$ which captures the migration opportunities of city i. In sum, there is more migration from city i to j if city i is large, city j has high real wages, migration costs are low and the migration opportunities in i are poor.

Persistence. Motivated by the fact that urbanization in Spanish America was relatively high for the 18th century (Arroyo Abad and van Zanden, 2016), I allow for agglomeration economies.[28] To incorporate different sources of persistence in the model, I follow Allen and Donaldson (2020) and include historical agglomeration economies.[29] In particular, the productivity of the city depends on the size of the city today and in the past with constant elasticities given by,

$$A_{it} = \bar{A}_i L_{it}^{\alpha_1} L_{it-1}^{\alpha_2}, \tag{10}$$

where $\bar{A}_i$ is the time-invariant component of location productivity.

General equilibrium and steady-state. Within each location all firms and individuals optimize and markets clear. An equilibrium is given by $\{L_{it}, w_{it}, V_{it}, \Pi_{it}\}_{i \in R}$ such that in each region total sales equals the total income ($w_{it}L_{it} = \sum_{j \in R} X_{ijt}$), trade is balanced ($w_{it}L_{it} = \sum_{j \in R} X_{jit}$), the total population equals the population arriving at a location ($L_{it} = \sum_{j \in R} L_{jit}$), and the total population in the last period equals the number of people exiting a location between $t-1$ and t ($L_{it-1} = \sum_{j \in R} L_{ijt}$).

A steady-state is an allocation such that $L_{it} = L_{it-1}$ for all cities i, hence where migration flows between cities cancel out. Intuitively, the existence of the equilibrium and steady-state depends on the strength of the agglomeration force (the local agglomeration economies) relative to the dispersion force (the availability of arable land for food production). Using results in Allen, Arkolakis and Li (2020), I provide conditions for the existence and uniqueness of the equilibrium and steady-state in the Appendix.

[27] Since one period corresponds to roughly a generation in the dataset (50 years), I abstract from more complex forward-looking behavior.

[28] A variety of factors such as knowledge spillovers, input sharing, location-specific capital, or knowledge about the local environment, drove agglomeration for pre-industrial cities (Jedwab, Johnson and Koyama, 2020)

[29] As shown in Allen and Donaldson (2020), this can be micro-founded in a variety of ways including the persistence of local knowledge or durable investment in local productivity.

6.2 Model Mechanisms

The model can explain the reduced-form patterns presented in Section 5. To see this, consider the behavior of the economy along its growth path. Iterating backward gives the following expression for the equilibrium city size,

$$\ln L_{it} = \tilde{\kappa}_i + \left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^T \ln L_{i0} - \frac{\sigma}{\nu}\sum_{k=0}^{T-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln V_{it-k}$$
$$-\frac{\mu(2\sigma-1)}{\nu}\sum_{k=0}^{T-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln P_{it-k}, \quad (11)$$

where $\tilde{\kappa}_i$ is a location-specific constant. This equation gives the equilibrium population size of city i as a function of the city's history. Intuitively, the equilibrium size of the city is larger if it has a history of high productivity, availability of arable land (both captured by κ_i'), larger historical population size (L_{i0}), and better historical access to trading opportunities (P_{ik}). The price index summarizes the role of trade costs for city growth. Equation 11 can be interpreted as the structural version of Equation 5. The derivations are provided in the Appendix.

Trade and city growth. First consider the 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. Note, that 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, that is $\partial P_{ik}\,/\,\partial\tau_{iek} > 0$, it follows that lower historical trade costs to Europe increases the population size in period t which is consistent with Fact 2 when $-\left(\mu(2\sigma-1)\,/\,\nu\right)\left(\alpha_2\mu(\sigma-1)\,/\,\nu\right)^k < 0$.

Consistent with Fact 3, the impact of a change in the historical trade cost is attenuated by the internal market size. Since $\partial P_{ik}\,/\,\partial L_{ik} < 0$, 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.

Trade and persistence. Consider next the persistence of the pre-reform settlement patterns documented in Fact 4. While the structural persistence elasticity $\alpha_2\mu(\sigma-1)\,/\,\nu$ is independent of trade costs, this is not the case for the observed relation between L_{i0} and L_{it}. In particular, the relation will be weaker in locations that have experienced larger changes in trade costs. Furthermore, since market access is 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.

What drives the persistence of historical market access? When $(\alpha_2 \mu(\sigma - 1) / \nu) < 1$, it follows that $\lim_{d \to \infty} \partial L_{it} / \partial \tau_{iek-d} = 0$. Hence, in this case, the impact of historical trading opportunities dissipates over time. The persistent impact of historical trading locations is therefore not driven by path dependence in this case. Historical patterns of trade continue to shape the location of economic activity as a result of gradual convergence to a new spatial equilibrium. This is a result of weak agglomeration forces relative to the importance of land in pre-industrial contexts. Due to the importance of land, this result will hold in most plausible calibrations of the model.

7 Quantitative Analysis

In this section I quantitatively assess the role of history in shaping the impact of changes in the location of trading opportunities.

7.1 Estimation and Identification of Structural Parameters

The model is fully parameterized by seven structural parameters and two tuples of fundamentals given by,

$$\Lambda = \left\{ \sigma, \theta, \mu, \alpha_1, \alpha_2, \{\bar{A}_i\}_{i=1}^R, \{\bar{H}_i\}_{i=1}^R, \tau, m \right\}. \tag{12}$$

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 τ_{ij} and m_{ij}. Second, I use the equilibrium conditions to recover $\{p_{it}^{\sigma-1}, P_{it}^{\sigma-1}, V_{it}^{\theta}, \Pi_{it}^{\theta}\}_{i \in R}$. Third, I estimate the structural version of the reduced-form equations to recover α_1 and α_2. In a final step, $\{\bar{A}_i\}_{i=1}^R$ and $\{\bar{H}_i\}_{i=1}^R$ 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.

Estimating the scale elasticities. Given data on $\{L_{it}, L_{it-1}, w_{it}\}_{i \in R}$, the system uniquely solves for the endogenous variables $\{p_{it}^{\sigma-1}, P_{it}^{\sigma-1}, V_{it}^{\theta}, \Pi_{it}^{\theta}\}_{i \in R}$. Combining the equilibrium

Table 10: Structural parameters

Parameter	Value	Description
α_1	0.091***	Productivity spillover
α_2	0.041**	Historical productivity spillover
$\kappa(1-\sigma)$	-3.13**	Elasticity of trade wrt. time
$-\lambda\theta$	-2.8*	Elasticity of migration wrt. time
σ	9	Elasticity of substitution
θ	3	Migration elasticity $\theta \in [2,4]$
$1-\mu$	0.55	Share of income from agriculture

Note: The table reports the parameters and baseline calibration of the model. α_1 and α_2 are estimated directly from the data of the 297 cities in the main sample. μ, σ, and θ are taken from the literature. **Controls:** Elevation, crop suitability, the location of active mines, distance to the coastline, and terrain ruggedness. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, * $p < .1$

conditions and taking logs gives,

$$\nu \ln L_{it} = -\sigma \ln V_{it} - \mu(2\sigma-1)\ln P_{it} + \alpha_2\mu(\sigma-1)\ln L_{it-1} + \sigma(1-\mu)\bar{H}_i + \mu(\sigma-1)\bar{A}_i, \quad (13)$$

where $\nu = \mu + \sigma(1-\mu) + \alpha_1\mu(1-\sigma)$. Equation 13 highlights the key identification challenge. The time invariant locational fundamentals $\bar{A}_i$ and $\bar{H}_i$ are unobserved, but correlated with L_{it} through migration. I address this by leveraging the time variation in the data by taking first differences. To account for potential changes in locational fundamentals, I flexibly control for locational fundamentals by including the controls used in Equation 4. This yields the regression equation

$$\Delta \ln L_{it} = -\frac{\sigma}{\nu}\Delta \ln V_{it} + \frac{\mu(1-2\sigma)}{\nu}\Delta \ln P_{it} + \frac{\alpha_2\mu(\sigma-1)}{\nu}\Delta \ln L_{it-1} + \phi x_i' + \eta_{it}, \quad (14)$$

where x_i' again denotes a vector of controls and η_{it} is an error term. The identification assumption is that locational fundamentals are accounted for by differencing and including the vector of controls such that $E[\eta_{it}|\Delta V_{it}, \Delta P_{it}, \Delta L_{it-1}, x_i] = 0$. Finally, α_1 is estimated similarly by using the market clearing condition for the traded good.

Parameters. Table 10 reports the baseline model parameters. μ is set equal to the share of GDP derived from land for colonial Mexico and Peru (Arroyo Abad and van Zanden, 2016). There are no estimates for how responsive migration flows are to differences in real wages across cities in this setting. I therefore use estimates for θ available for developing countries which typically range between 2 and 4 (Bryan and Morten, 2019). I set $\tau_{ijt} = T_{ijt}^{\kappa}$ and $m_{ijt} = T_{ijt}^{\lambda}$ where κ and λ are the elasticities of trade and migration costs to travel time respectively. I match the shipping time elasticity in the model $(1-\sigma)\kappa$ to the estimate in Table 3. The time elasticity for migration $-\lambda\theta$ is estimated using census data for Mexico and Argentina for the second half of the 19th century.[30] Finally, I impose σ to equal 9 following (Eaton and Kortum, 2002; Donaldson and Hornbeck, 2016).

The estimates of α_1 and α_2 are 0.091 and 0.041 respectively and are both estimated precisely. This is in line with the agglomeration elasticities at the city level documented in the literature (Combes and Gobillon, 2015; Allen and Donaldson, 2020). The travel time elasticities of trade and migration are also found to be in line with estimates in the literature. A one percent increase in travel time reduces the value of bilateral trade and migration by around three percent. [31] There exists a unique equilibrium and steady state of the model under this calibration.

7.2 Counterfactuals

Benchmark counterfactual. The counterfactual exercises compare the long-run equilibrium for two alternative trade cost matrices. The first scenario keeps trade costs fixed at 1760 levels while the second scenario considers a uniform fifty percent reduction in trade costs to Europe for all cities. I simulate the model for three periods after 1760 for each of the two scenarios. The objects of interest are ΔP and $\Delta\Omega$. ΔP denotes the percentage change in $\{P_i\}_{i=1}^{N}$ averaged over all the cities across the two scenarios. $\Delta\Omega$ denotes the change in population-weighted welfare ($\Delta\Omega = \sum_{i=1}^{N} (L_i \,/\, \bar{L})\, V_i$) across the two scenarios.

The results are presented in Table 11. The reduction in transportation costs to Europe reduces the price index by 12.68 percent on average across all cities. The population-weighted welfare Ω increases by 16.83 percent. The effects are larger when migration costs change in conjunction with trade costs. While the average effect on the price index is negative for all cities, the reduction is larger in smaller cities. For cities with a population size in 1750 below the median, the price index is reduced by 17.2 percent. For

[30]An alternative approach is to use data on migration during the colonial period from Cook (1981). These data have the advantage of overlapping with the colonial period. However, since the spatial variation is smaller (the data are only available for Peru), I chose to use the census data as the baseline approach.

[31]Calculating sailing times for a mid-19th-century clipper, Pascali (2017) finds a smaller time elasticity of around -0.8. Reassuringly, this is consistent with the importance of sailing time declining over the 19th century.

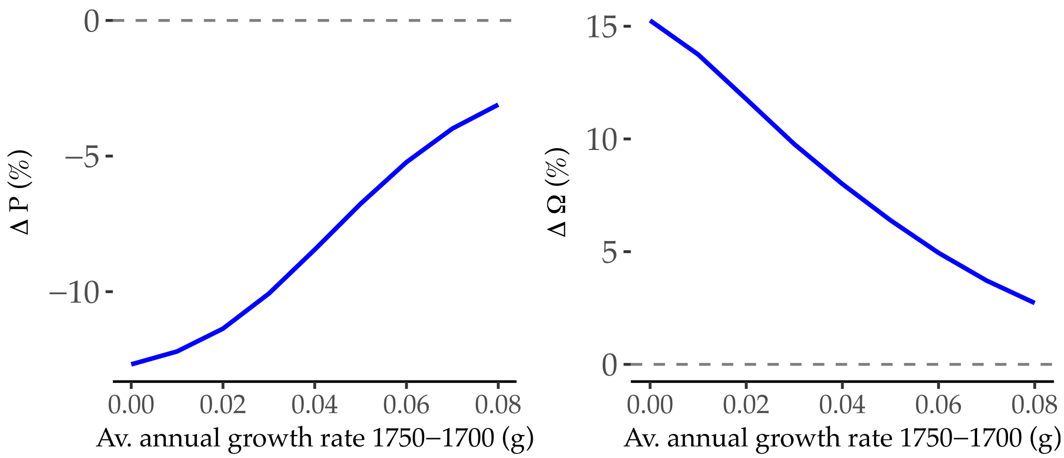

Figure 12: The figure depicts how pre-reform urban growth attenuates the impact of the reform. For each counterfactual, the model is solved forwards three periods from 1750. The equilibrium with trade costs fixed at 1760 levels is compared to a scenario where all cities uniformly reduce their trade cost to Europe by 50 percent. The simulations are run for different initial conditions where $L^g_{i1750} = L_{i1700} \times (1+g)^{50}$. g is denoted on the horizontal axis.ΔP denotes the average percentage change in the price index across all cities in the two scenarios. $\Delta\Omega$ denotes the population-weighted change in welfare across the two scenarios. $\Delta\Omega = \sum_{i=1}^{N} (L_i \,/\, \bar{L})\, V_i$ denotes the population.

cities above the median, the price index is 8.2 percent lower as a result of the reduction in trade costs.

The role of pre-reform urban growth. To further explore the role of initial population size, I simulate the model under alternative assumptions about the pre-reform population size $\{L^g_{i1750}\}_{i=1}^{R}$. I consider changes in the initial population size resulting from urban growth before the reform. I calculate counterfactual initial population size by assuming a constant annual growth rate of g between 1700 and 1750. In particular, $L^g_{i1750} = L_{i1700} \times (1+g)^{50}$. The object of interest is now $\Delta P(g)$ and $\Delta\Omega(g)$, which gives the average reduction in the price index and welfare induced by the reform as a function of the pre-reform growth rate.

Figure 12 and Table 11 present the result. Figure 12 shows that larger rates of urban growth prior to the reform, attenuates the long-term impact. As g becomes larger the impact of the decline in trade costs to Europe quickly attenuates. For g equal to 0.01, ΔP is given by -12.2. When g increases to 0.05, ΔP is approximately half the size. Taken together, the findings show that the location of economic activity adapts to changes in the location of trading opportunities, but to a lesser extent when the changes are preceded by urban growth.

Equalizing historical population size. The above counterfactual exercises show that when a larger share of the population lives in large cities, the impact of the reform is attenuated. To further explore the role of initial density, I simulate a scenario where the historical or pre-reform city size is equalized across all cities. This corresponds to reducing the share of the population that lives in the largest cities, and could therefore result in a larger impact of the reform. Panel (c) in Table 11 shows that this is indeed the case. The price index is reduced by 13.4 percent and the population-weighted welfare by 18.1 in these scenarios. Again, the same holds when assuming that migration costs change in conjunction with trade costs.

The impact across macroregions. Finally, I simulate the model and again split the sample into different macroregions following Mahoney (2010). I find that the impact is larger for the periphery and semiperiphery. While the average reduction in the price index is 12.67, the impact in the core, periphery, and semiperiphery is 8.1, 14.47, and 13.43 respectively. This is consistent with the reduced form evidence. However, as pointed out in Section 5, this could also be driven by differences in locational fundamentals across the macroregions. To isolate the role of historical population size, I simulate the model after equalizing the locational fundamentals. In particular, I consider the vector of fundamentals $\{A'_i\}_{i=1}^{R}$ where $A'_i = A'$ for all i. I find that the impact on the price index for the whole sample is 16.71. The impact for the core, semi-periphery, and periphery are 12.51, 16.4, and 18.1 respectively. This shows that differences in population size are important in accounting for the different impacts across the macroregions. However, as the difference is somewhat smaller, also differences in locational fundamentals appear to matter.

7.3 Robustness Checks

In this section, I briefly discuss the main robustness checks. First, I find that the main results are not sensitive changes in parameter values. The parameter σ, which determines the elasticity of trade flows to trade costs, is taken from the literature. I consider several other plausible values. I also consider different values of θ and the historical scale elasticities. I find that the results are largely unchanged. Moreover, due to the importance of land, the uniqueness of the equilibrium and steady state is robust to plausible changes in the calibration of the model. As a result, the model has a unique equilibrium and steady state for plausible changes in the parameter values.

Next, I consider alternative evolutions of locational fundamentals $\{\bar{A}_i\}_{i=1}^{N}$ and $\{H_i\}_{i=1}^{N}$. In particular, I simulate the model while allowing for positive growth rates in locational fundamentals. Finally, I consider alternative assumptions about migration and trade costs. There were substantial declines in international trade costs during the second half of the 19th century. I therefore simulate the model, while assuming a gradual decline in international trade costs. Increased maritime trade might have facilitated migration. I therefore repeat the exercise while allowing migration costs to fall in conjunction with the trade costs. The results from these exercises are reported in Table 11. In sum, the findings are robust to alternative assumptions about the trajectory of locational fundamentals, agents' preferences, trade costs, as well as migration costs.

8 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 this question by leveraging the reorganization of long-distance trade in the Spanish Empire. I combine a difference-in-differences design with a parsimonious dynamic spatial general equilibrium model that I calibrate to match the observed data.

I find that the reform increased population growth by lowering the price of traded goods, but had a smaller effect in locations with a larger home market. Furthermore, changes in trade costs attenuated the persistence of the pre-reform settlement pattern by disproportionally increasing economic growth in smaller cities. Finally, I find that the persistence of the pre-reform settlement pattern is not driven by self-sustaining agglomerations arising around central pre-reform trading locations, but by a slow convergence to the new steady-state. In conclusion, the findings provide evidence that the location of economic activity adapts to changes in the location of trading opportunities in the long run, but can persist when these 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. Second, path dependence is likely to play a more important role for persistence in industrialized contexts with stronger agglomeration economies. Exploring these issues is a potentially interesting avenue for future research.

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8 Tables

Table 1: Summary statistics of the city-panel

Statistic	N	Mean	St. Dev.	Min	Median	Max
Population	1,566	6,502.42	14,204.01	400.00	2,000.00	200,000.00
Shipping time 1760 (days)	1,782	58.62	17.90	34.86	54.08	145.27
Shipping time 1810 (days)	1,782	53.80	17.32	26.02	51.93	143.18
Δ Shipping time (days)	1,782	4.82	6.61	0.00	1.91	27.32
Elevation	1,782	0.24	0.43	0	0	1
Terrain ruggednes	1,782	263.33	221.74	2.04	215.08	1,033.84
Average crop suitability	1,782	0.00	1.00	−1.52	−0.11	2.76
Mining center	1,782	0.07	0.26	0	0	1
Average temperature (celsius)	1,782	20.98	4.90	4.52	21.92	28.49
Precipitation (mm.)	1,782	1,408.01	1,223.49	3.06	1,088.19	7,292.16
Coffee	1,782	6.75	1.22	3	6.8	8
Tobacco	1,782	6.31	1.16	2.69	6.26	8.08
Cotton	1,782	6.36	1.32	1	6.3	8
Wheat	1,782	6.84	1.49	2.51	7.67	8.18
Maize	1,782	5.74	1.34	2	5.9	8
Sugar cane	1,782	6.64	1.30	3	6.8	8
Distand to coast (km)	1,782	175.68	190.04	2.02	100.89	988.70
Distand to river (km)	1,782	458.61	340.09	1.19	381.30	1,303.24
Distand to port in 1750 (km)	1,782	304.28	370.87	5.45	192.80	2,516.95
Decade	1,782	1,725.00	85.42	1,600	1,725	1,850

Note: The table reports summary statistics of the key variables used in the analysis. The unit of analysis is the city. The dataset is a panel at a 50-year frequency for the period 1600-1850 for 297 cities. *Elevation* is an indicator variable equal one if the elevation is above 1500m. *Crop suitability* is the average suitability for tobacco, cotton, sugar cane, cacao, and coffee (standardized).

Table 2: Ports 1700 - 1810

Port	*Country*	*Direct trade (decade)*	*Longitude*	*Latitude*
Cadiz	Spain	<1700	-6.28	36.53
Acapulco	Mexico	<1700	-99.91	16.85
Portobelo	Panama	<1700	-79.65	9.55
Panama	Panama	<1700	-79.53	8.95
El Callao	Peru	<1700	-77.15	-12.06
Cartagena de Indias	Colombia	<1700	-75.55	10.42
Veracruz	Mexico	<1700	-96.14	19.19
Batabano	Cuba	1765	-82.29	22.72
Isla de Trinidad	Trinidad and Tobago	1765	-61.51	10.65
Isla Margarita	Venezuela	1765	-63.85	10.95
La Habana	Cuba	1765	-82.35	23.14
Monte-Christi	Dominican Republic	1765	-71.64	19.85
San Juan de Puerto Rico	Puerto Rico	1765	-66.12	18.47
Santiago de Cuba	Cuba	1765	-75.82	20.022
Santo Domingo	Dominican Republic	1765	-69.94	18.48
Trinidad	Cuba	1765	-79.98	21.80
Campeche	Mexico	1770	-90.54	19.84
Arica	Chile	1778	-70.32	-18.48
Buenos Aires	Argentina	1778	-58.37	-34.61
Chagres	Panama	1778	-80.00	9.32
Concepcion	Chile	1778	-73.05	-36.83
Guayaquil	Ecuador	1778	-79.88	-2.19
Montevideo	Uruguay	1778	-56.20	-34.91
Nuevitas	Cuba	1778	-77.27	21.55
Omoa	Honduras	1778	-88.04	15.78
Riohacha	Colombia	1778	-72.91	11.55
Santa Marta	Colombia	1778	-74.21	11.24
Cumana	Venezuela	1788	-64.18	10.47
La Cruz	Venezuela	1788	-64.64	10.21
La Guaira	Venezuela	1788	-66.93	10.60
San Blas	Colombia	1789	-105.29	21.53
Maracaibo	Venezuela	1793	-71.62	10.65
Matanzas	Cuba	1793	-81.58	23.05
Villahermosa	Mexico	1793	-92.93	17.99
Acajutla	El Salvador	1796	-89.83	13.59
Isla de Carmen	Mexico	1796	-91.81	18.65
Puerto Cabello	Venezuela	1798	-68.01	10.48
El Realejo	Nicaragua	1796	-87.17	12.54
San Andres	Colombia	1798	-81.71	12.58
Santo Tomas de Castilla	Guatemala	1798	-89.00	15.64
Valparaiso	Chile	1798	-71.60	-33.05
Baracoa	Cuba	1803	-74.50	20.35
Manzanillo	Mexico	1803	-104.28	19.12
Sisal	Mexico	1807	-88.21	20.69
San Bernardo	United States	1808	-96.63	28.62
Matina	Costa Rica	1811	-83.29	10.08
Manta	Ecuador	Independence	-80.91	-0.97
Esmeraldas	Ecuador	Independence	-79.90	0.95
Trujillo	Peru	Independence	-79.00	-8.10
Huacho	Peru	Independence	-77.61	-11.11
Paita	Peru	Independence	-81.11	-5.09
Huarmey	Peru	Independence	-78.15	-10.07
Maldonado	Uruguay	Independence	-54.95	-34.90
Carupano	Venezuela	Independence	-63.25	10.67
Barcelona	Venezuela	Independence	-64.66	10.13
Barranquilla	Colombia	Independence	-74.80	10.96
Buenaventura	Colombia	Independence	-77.35	3.88
Puntarenas	Costa Rica	Independence	-84.83	9.98
Tela	Honduras	Independence	-87.46	15.76
Tuxpan	Mexico	Independence	-97.40	21.86

Table 3: The shipping time elasticity of trade 1797 - 1820

Dependent variable:	Value of exports (ln)			
	(1)	(2)	(3)	(4)
Panel (a): OLS Estimator				
Shipping time(ln)	-2.19^{*}	-3.30^{***}	-3.13^{***}	-2.87^{***}
	(1.17)	(0.97)	(1.03)	(1.11)
Panel (b): PPML Estimator				
Shipping time(ln)	-2.59^{*}	-3.34^{***}	-3.09^{***}	-3.22^{***}
	(1.17)	(0.86)	(0.83)	(0.86)
N	211	211	211	211
Year FE		✓	✓	
Region FE		✓	✓	✓
Viceroyalty FE			✓	
Region × Year FE				✓

Note: The table reports the relationship between shipping time and the value of exports from Spain. Shipping time is measured in days. The value of trade is measured in *reales de vellón*. The sample contains ports with limited direct trade with Spain before the reform period. The data is from Fisher (1993). Robust standard errors in parenthesis. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table 5: Shipping time and settlements

Dependent variable:	Formation of a settlements: $S_{it} - S_{it-1}$			
	(1)	(2)	(3)	(4)
Panel (a): Settlement formation 1800-1750				
Decline in shipping time (ΔT)	0.019	0.043***	0.044**	0.055***
	(0.016)	(0.014)	(0.018)	(0.016)
N	5,014	5,014	5,014	5,014
R^2	0.001	0.025	0.047	0.075
Panel (b): Settlement formation 1750-1700				
Decline in shipping time (ΔT)	−0.016	0.012	0.005	0.024*
	(0.020)	(0.014)	(0.015)	(0.013)
N	5,014	5,014	5,014	5,014
R^2	0.001	0.045	0.078	0.152
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Population (1750)				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is at a 0.5°×0.5° grid-cell in a certain decade. **Dependent variable:** Number of settlements in a grid-cell. **Observations:** The dataset is a balanced panel at a 10-year frequency for the period 1710-1810 for 5,014 grid cells. The full dataset contains 11 × 5,014 = 55,154 observations. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, and distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table 6: Shipping time, city size, and population growth

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it-1}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	0.067^{*}	0.080^{**}	0.080^{**}	0.083
	(0.035)	(0.038)	(0.038)	(0.058)
Population (1750)	-0.238^{***}	-0.243^{***}	-0.253^{***}	-0.241^{***}
	(0.074)	(0.077)	(0.076)	(0.079)
Decline in shipping time × Population (1750)	−0.139	−0.154	−0.166	−0.156
	(0.098)	(0.103)	(0.103)	(0.105)
N	297	297	297	297
R^2	0.181	0.198	0.213	0.251
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.160^{***}	0.150^{**}	0.143^{**}	0.102
	(0.048)	(0.059)	(0.059)	(0.069)
Population 1750	-0.315^{***}	-0.319^{***}	-0.347^{***}	-0.321^{***}
	(0.072)	(0.079)	(0.083)	(0.084)
Decline in shipping time × Population 1750	−0.167	-0.196^{*}	-0.231^{*}	-0.231^{*}
	(0.101)	(0.113)	(0.119)	(0.119)
N	297	297	297	297
R^2	0.177	0.194	0.235	0.280
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.031	0.011	0.005	−0.015
	(0.037)	(0.039)	(0.035)	(0.057)
Population 1750	−0.041	−0.043	−0.057	−0.034
	(0.038)	(0.036)	(0.036)	(0.032)
Decline in shipping time × Population 1750	−0.007	−0.021	−0.041	−0.034
	(0.055)	(0.055)	(0.052)	(0.050)
N	245	245	245	245
R^2	0.014	0.045	0.070	0.172
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Audiencia FE				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. Panel (c) is a placebo exercise. **Dependent variable:** The change in the natural logarithm of the city population. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table 7: Shipping time and urban population growth by market size

Dependent variable:	Population growth 1800-1750			
	(1)	(2)	(3)	(4)
Panel (a): Colonial center				
Decline in shipping time (ΔT)	0.167	0.058	-0.152	-0.234^{*}
	(0.133)	(0.143)	(0.154)	(0.119)
N	99	99	99	99
R^2	0.013	0.073	0.162	0.322
Panel (b): Colonial semiperiphery				
Decline in shipping time (ΔT)	-0.005	-0.098	0.378	-0.132
	(0.129)	(0.104)	(0.404)	(0.280)
N	70	70	70	70
R^2	0.00001	0.031	0.087	0.418
Panel (c): Colonial periphery				
Decline in shipping time (ΔT)	0.069^{**}	0.117^{**}	0.173^{***}	0.142^{**}
	(0.027)	(0.048)	(0.056)	(0.061)
N	93	93	93	93
R^2	0.041	0.083	0.134	0.173
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Population (1750)				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** The change in the natural logarithm of the city population. **Samples:** *Core:* Mexico, Peru, Bolivia. *Semiperiphery:* Guatemala, Ecuador, Colombia. *Periphery:* Uruguay, Argentina, Chile, Paraguay, El Salvador, Honduras, Nicaragua, Costa Rica. **Controls:** Elevation, crop suitability, the location of active mines, terrain ruggedness, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table 8: Spatial persistence in high and low exposure areas (city-level)

Dependent variable:	Population 2000 (ln)			
	(1)	(2)	(3)	(4)
Panel (a): Full sample				
Population 1750 (ln)	0.271***	0.288***	0.331***	0.343***
	(0.072)	(0.068)	(0.044)	(0.045)
N	297	297	297	297
R^2	0.098	0.130	0.261	0.275
Panel (b): ΔT <Median				
Population 1750 (ln)	0.379***	0.407***	0.403***	0.438***
	(0.041)	(0.046)	(0.033)	(0.033)
N	151	151	151	151
R^2	0.185	0.220	0.264	0.307
Panel (c): ΔT $\geq$Median				
Population 1750 (ln)	0.167	0.197**	0.270***	0.281***
	(0.127)	(0.091)	(0.085)	(0.079)
N	146	146	146	146
R^2	0.035	0.181	0.286	0.327
Country FE			✓	✓
Baseline controls		✓		✓

Note: The table reports OLS estimates. The unit of observation is at the city. The full sample contains 297 observations. **Geographical controls:** Altitude, ruggedness, rainfall, and the distance to the coast. **Standard errors** are clustered at the country-level. ***p < .01, **p < .05, * p < .1

Table 9: Spatial persistence in high and low exposure areas (region-level)

Dependent variable:	Population density 2000 (ln)			
	(1)	(2)	(3)	(4)
Panel (a): Full sample				
Population density 1500 (ln)	0.382***	0.299***	0.505***	0.406***
	(0.103)	(0.100)	(0.143)	(0.138)
N	311	282	311	282
R^2	0.293	0.364	0.442	0.559
Panel (b): ΔT <Median				
Population density 1500 (ln)	0.521***	0.474***	0.578***	0.521***
	(0.074)	(0.092)	(0.095)	(0.112)
N	141	135	141	135
R^2	0.448	0.506	0.612	0.680
Panel (c): ΔT ≥Median				
Population density 1500 (ln)	0.363***	0.210***	0.347	0.192
	(0.112)	(0.070)	(0.229)	(0.192)
N	157	144	157	144
R^2	0.307	0.484	0.489	0.578
Country FE			✓	✓
Baseline controls		✓		✓

Note: The table reports OLS estimates. The unit of analysis is the province. Pre-colonial population density is the number of indigenous people per square kilometer before the arrival of Columbus from Maloney and Valencia (2016). The dependent variable is the log of people per square km in 2000. The full sample contains 258 observations. **Geographical controls:** Altitude, ruggedness, rainfall, and inverse distance to the coast (see Maloney and Valencia (2016) for details). **Standard errors** are clustered at the country-level. ***p < .01, **p < .05, * p < .1

Table 11: *Main counterfactuals*

	Migration costs fixed	Migration costs not fixed
	(1)	(2)
Panel (a): Benchmark		
ΔP (%)	-12.68	-16.83
$\Delta\Omega$ (%)	15.26	40.27
Panel (b): Pre-reform urban growth		
$g = 0.01$:		
ΔP (%)	-12.2	-16.83
$\Delta\Omega$ (%)	13.75	28.21
$g = 0.02$:		
ΔP (%)	-11.36	-15.1
$\Delta\Omega$ (%)	11.77	18.1
$g = 0.03$:		
ΔP (%)	-10.1	-12.92
$\Delta\Omega$ (%)	9.77	11.87
Panel (c): Equalized historical density		
ΔP (%)	-13.4	-19.46
$\Delta\Omega$ (%)	18.1	66.19

Note: The table reports the main counterfactual exercises. For each counterfactual the model is solved forwards three periods from 1750. The equilibrium with trade costs fixed at 1760 levels is compared to a scenario where all cities uniformly reduce their trade cost to Europe by 50 percent. ΔP denotes the average percentage change in the price index across all cities in the two scenarios. $\Delta\Omega$ denotes the population weighted change in welfare across the two scenarios. $\Delta\Omega = \sum_{i=1}^{N} (L_i \,/\, \bar{L})\, V_i$ denotes the population. Panel (a) displays the baseline case with the actual L_{1750}. Panel (b) displays the simulations under different assumptions on the initial population density. Panel (c) displays the scenario where L_{1750} is equalized across all cities.

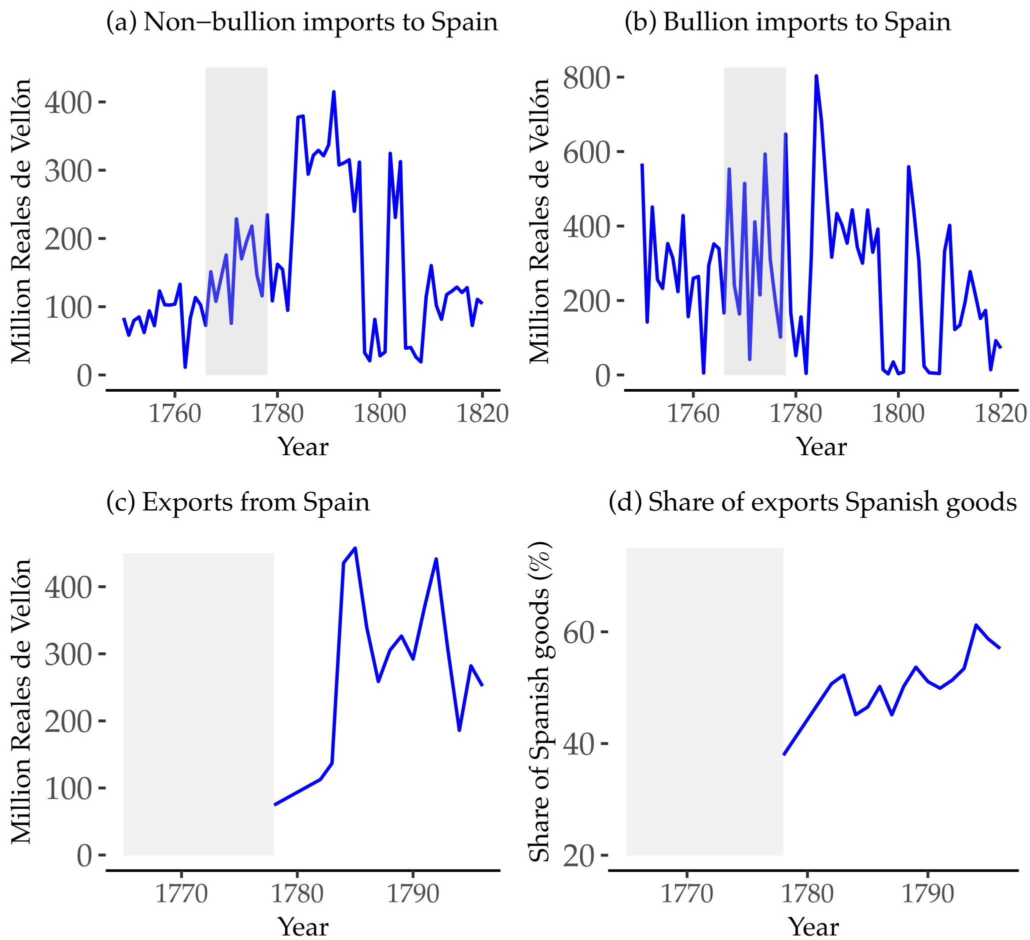


Figure 2: Panel (a) displays the value of private non-bullion imports to Spain (in million reales de vellón) from American ports between 1750 and 1820 at constant prices. Panel (b) displays private bullion imports to Spain between 1750 and 1820 at constant prices. The large drop in 1797 is due to the British blockade of Cadiz as part of the Anglo-Spanish War 1796-1808. The lower level after 1807 was due to the Peninsular War as well as the Spanish-American wars of independence. Data for 1780 is missing in the original data source (imputed with average). Panel (c) displays exports from Spain for the years 1782 to 1796. Panel (d) displays the share of Spanish exports originating in Spain for the years 1782 to 1796. The shaded area denotes the main reform period. Source: Cuenca-Esteban (2008) and Fisher (1985).

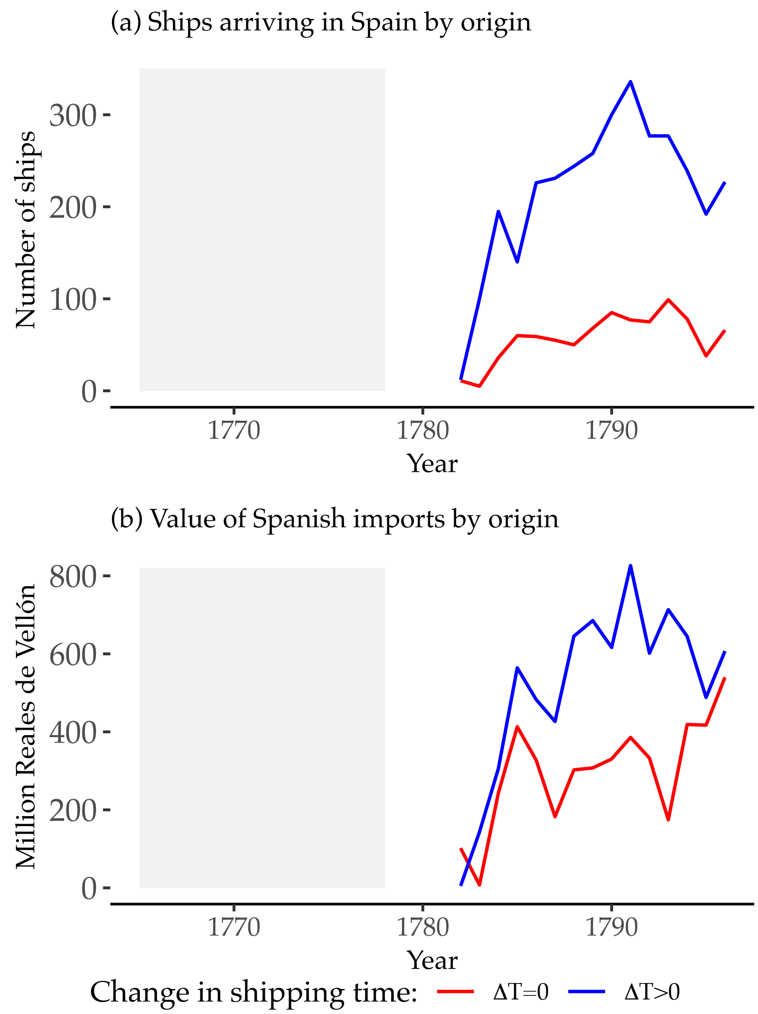


Figure 5: Panel (a) displays the number of ships arriving in Cadiz from ports experiencing changes in shipping time as a result of the reform ($\Delta T > 0$) and ports without changes in the shipping time ($\Delta T = 0$) for the years 1782 to 1796. Panel (b) displays the value of imports arriving in Cadiz (in million reales de vellón) 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 1782 to 1796. Source: Fisher (1985).

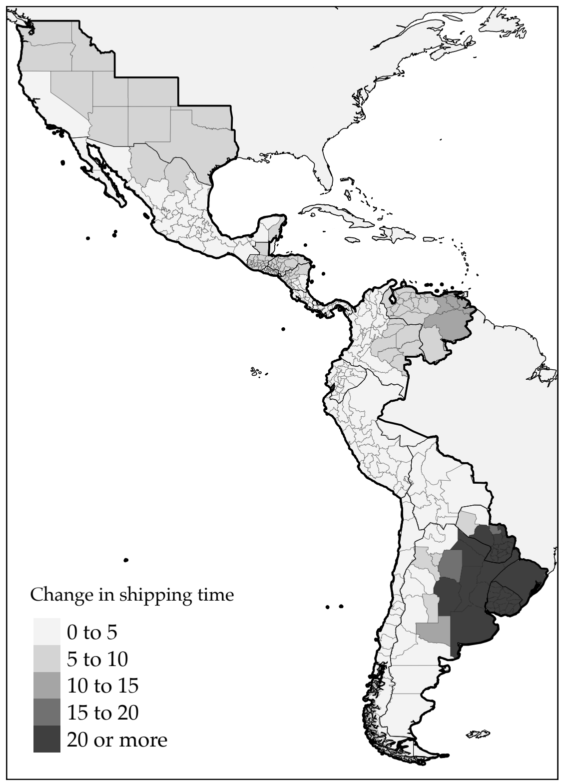


Figure 6: The figure depicts the difference between shipping times in 1760 and 1810 aggregated to the province-level. Darker colors indicate larger reductions in shipping times. Lines denote country and province borders.

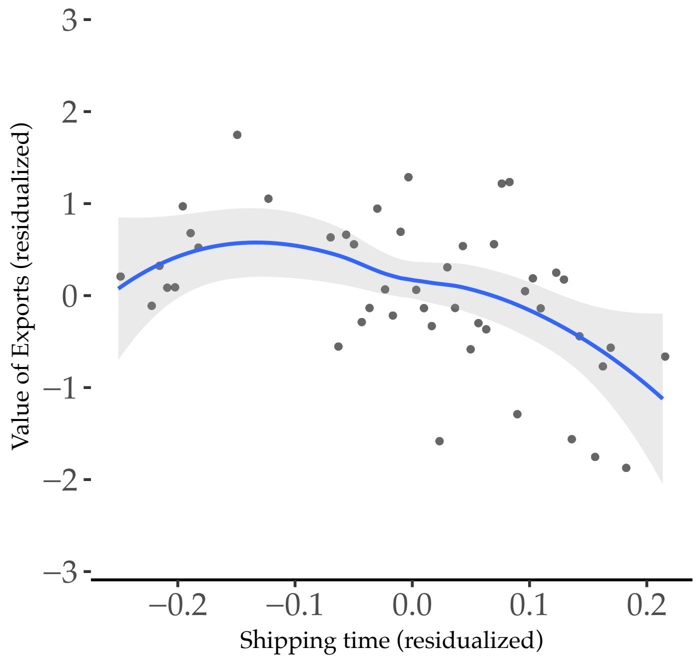


Figure 7: The figure depicts the relation between the log shipping time and the log value of exports from Spain. The value of trade is measured in *reales de vellón* at constant prices. The full sample contains 211 observations. **Controls:** Year × region fixed effects and region fixed effects. **Standard errors:** Robust standard errors in parenthesis.

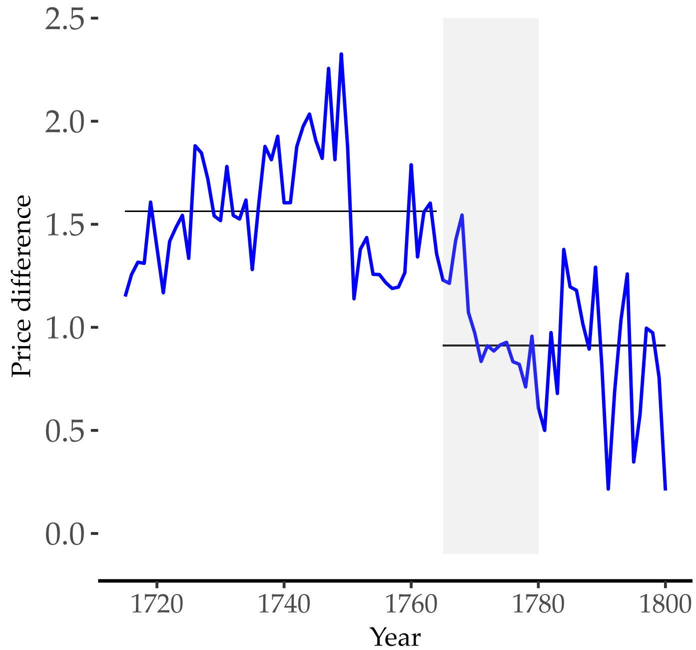


Figure 8: The figure depicts the difference in the average log price for commodities (wine, salt, sugar, cinnamon) in Spain (Castille) and cities in Spanish America (Buenos Aires, Potosí, Lima, Bogotá, Santiago de Chile, Mexico City)

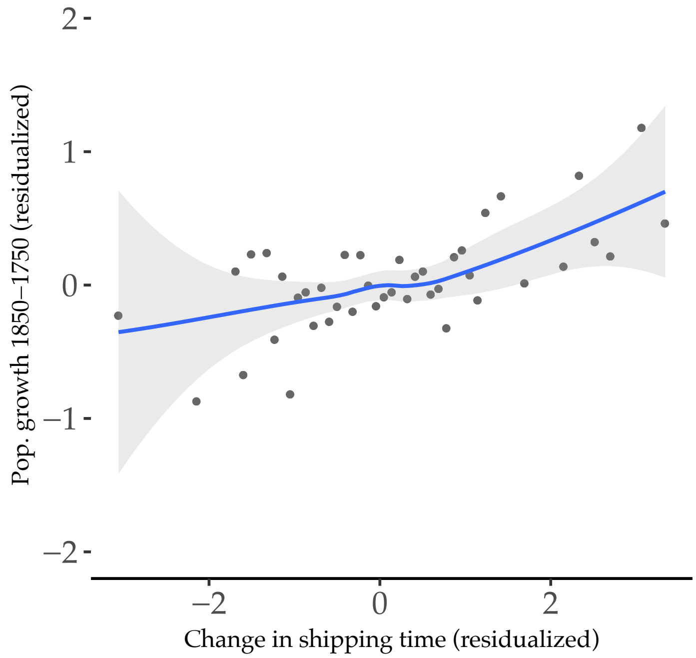


Figure 9: The figure depicts the relation between the change in log shipping time (ΔT_i) and the change in log population (ΔL_{it}) between 1750 and 1850. The full sample contains 297 observations. **Controls:** Elevation, crop suitability, the location of active mines, terrain ruggedness, distance to the coastline, and log population size in 1750. **Standard errors:** Clustered at the level of the closest port.

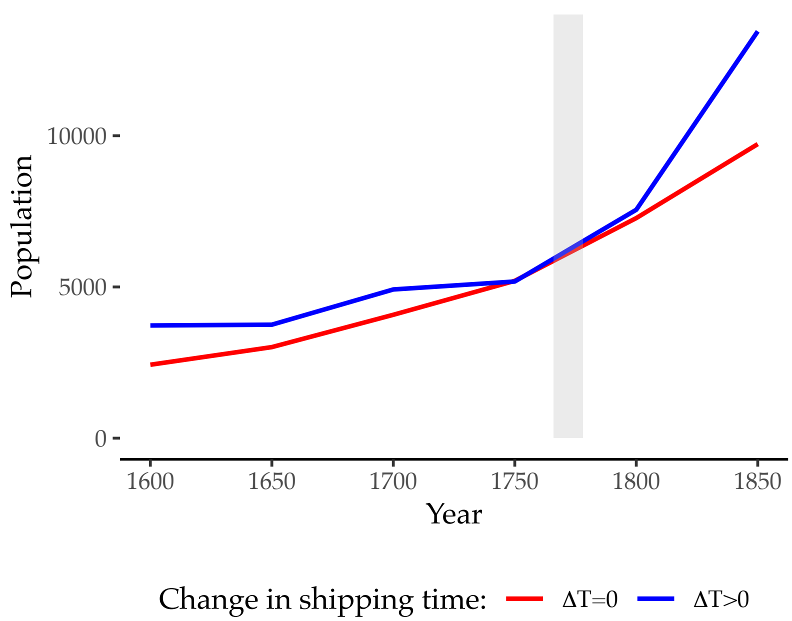


Figure 12: The figure depicts the average population size for cities with changes in the shipping time to Europe and cities without changes in the shipping time to Europe. The shaded area shows the main period of the reform.

Supplementary Appendix
(For online publication only)

Contents

A Model Details

This section provides the main steps of the derivation of the model, the equilibrium conditions, and the estimation strategy.

Preferences. The utility function is defined over a composite of differentiated varieties and food that is sourced from the immediate hinterland and is non-traded. The preferences are defined as follows, $U_{it} = \frac{C_{it}^{\mu} F_{it}^{1-\mu}}{\mu^{\mu}(1-\mu)^{1-\mu}}$ where $C_{it} = \left(\sum_{j \in N} c_{jit}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$ and c_{ji} is the amount of the location j specific good consumed in location i. It follows that the demand for the traded and non-traded variety are given by $F_{it} = (1-\mu)Y_{it} / r_{it}$ and $C_{it} = \mu Y_{it} / P_{it}$ where Y_{it} is the income and $P_{it} = \left(\sum_{j \in N} p_{jit}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$. Further, the demand for each traded variety is given by $c_{jit} = p_{jit} E_{it} P_{it}^{\sigma-1}$ where $E_{it} = \mu Y_{it} = w_{it} L_{it}$. Inserting the demand functions into the utility function gives the indirect utility function for an individual in location i that is provided in the paper, $V_i = w_i / \mu P_i^{\mu} r_i^{1-\mu}$.

Production. Production takes place under perfect competition and as a result, the price for traded and non-traded goods is equal to its marginal cost. Since a worker in location i can produce A_{it} units of a good and the nominal wage is w_{it}, the price of the good in location i is given by $p_{it} = w_{it} / A_{it}$. Since there are iceberg transportation costs, the price faced by an individual in location i is given by $p_{jit} = \tau_{jit} w_{jt} / A_{jt}$ where $A_{it} = \bar{A}_i L_{it}^{\alpha_1} L_{it-1}^{\alpha_2}$. Finally, the use of land in food production features constant returns to scale and is a function of the availability of arable land $\bar{H}_i$ which is exogenous in each location. As a result, $F_i = \bar{H}_i$. The land market is perfectly competitive. Since the market for land is competitive and supply exogenous, the price for land is pinned down by the demand function for F_i is given by $r_{it} = (1-\mu)Y_{it} / \bar{H}_i$.

Trade. Assuming market clearing such that $c_{jit} = q_{jit}$, the value of trade from location j to location i is given by $X_{jit} = q_{jit} p_{jit} = p_{jit}^{1-\sigma} \mu Y_{it} P_{it}^{\sigma-1} = \left(\tau_{jit} \frac{w_{jt}}{A_{jt}}\right)^{1-\sigma} \mu Y_{it} P_{it}^{\sigma-1}$ where q_{jit} denotes the number of units of the location j goods that arrive in location i. 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 region i to region j is given by $V_{ij} = \frac{V_j}{m_{ij}} \epsilon_j$ where ϵ_j is an idiosyncratic taste shifter, assumed to be an *iid* draw from a Fréchet-distribution with shape parameter θ capturing individual-level heterogeneity in location preferences. An individual chooses to move from i to j if the realized utility of that location is higher, which happens with probability $Pr\left(V_{ij}\epsilon_j \geq V_{ik}\epsilon_k \forall k \neq j \in R\right)$. Since the idiosyncratic location preferences are *iid* and there is a continuum of agents in each location this probability corresponds to the share of agents in city i moving to j, denoted π_{ij}. It follows that the conditional probability of moving is,

$$\pi_{ij}|\epsilon_j = Pr\left(\epsilon_k \leq \frac{V_{ij}\epsilon_j}{V_{ik}} \epsilon_k \forall k \neq j \in R\right) = \prod_{k \neq j} Pr\left(\epsilon_k \leq \frac{V_{ij}\epsilon_j}{V_{ik}}\right). \tag{A.1}$$

As a result, the unconditional distribution is given by,

$$\pi_{ij} = \int_0^{\infty} f(\epsilon_j) \prod_{k \neq j} Pr\left(\epsilon_k \leq \frac{V_{ij}\epsilon_j}{V_{ik}}\right) d\epsilon_j = \int_0^{\infty} \theta \epsilon_j^{-1-\theta} \exp\{-\epsilon_j^{-\theta}\} \exp\{-V_{ij}^{-\theta} \epsilon_j^{-\theta} \sum_{k \neq j} V_{ik}^{\theta}\} d\epsilon_j \tag{A.2}$$

$$= \int_0^{\infty} \theta \epsilon_j^{-1-\theta} \exp\{-\epsilon_j^{-\theta} \Phi_j\} d\epsilon_j = \Phi_j^{-1} = \frac{V_{ij}^{\theta}}{\sum_{k \in R} V_{ik}^{\theta}} = \frac{(V_j / m_{ij})^{\theta}}{\sum_{k \in R} (V_k / m_{ik})^{\theta}}, \tag{A.3}$$

which follows after making the substitution defining $x = \epsilon_j^{-\theta} \Phi_j$. The number of people moving from i to j is the $L_{ijt} = \pi_{ij} L_{it-1} = L_{it-1} V_j^{\theta} \Pi_i^{-\theta} m_{ij}^{-\theta}$ which is the expression in the text.

Equilibrium. The equilibrium of the model is characterized by the following five equations.

1. $w_i L_i = \sum_{k \in R} X_{ik}$. The total expenditure on goods produced in i equals the revenue in each location, which in turn equals the cost of labor when there are zero profits (goods market clearing).

2. $w_i L_i = \sum_{k \in R} X_{ki}$. Revenue from trade equals total expenditure on goods (balanced trade in each location).

3. $\sum_{k \in R} L_i = \bar{L}$. The total population size of the economy is fixed.

4. $L_i = \sum_{k \in R} L_{ji}$. The total population equals the number arriving at the location.

5. $L_{it-1} = \sum_{k \in R} L_{ijt}$. The total population equals the number exiting that location.

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 $w_i^{1-\sigma} A_i^{\sigma-1} \propto w_i L_i P_i^{\sigma-1}$. Using the indirect utility, it follows that $P_i^{\sigma-1} = w_i^{\sigma-1} V_i^{\frac{1-\sigma}{\mu}} \bar{H}_i^{\frac{(1-\mu)(\sigma-1)}{\mu}} L_i^{\frac{(\mu-1)(\sigma-1)}{\mu}}$. Inserting this gives the following expression for the nominal wage,

$$w_i = A_i^{\tilde{\sigma}} L_i^{\tilde{\sigma}\left(\frac{1}{1-\sigma} + \frac{1-\mu}{\mu}\right)} V_i^{\frac{\tilde{\sigma}}{\mu}} \bar{H}_i^{\frac{(\mu-1)\tilde{\sigma}}{\mu}}, \tag{A.4}$$

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 (4. and 5.) then results in the following equations for the equilibrium of the model,

$$L_i^{\tilde{\sigma}\left(1-\sigma\frac{\mu-1}{\mu} - \alpha_1(\sigma-1)\right)} V_i^{\frac{\tilde{\sigma}\sigma}{\mu}} = \bar{A}_i^{\tilde{\sigma}(\sigma-1)} \bar{H}_i^{\frac{(1-\mu)\tilde{\sigma}\sigma}{\mu}} L_{it-1}^{\alpha_2\tilde{\sigma}(\sigma-1)} \sum_{j \in R} \tau_{ij}^{1-\sigma} \bar{A}_j^{\tilde{\sigma}\sigma} L_j^{\tilde{\sigma}\left(1+\alpha_1\sigma + \frac{(1-\sigma)(1-\mu)}{\mu}\right)} V_j^{\frac{\tilde{\sigma}(1-\sigma)}{\mu}} \bar{H}_j^{\frac{\tilde{\sigma}(\mu-1)(1-\sigma)}{\mu}} L_{jt-1}^{\sigma\tilde{\sigma}\alpha_2}, \tag{A.5}$$

$$\Pi_i^{\theta} = \sum_{j \in R} m_{ij}^{-\theta} V_j^{\theta}, \tag{A.6}$$

$$L_i V_i^{-\theta} = \sum_{j \in R} m_{ij}^{-\theta} \Pi_j^{-\theta} L_{jt-1}. \tag{A.7}$$

Existence and uniqueness. The set of model parameters that guarantee the uniqueness and existence of the equilibrium can be derived using the results in Allen and Donaldson (2020) and Allen, Arkolakis and Li (2020). There are $3 \times R$ endogenous variables that need to be solved. Ordering the endogenous variables as L, V, and Π gives the following matrices of coefficients,

$$\mathbf{B} = \begin{bmatrix} \tilde{\sigma}(1 - \sigma\frac{\mu-1}{\mu} - \alpha_1(\sigma-1)) & \frac{\tilde{\sigma}\sigma}{\mu} & 0 \\ 0 & 0 & \theta \\ 1 & -\theta & 0 \end{bmatrix}, \tag{A.8}$$

$$\mathbf{\Gamma} = \begin{bmatrix} \tilde{\sigma}(1 + \alpha_1\sigma + \frac{(1-\sigma)(1-\mu)}{\mu}) & \frac{\tilde{\sigma}(1-\sigma)}{\mu} & 0 \\ 0 & \theta & 0 \\ 0 & 0 & -\theta \end{bmatrix}. \tag{A.9}$$

As a result,

$$\mathbf{\Gamma}\mathbf{B}^{-1} = \frac{1}{b_{11}\theta^2 + \frac{\tilde{\sigma}\sigma\theta}{\mu}} \begin{bmatrix} \theta^2\Gamma_{11} + \frac{\theta\tilde{\sigma}(1-\sigma)}{\mu} & 0 & \frac{\Gamma_{11}\tilde{\sigma}\sigma\theta}{\mu} - \frac{\theta b_{11}\tilde{\sigma}(1-\sigma)}{\mu} \\ \theta^2 & 0 & -\theta^2 b_{11} \\ 0 & -\theta^2 b_{11} - \frac{\tilde{\sigma}\sigma\theta}{\mu} & 0 \end{bmatrix}. \tag{A.10}$$

As noted in Allen and Donaldson (2020), the spectral norm of the absolute value of the above matrix is equivalent to the spectral norm of the smaller matrix,

$$\mathbf{A}^p = \left| \frac{1}{\theta^2 b_{11} + \frac{\tilde{\sigma}\sigma\theta}{\mu}} \right| \begin{bmatrix} |\theta^2\Gamma_{11} + \frac{\theta\tilde{\sigma}(1-\sigma)}{\mu}| & |\Gamma_{11} - \frac{\theta b_{11}(1-\sigma)}{1-\mu}| \\ |\theta^2| & |-\theta^2 b_{11}| \end{bmatrix}. \tag{A.11}$$

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 locations 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.

$$L_i^{\tilde{\sigma}\left(1-\sigma\frac{\mu-1}{\mu}-(\alpha_1+\alpha_2)(\sigma-1)\right)} V_i^{\frac{\tilde{\sigma}\sigma}{\mu}} = \bar{A}_i^{\tilde{\sigma}(\sigma-1)} \bar{H}_i^{\frac{(1-\mu)\tilde{\sigma}\sigma}{\mu}} \sum_{j\in R} \tau_{ij}^{1-\sigma} \bar{A}_j^{\tilde{\sigma}\sigma} L_j^{\tilde{\sigma}\left(1+(\alpha_1+\alpha_2)\sigma+\frac{(1-\sigma)(1-\mu)}{\mu}\right)} V_j^{\frac{\tilde{\sigma}(1-\sigma)}{\mu}} \bar{H}_j^{\frac{\tilde{\sigma}(\mu-1)(1-\sigma)}{\mu}} \tag{A.12}$$

$$\Pi_i^{\theta} = \sum_{j\in R} m_{ij}^{-\theta} V_j^{\theta} \tag{A.13}$$

$$L_i V_i^{-\theta} = \sum_{j\in R} m_{ij}^{-\theta} \Pi_j^{-\theta} L_{jt} \tag{A.14}$$

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 given at approximately 0.9 in both cases. As a result, the equilibrium and steady-state are both unique.

Reduced form relationships. The deterministic component of indirect utility is given by $V_i = w_i P_i^{-\mu} r_i^{\mu-1} / \mu$ where again $r_i = (1-\mu) w_i L_i / \bar{H}_i$ and assuming quasi-symmetric trade costs $w_i^{1-\sigma} A_i^{\sigma-1} \propto w_i L_i P_i^{\sigma-1}$. As a result, $V_i^{-\sigma} = w_i^{-\mu\sigma} P_i^{\mu\sigma} L_i^{\sigma(1-\mu)} \bar{H}_i^{\sigma(\mu-1)}$ and $w_i^{-\sigma\mu} \propto A_i^{\mu(1-\sigma)} L_i^{\mu} P_i^{\mu(\sigma-1)}$. This gives,

$$L_{it}^{\mu+\sigma(1-\mu)+\alpha_1\mu(1-\sigma)} = \kappa V_{it}^{-\sigma} \bar{A}_i^{\mu(\sigma-1)} L_{it-1}^{\alpha_2\mu(\sigma-1)} P_{it}^{\mu(1-2\sigma)} \bar{H}_i^{\sigma(1-\mu)}, \tag{A.15}$$

This gives,

$$\nu \ln L_{it} = \kappa' - \sigma \ln V_{it} + \mu(\sigma-1)\ln \bar{A}_i + \alpha_2\mu(\sigma-1)\ln L_{it-1} - \mu(2\sigma-1)\ln P_{it}, \tag{A.16}$$

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

$$\begin{aligned} \ln L_{it} = \tilde{\kappa}_i + \left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^T \ln L_{i0} - \frac{\sigma}{\nu}\sum_{k=0}^{T-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln V_{it-k} \\ - \frac{\mu(2\sigma-1)}{\nu}\sum_{k=0}^{T-1}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k \ln P_{it-k}. \end{aligned} \tag{A.17}$$

To analyze the comparative statics underlying the reduced form exercise consider the above equation I consider a reduction in the trade cost to Europe in period k for city i (that is a change in τ_{iek}). It follows that,

$$\frac{\partial \ln L_{it}}{\partial \tau_{iek}} = -\frac{\mu(2\sigma-1)}{\nu}\left(\frac{\alpha_2\mu(\sigma-1)}{\nu}\right)^k P_{ik}^{\sigma-1} \tau_{iek}^{-\sigma} \left(\frac{w_{ek}}{A_{ek}}\right)^{(1-\sigma)} < 0, \tag{A.18}$$

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

B Data Details

Urban population. I use data on urban populations from Buringh (2013) made available by the Centre for Global Economic History at Utrecht University. The basic criterion to select for inclusion in the database was the availability of historical data on its population size for the period between 1500 and 1800. 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. If one of these criteria was met the city was included in the dataset. For these cities, the database is constructed by consulting a variety of sources. Following Arroyo Abad and 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 central Mexico is from Gerhard (1993*a*). Data on Northern Mexico and the Southwestern United States is from Gerhard (1993*b*). Southern Mexico and parts of Guatemala are from Gerhard (1993*c*). For Peru I use information in Cook (1981). 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).

The reporting year in the national and regional sources occasionally does not coincide with the 50-year bin in which the data is coded in the dataset. For example, for New Granada (approximately present-day Colombia) the first colonial census was conducted between 1777 and 1779. In most cases, I assign the observation to the closest 50-year period. For example, observations for 1790 would be assigned to 1800. If there are observations on both sides of the year of interest, I calculate the average annual growth and use this to predict the population size. For example, if population data is available for 1790 and 1805, I calculate the average annual growth rate between 1790 and 1805 and use this to predict the population size in 1800. Importantly for this study, the data quality and the number of sources available increased over the colonial period. Moreover, most of the identifying variation in the data is from after 1750 when the data quality is higher. As a result of these considerations, I restrict the sample to cover the period after 1600.

Next, I use the national and regional sources to validate the data on cities in the Americas recorded in Buringh (2013). Reassuringly, there is a high correlation between the two datasets for the countries and period in question. In the cases where the data sources do not coincide, I adjust Buringh (2013) with the regional and national data sources. However, I re-estimate the models without the corrections to the data as a robustness check. Unsurprisingly, I find very similar results as in the baseline case. Taken together, these exercises provide some assurance about the quality of the data sources.

For data before 1600, mainly used in the cross-sectional regressions in Section 5, I follow the literature and mainly rely on Denevan (1992). As a robustness check, I collect data on tributary counts for New Spain and compare the resulting persistence elasticity with the one based on Denevan (1992). Data on central Mexico is from Gerhard (1993*a*). For the earliest period in the sample, numbers mainly come from Spanish reports on military numbers, males in city-states, and written impressions by early settlers and conquistadors. However, once a higher administrative capacity had been achieved, the main data source is tribute counts. The motivation for these counts was fiscal and the relationship between total population and tributary count changed over time. In a few cases, I have used conversions between tributary counts and population numbers available in Gerhard (1993*a*). Some of the entries report total population data directly. This is typically the case for the second half of the 18th century. In addition to tributary counts, important sources that form the basis of the data used in the paper are various civil, fiscal, and ecclesiastical records.

Settlements. Economic expansion, an increased military presence, and missionary activity also led to the formation of new settlements (Morse, 1974). Examples of settlements founded in this period that later grew into larger cities are San Francisco, Albuquerque, San Antonio, Montevideo, Copiapo, and Rancagua (Morse, 1974; Parry, 1990). To capture this, I further supplement the dataset territorial gazetteer of around 15,000 places that existed in the Spanish Empire during the 18th and early 19th century (Stangl, 2019). The city (*cidudad*) was the highest legal denomination given a settlement in the Spanish Empire. The founding of cities was typically a conscious effort by the crown to ensure territorial control, rather than something which naturally occurred through population growth. Criteria for locations chosen depended on a range of micro-geographic factors such as ease of defense and water supply. Often these were founded in localities where large population centers already were located. Moreover, towns were in some cases upgraded from town status (*villa*) to city status. Few settlements with the status of city were founded during the study period, however, several settlements were founded that later would evolve into large population centers. The town (*villa*) was a legal status granted a settlement in the Spanish Empire. The formation of new towns was frequent throughout the study period. 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). Around 11 percent of cell/decade combinations have a settlement in the main dataset.

Assessing the shipping times. I validate the estimated shipping times both qualitatively and quantitatively. First, I find a good correspondence between predicted trade routes and the location of known historical trade routes. Second, I compare the results to measures of sailing times from a database of bilateral sailing 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 5 knots is used, which is 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. Figure A3 shows that these alternative shipping time measures are correlated with the measure developed in this paper. Furthermore, I assess the correlation between historical and contemporary wind patterns. There is a strong correlation between wind speed and direction in these two datasets. Panel (a) in Figure A2 depicts the distribution of recorded wind directions and Panel (b) depicts the sailing speeds. The figure shows that the average sailing speed was around 5 knots and that most sailings took place in the direction of the wind or at 90 degrees where sails work most efficiently (Pascali, 2017; Kelly and Ó Gráda, 2019).

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

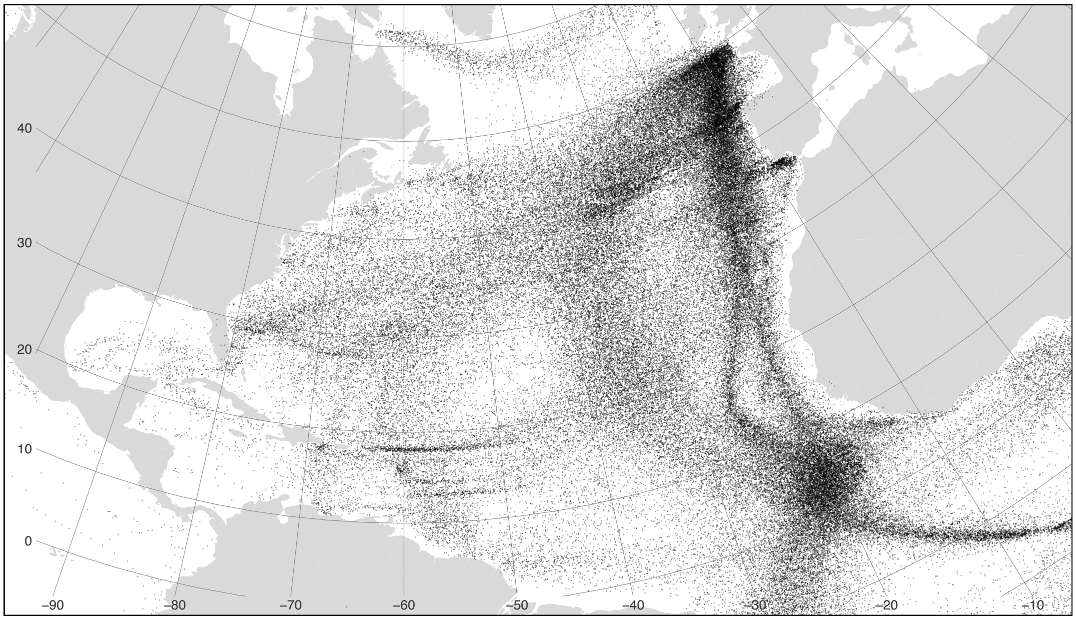


Figure A1: The figure shows the logbook entries used to estimate the travel times in the main analysis. Each dot represents a logbook entry between 1750 and 1850. Source: CLIWOC.

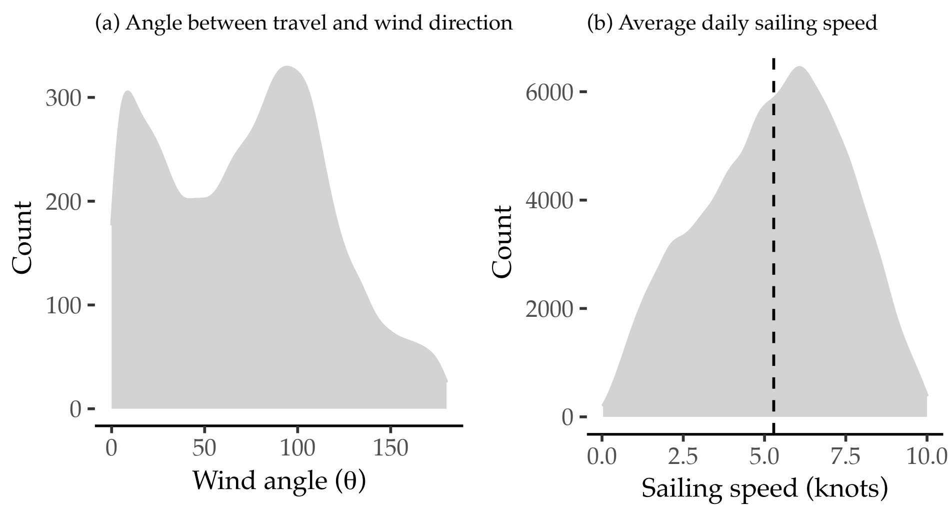


Figure A2: Panel (a) depicts the deviation of the sailing direction and wind direction for the logbook entries. Panel (b) depicts the average daily speed imputed from the logbook entries. The vertical line denotes the average sailing speed in the sample.

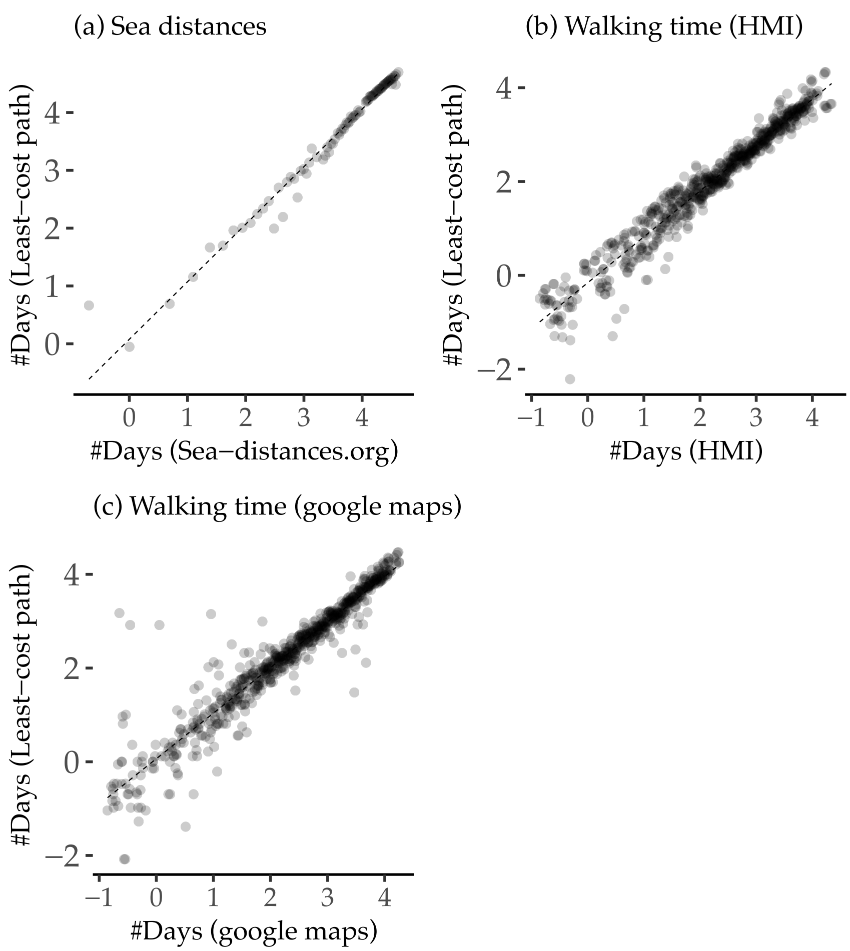


Figure A3: The figures depict the results from the main validation exercises. Panel (a) depicts the relationship between sailing times produced by the least-cost path on the constructed cost-surface and sailing times from sea-distances.org for voyages between Cadiz and 21 ports in Spanish America. The travel times are set to 4 knots which is the average speed attained over the cost-surface. Panel (b) depicts the relationship between bilateral shipping times between large cities generated by the least-cost path on the constructed cost-surface and the Human Mobility Index developed in Özak (2010, 2018). Panel (c) depicts the relationship between bilateral shipping times between major cities generated by the least-cost path on the constructed cost-surface and google maps.

C Further Historical Background

This section provides a more detailed historical background for the analysis. 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 restricted 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 (*recuas*) or wagons (*carros*) 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 early to the mid 18th century as a result of the treaty of Utrecht, the *asiento* (Walker, 1979). These measures facilitated 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 was 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 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. 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 was 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. However, while the reform stimulated trade, the terms of trade in many ports presumably remained depressed (Francis, 2017). 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). The composition of Spanish imports in the late 18th century can be seen in Figure A4.

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 large effects on trade and affect economic development in the second half of the 18th century.

D Robustness Checks

In this section, I elaborate on the robustness checks. 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 at which ports opened was driven by their economic potential. To mitigate this concern, I restrict the sample to only include areas far away from ports in the estimation. These were unlikely to be directly targeted by the reform. These results are reported in Table A5 and A6. To account for potentially spatially correlated error terms, I calculate standard errors accounting for spatial correlation in line with Conley (1999). I also re-estimate the model after remove outliers. To further address concerns about measurement error, I re-estimate the model for cities in locations with high state capacity. Following Acemoglu, Moscona and Robinson (2016), I measure state capacity by the location of post offices in 1750. This draws on the notion of infrastructural power, or "the capacity to actually penetrate society and to implement logistically political decisions" (Mann, 1986, p. 170), as being an important determinant of state capacity. The effects on urban growth are already positive before independence. However, if trade contributed to political fragmentation (see e.g. Arteaga, 2016; Bonfatti, 2017), then conditioning on country fixed effects might lead to post-treatment bias. I address this by constructing viceroyalty and *audiencia* fixed effects using borders between 1710 and 1750. Finally, I explore the relationship between increased access to trade on the slave trade. Using data from Behrendt et al. (1999), which covers around 80 percent of all voyages of the slave trade, I find little evidence that the population growth is driven by increased demand for coerced labor. Several of these results are reported in the Appendix. Taken together, these exercises provide support for the causal interpretation of the estimates. The findings provide evidence that cheaper access to traded goods and better export opportunities increased urban growth and that the size of the home market was an important mediating factor.

Another threat to the research design is that the effect is not driven by changes in the trading environment, but rather other events occurring in the late 18th century. Other administrative, ecclesiastical, and military reforms were conducted in Spanish America. One important reform was the separation of the Viceroyalty of *Rio de la Plata* from the Viceroyalty of Peru in the second half of the 18th century. This potentially induced economic growth in locations that also experienced large reductions in shipping times. However, when dropping cities in the Viceroyalty of *Rio de la Plata* or the whole of Argentina the estimated coefficients are similar. Moreover, I exploit the fact that the Viceroyalty of New Granada was separated from the Viceroyalty of Peru already in 1717. I do not find evidence that this reform affected city growth.

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 both the decline in shipping times and urban growth. A more systematic approach to sensitivity analysis is developed in Cinelli and Hazlett (2020). Following this approach, I calculate the robustness value (RV), which quantifies the strength any unobserved confounder would need to fully account for the estimated effect. I find that a robustness value of 17.64 to account for a true effect of zero, and 7.64 to account for a true effect that is statistically insignificant. In other words, if there exists a confounder that explains 17.64 of the outcome and the treatment, then controlling for this confounder would make the effect of declining shipping time zero. This is substantially larger than the effect of important covariates such as the initial population size. As a result, the estimated effect of the decline in shipping time is unlikely to be driven by an unobserved confounder.

A further concern is that the effects found are driven by the large cities or the main administrative centers. To address this, I remove the four most important cities from the sample (Buenos Aires, Mexico City, Potosí, and Lima). These results are reported in Table A3 and A4. The conclusions from the main analysis remain unaffected. Table A7 provides the estimated coefficients for the dynamic regression model with the number of settlements as the dependent variable across different specifications. As can be seen from this table, the results are similar to the main analysis. Table A2 provides different estimates of the reduction in price dispersion across different specifications. The results are robust except for adding a linear time trend as a control. Finally, Figure A9 reports a range of specification tests from re-estimating the model by sequentially removing parts of the sample. The figure shows the estimates in Table 5 for different subsamples. Panel (a) and (b) shows the model re-estimated after removing each port catchment area. Panel (c) and (d) show the model re-estimated after removing each country. Panel (e) and (f) show the model re-estimated after removing each viceroyalty.

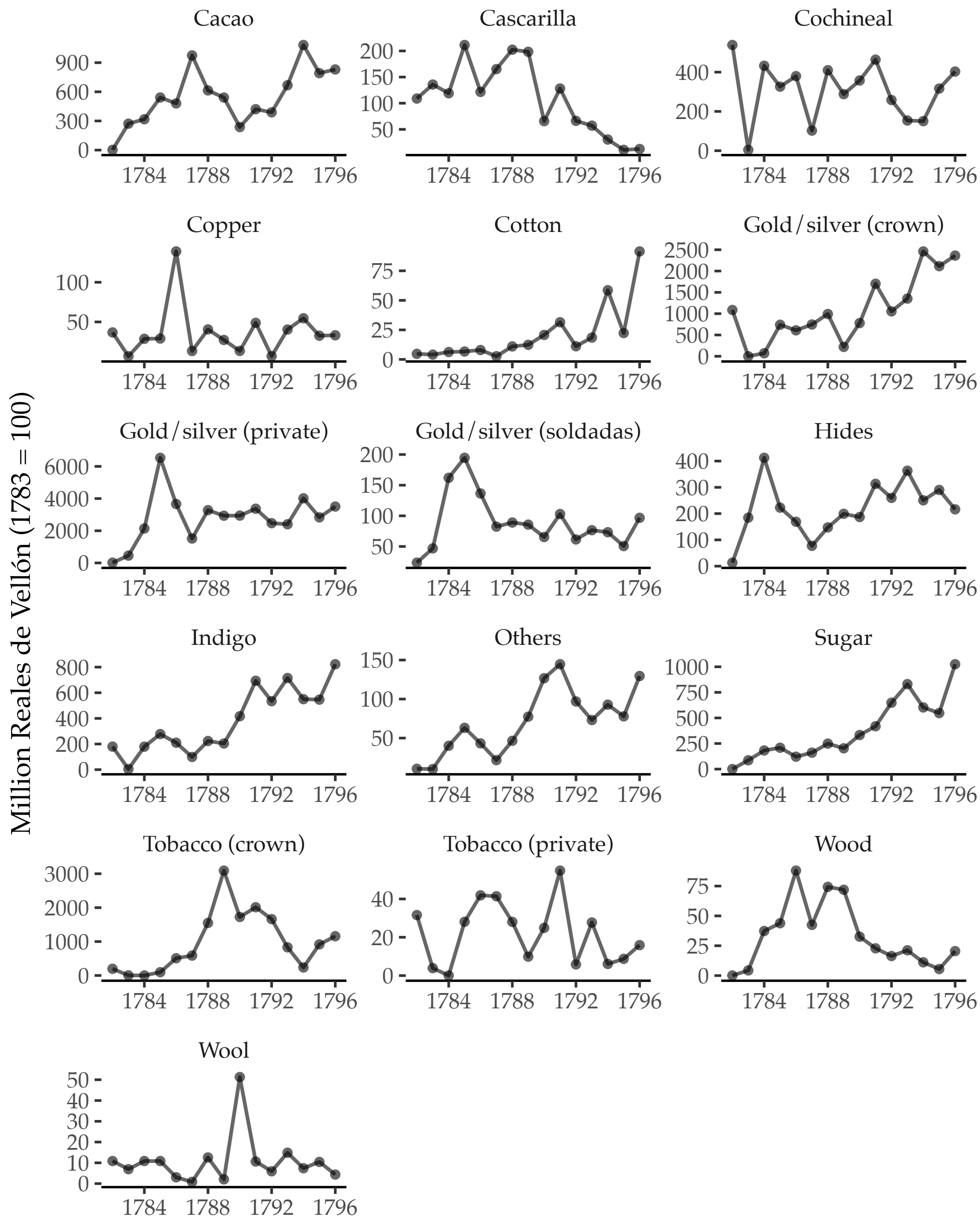


Figure A4: The figure depicts the imports to Cadiz of various commodities (in million reales de vellón) for the years 1782 to 1796. Source: Fisher (1985).

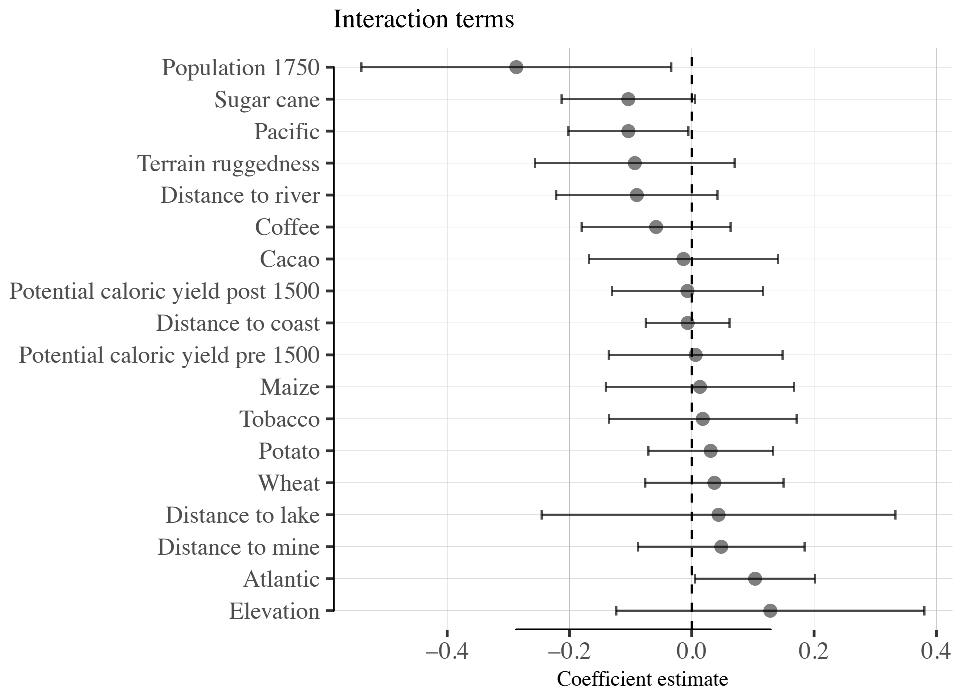


Figure A5: The figure depicts the interaction between the decline in shipping time and a range of variables as well as their 95 percent confidence intervals. Each point is the coefficient from a regression where population growth between 1750 and 1850 is regressed on each variable interacted with the decline in shipping time (ΔT) using the baseline specification. All variables are standardized to facilitate comparison.

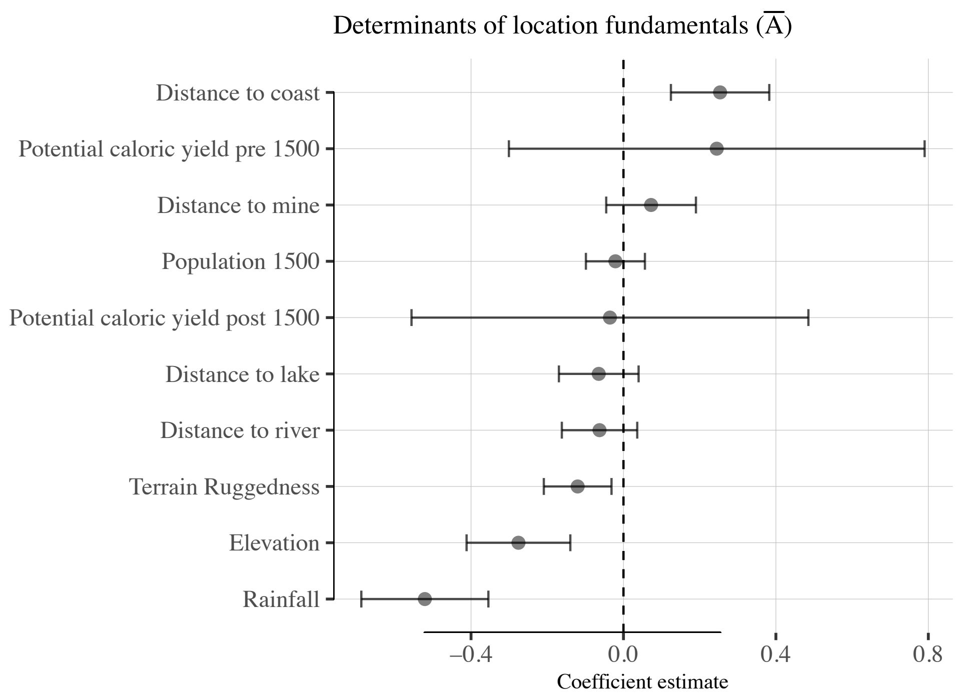


Figure A6: The figure depicts the correlates of the locational fundamentals implied by the model ($\bar{A}$) and 95 percent confidence intervals. The variables are standardized.

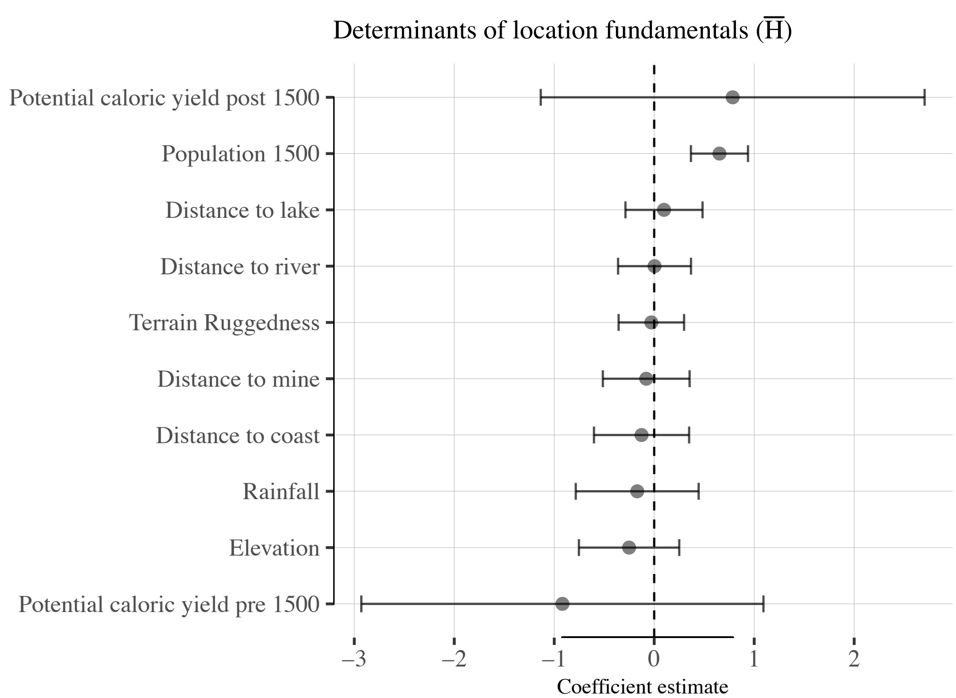
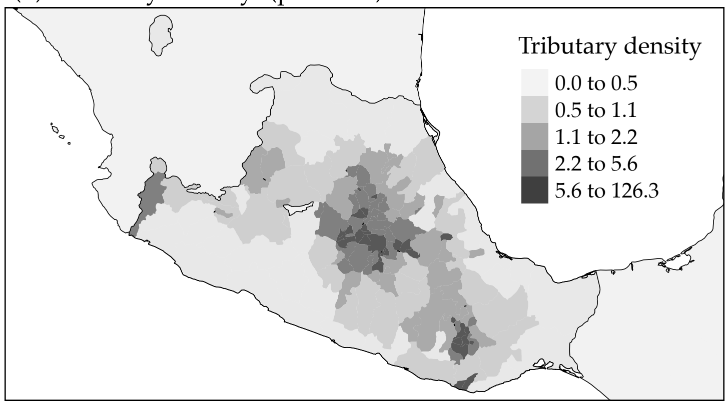
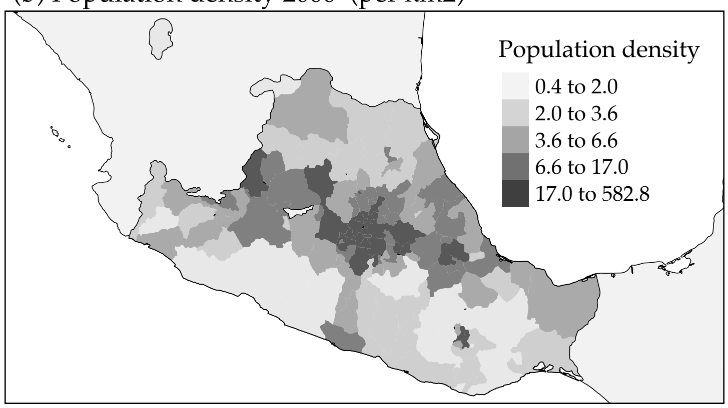


Figure A7: The figure depicts the correlates of the locational fundamentals implied by the model ($\bar{H}$) and 95 percent confidence intervals. The variables are standardized.

(a) Tributary density (per km2)



(b) Population density 2000 (per km2)



(c) Population density 2000

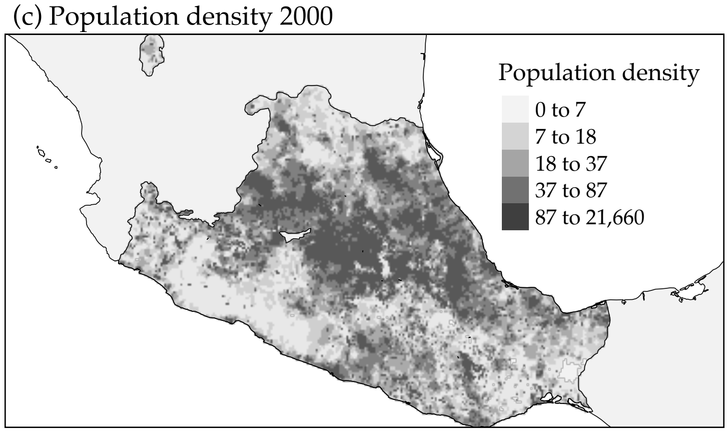


Figure A8: The figure depicts the population density and tributary density for central Mexico. Panel (a) depicts the tributary density by political division for the colonial era. Data are from Gerhard (1993*a*). Panel (b) depicts the population density aggregated to the same political boundaries in 2000. Panel (c) shows the underlying raster containing population density for 2000.

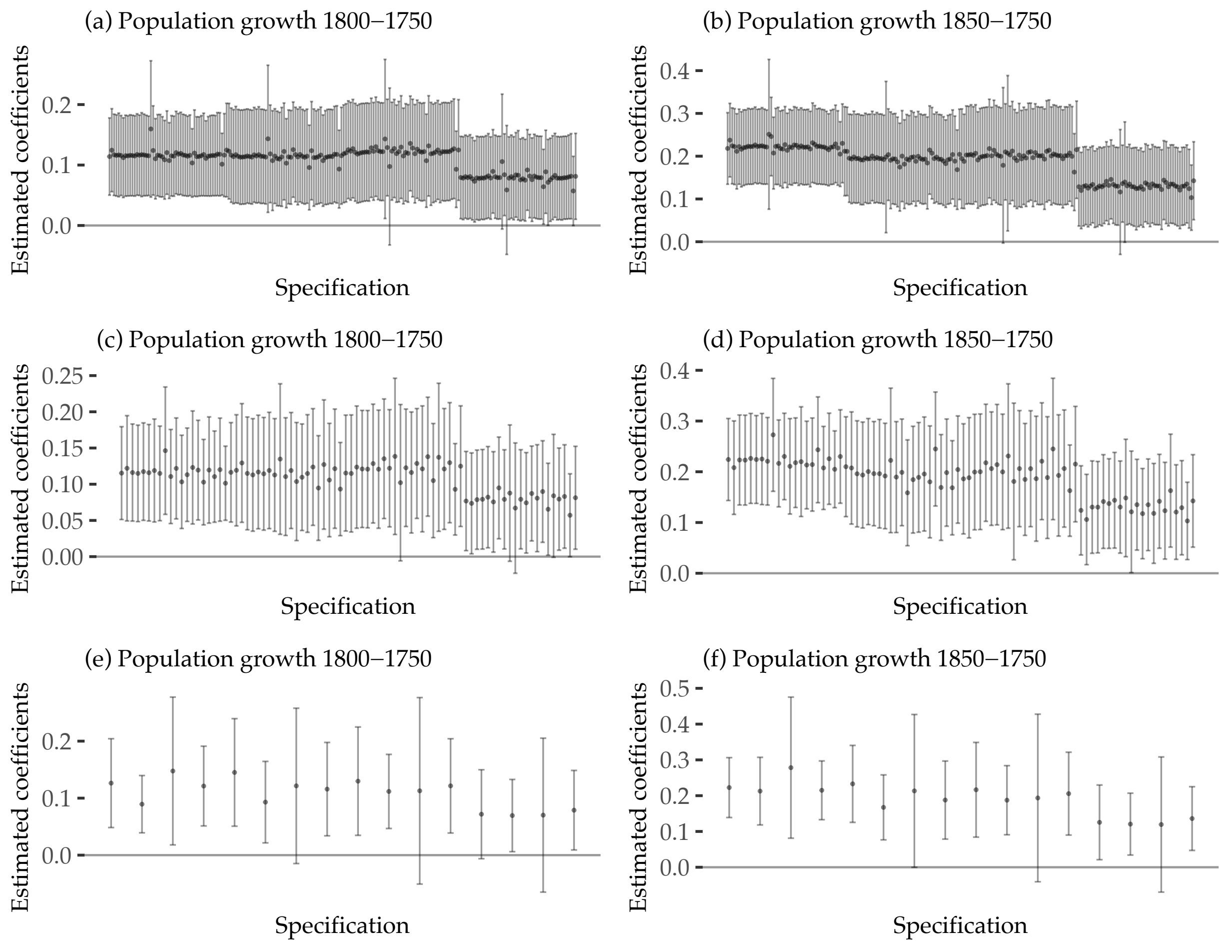


Figure A9: The figure shows the estimates in Table 5 for different subsamples. The decline in shipping time is standardized. Panel (a) and (b) shows the model re-estimated after removing each port catchment area. Panel (c) and (d) show the model re-estimated after removing each country. Panel (e) and (f) show the model re-estimated after removing each viceroyalty.

Table A1: Event-study specification

Dependent variable:	City population (ln)			
	(1)	(2)	(3)	(4)
Δ T $\times$ $\mathbb{1}$ (*year* = 1600)	−0.045	−0.061	−0.042	−0.071
	(0.063)	(0.067)	(0.080)	(0.074)
Δ T $\times$ $\mathbb{1}$ (*year* = 1650)	−0.002	0.009	0.025	−0.009
	(0.039)	(0.052)	(0.058)	(0.054)
Δ T $\times$ $\mathbb{1}$ (*year* = 1700)	0.014	0.042	0.043	0.018
	(0.043)	(0.054)	(0.049)	(0.044)
Δ T $\times$ $\mathbb{1}$ (*year* = 1800)	0.122***	0.120***	0.131***	0.097**
	(0.040)	(0.045)	(0.046)	(0.040)
Δ T $\times$ $\mathbb{1}$ (*year* = 1850)	0.230***	0.200***	0.193***	0.134**
	(0.049)	(0.058)	(0.064)	(0.054)
City FE	✓	✓	✓	✓
Baseline controls × time FE		✓	✓	✓
Viceroyalty × time FE			✓	✓
Population 1750 × time FE				✓
N	1,566	1,566	1,566	1,566
R^2	0.829	0.845	0.859	0.874

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 level of the closest port. ***p < .01, **p < .05, * p < .1

Table A2: Price differences

Dependent variable:	Price ratio: $\ln p_{i,am} - \ln p_{i,es}$				
	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}[Year \geq 1778]$	−0.560***	−0.507***	−0.420***	−0.406***	−0.143
	(0.120)	(0.117)	(0.063)	(0.065)	(0.091)
Commodity FE		✓	✓	✓	✓
Location FE			✓	✓	✓
War FE				✓	✓
Trend					✓
N	785	785	785	785	785
R^2	0.028	0.117	0.665	0.666	0.672

Note: The table reports OLS estimates. **Dependent variable:** The difference in the natural logarithm of prices in Spanish America and Spain. The commodities are wine, sugar, cinnamon, salt. The locations are Spain (Castille), Santiago de Chile, Buenos Aires, Bogotá, Callao. **Standard errors:** Heteroscedasticity robust. Sources: GPIH and Hamilton (1947). ***p < .01, **p < .05, * p < .1

Table A3: Shipping time and population growth (capitals excluded)

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it'}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	0.106***	0.101**	0.105**	0.060
	(0.036)	(0.044)	(0.044)	(0.040)
N	293	293	293	293
R^2	0.040	0.059	0.065	0.244
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.214***	0.182***	0.183***	0.109**
	(0.046)	(0.056)	(0.060)	(0.048)
N	293	293	293	293
R^2	0.068	0.089	0.115	0.325
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.039	0.016	0.005	0.006
	(0.035)	(0.041)	(0.038)	(0.037)
N	241	241	241	241
R^2	0.007	0.036	0.056	0.057
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Population 1750				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** Population growth. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. ***p < .01, **p < .05, * p < .1

Table A4: *Shipping time and population growth (capitals excluded)*

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it-1}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	0.053	0.062	0.058	0.051
	(0.047)	(0.053)	(0.047)	(0.077)
Population 1750	-0.296^{***}	-0.298^{***}	-0.312^{***}	-0.300^{***}
	(0.065)	(0.070)	(0.068)	(0.071)
Decline in shipping time × Population 1750	-0.129	-0.148	-0.164^{*}	-0.161^{*}
	(0.085)	(0.095)	(0.093)	(0.097)
N	293	293	293	293
R^2	0.202	0.218	0.235	0.268
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.153^{***}	0.138^{**}	0.125^{**}	0.078
	(0.057)	(0.070)	(0.063)	(0.067)
Population 1750	-0.387^{***}	-0.393^{***}	-0.426^{***}	-0.404^{***}
	(0.058)	(0.064)	(0.067)	(0.067)
Decline in shipping time × Population 1750	-0.128	-0.162	-0.198^{*}	-0.207^{*}
	(0.094)	(0.109)	(0.110)	(0.107)
N	293	293	293	293
R^2	0.189	0.208	0.251	0.296
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.037	0.012	-0.001	-0.001
	(0.036)	(0.042)	(0.039)	(0.066)
Population 1750	-0.023	-0.025	-0.041	-0.016
	(0.039)	(0.038)	(0.039)	(0.034)
Decline in shipping time × Population 1750	-0.008	-0.032	-0.049	-0.034
	(0.059)	(0.063)	(0.060)	(0.065)
N	241	241	241	241
R^2	0.008	0.038	0.061	0.160
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Audiencia FE				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** Population growth. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table A5: *Shipping time and population growth (far from port)*

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it'}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	0.079^{***}	0.051	0.060^{*}	0.004
	(0.022)	(0.032)	(0.032)	(0.032)
N	226	226	226	226
R^2	0.022	0.044	0.065	0.289
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.204^{***}	0.163^{***}	0.174^{***}	0.100^{**}
	(0.041)	(0.044)	(0.049)	(0.039)
N	226	226	226	226
R^2	0.064	0.101	0.145	0.318
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.018	-0.021	-0.013	-0.016
	(0.027)	(0.035)	(0.039)	(0.036)
N	192	192	192	192
R^2	0.001	0.045	0.073	0.076
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Population 1750				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** Population growth. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table A6: *Shipping time and population growth (far from port)*

Dependent variable:	City population growth: $\ln L_{it} - \ln L_{it-1}$			
	(1)	(2)	(3)	(4)
Panel (a): Population growth 1800-1750				
Decline in shipping time (ΔT)	-0.013	-0.026	-0.028	-0.084
	(0.044)	(0.056)	(0.050)	(0.055)
Population 1750	-0.303^{***}	-0.306^{***}	-0.326^{***}	-0.343^{***}
	(0.070)	(0.076)	(0.076)	(0.065)
Decline in shipping time × Population 1750	-0.247^{**}	-0.260^{**}	-0.290^{**}	-0.329^{***}
	(0.105)	(0.115)	(0.118)	(0.101)
N	226	226	226	226
R^2	0.210	0.230	0.270	0.381
Panel (b): Population growth 1850-1750				
Decline in shipping time (ΔT)	0.116^{**}	0.085	0.076	-0.012
	(0.055)	(0.068)	(0.064)	(0.069)
Population 1750	-0.324^{***}	-0.336^{***}	-0.370^{***}	-0.358^{***}
	(0.069)	(0.079)	(0.084)	(0.066)
Decline in shipping time × Population 1750	-0.210^{**}	-0.257^{**}	-0.320^{**}	-0.332^{***}
	(0.104)	(0.124)	(0.128)	(0.103)
N	226	226	226	226
R^2	0.171	0.205	0.263	0.332
Panel (c): Population growth 1750-1700				
Decline in shipping time (ΔT)	0.011	-0.027	-0.024	-0.052
	(0.034)	(0.039)	(0.036)	(0.058)
Population 1750	-0.046	-0.055	-0.073^{*}	-0.017
	(0.052)	(0.044)	(0.044)	(0.030)
Decline in shipping time × Population 1750	-0.004	-0.029	-0.064	0.001
	(0.078)	(0.070)	(0.062)	(0.056)
N	192	192	192	192
R^2	0.015	0.057	0.089	0.220
Baseline controls		✓	✓	✓
Viceroyalty FE			✓	✓
Audiencia FE				✓

Note: The table reports OLS estimates. The decline in shipping time is standardized. The unit of observation is a city in a certain year. **Dependent variable:** Population growth. **Controls:** Elevation, crop suitability, terrain ruggedness, the location of active mines, distance to the coastline. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

Table A7: Event-study specification (settlements)

Dependent variable:	Indicator for cell containing a settlement			
	(1)	(2)	(3)	(4)
Δ T $\times$ $\mathbb{1}$ $(year = 1710)$	-0.011	-0.019^{**}	-0.025^{**}	-0.031^{***}
	(0.011)	(0.008)	(0.010)	(0.008)
Δ T $\times$ $\mathbb{1}$ $(year = 1720)$	-0.004	-0.011	-0.016	-0.021^{**}
	(0.010)	(0.008)	(0.010)	(0.008)
Δ T $\times$ $\mathbb{1}$ $(year = 1730)$	-0.002	-0.007	-0.012	-0.016^{**}
	(0.009)	(0.008)	(0.010)	(0.007)
Δ T $\times$ $\mathbb{1}$ $(year = 1740)$	-0.001	-0.005	-0.009	-0.012^{*}
	(0.008)	(0.006)	(0.008)	(0.006)
Δ T $\times$ $\mathbb{1}$ $(year = 1750)$	-0.005	-0.007^{**}	-0.009^{**}	-0.011^{***}
	(0.004)	(0.003)	(0.004)	(0.003)
Δ T $\times$ $\mathbb{1}$ $(year = 1770)$	0.002	0.005^{**}	0.007^{**}	0.009^{***}
	(0.003)	(0.002)	(0.003)	(0.002)
Δ T $\times$ $\mathbb{1}$ $(year = 1780)$	0.002	0.013	0.016	0.020^{**}
	(0.008)	(0.009)	(0.010)	(0.009)
Δ T $\times$ $\mathbb{1}$ $(year = 1790)$	0.014	0.033^{***}	0.037^{**}	0.042^{***}
	(0.012)	(0.011)	(0.015)	(0.013)
Δ T $\times$ $\mathbb{1}$ $(year = 1800)$	0.014	0.037^{***}	0.041^{**}	0.048^{***}
	(0.013)	(0.012)	(0.016)	(0.014)
Δ T $\times$ $\mathbb{1}$ $(year = 1810)$	0.017	0.042^{***}	0.047^{***}	0.057^{***}
	(0.015)	(0.013)	(0.018)	(0.015)
City FE	✓	✓	✓	✓
Baseline controls $\times$ time FE		✓	✓	✓
Viceroyalty $\times$ time FE			✓	✓
Population 1750 $\times$ time FE				✓
N	55,154	55,154	55,154	55,154

Notes: The table reports OLS estimates. The unit of analysis is at a 0.5°×0.5° grid-cell. The decline in shipping time is standardized. **Observations:** The dataset is a balanced panel at a 10 year frequency for the period 1710-1810 for 5,014 grid cells. The full dataset contains 11 $\times$ 5,014 = 55,154 observations. The omitted year is the year prior to the treatment (1760). **Controls:** Distance to the coast (log), elevation, presence of an active mine, terrain ruggedness, and crop suitability. **Standard errors:** Clustered at the level of the closest port. 51 clusters. $^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

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