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Cattedra Economic Growth and Development

# Ports as Engines of Growth: Evidence from Chinese Regions

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## **ABSTRACT**

How do ports infrastructures affect regional economic development? This question is relevant since ports are key to trade and economic activity. Throughout this paper, I try to answer this question running a cross regional analysis using an Instrumental Variable approach, using the location of historical ancient ports to predict the presence of major seaports and estimate their effect on regional GDP.

Results show that regions with modern major seaports experience higher levels of GDP, even after controlling for covariates. This is relevant for policymakers because it shows that investing in port infrastructures can lead to regional economic growth. In fact, according to World Bank each dollar spent in ports infrastructure can generate up to five dollars of economic benefits.

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## INTRODUCTION

Focus of the paper is trying to understand whether modern ports affect regional economic development, Geographical factors such as access to the sea are widely recognized as advantages and by focusing on modern ports, this study aims to show that such advantages remain economically significant today and explain through which mechanisms they operate and are enhanced.

To answer the research question, I run a cross-regional analysis based on a dataset of Chinese regions. The model is a Two-Stage Least Squares regression, the main outcome is total GDP, and the key independent variable is the presence of a modern seaport infrastructure in the region. To address issues related to endogeneity, I use the regional presence of ancient ports as instrument to predict the location of modern seaports.

Results show that the presence of modern port infrastructures has a significant impact on regional GDP. The effect remains statistically significant even after controlling for a wide range of key geographic variables. It suggests that these typologies of infrastructures contribute to achieve development outcomes.

The results achieved provide causal evidence that the presence of a modern seaport can be a driver of long-term economic performance. This analysis contributes to a deeper understanding of why coastal regions tend to perform better than inland regions. In fact, according to the comparative development literature, the access to maritime trade routes creates long-lasting economic advantages. It also explains the role of geography in shaping development: physical proximity to the sea and trade networks can translate into a structural and persistent advantage over time.

Modern seaports facilitate trades, reduce transportation costs and enhance access to global markets, but over time their influence goes beyond logistics. Over time port regions have attracted higher levels of human capital and developed better institutions, factors that are central topics to the comparative development literature.

## **PAPER ORGANIZATION**

The paper is organized as follows:

- Section 1 provides historical and theoretical background about the role of ports, how they evolved over time, their economic functions and how maritime trades affect global economy.
- Section 2 presents the set of data used to construct the empirical analysis in section 3. In this section all variables are explained, and particular attention is given to the construction of the dataset containing ancient ports' location, explaining what ancient ports are and how they will be useful throughout this study.
- Section 3 conducts the empirical analysis. Identification strategy and econometric model (OLS and 2SLS) are explained, with particular focus on the choice of ancient ports as instrument of exogenous variation on modern ports presence.
- Section 4, here the outcomes of the regression models are presented. Those results are shown to be robust even controlling for other variables that could affect GDP.
- Section 5 concludes the paper by summarizing the main findings of the empirical analysis. This section also explores how the paper connects with the existing comparative development literature and explains the possible mechanisms through which the presence of a seaport can affect the development of each region, such as accumulation of human capital, development of better institutions exc.

## **SECTION 1: HISTORICAL AND ECONOMIC ROLE OF PORTS**

Evolution of seaports throughout history has been shaped by technological advancements and by the increased demand for global trade.

Ports have played a crucial role in facilitating commerce and building a global market and as long as trade continues to grow, ports will remain at the forefront, driving innovation and connecting the world.

### **1.1. Historical Evolution of ports in China**

#### **1.1.1. Origins and Early Inland Port Development (221 BC – 618 AD)**

The Chinese port system has its origins during the Qin and Han dynasties (221 BC-220 AD) where a sophisticated system of fluvial and canal ports emerged in order to facilitate two main priorities: to support military campaigns and to facilitate the grain provision system across the Imperial cities.

Cities along the Yellow and Huai rivers, such as Kaifeng and Luoyang, emerged as key shipping hubs at the time, connecting different regions through early canal systems. This system shows how early port infrastructure in China served not primarily commercial purposes, but the logistical needs of the central government.

#### **1.1.2. The Grand Canal and the North-South Axis (618 – 1644 AD)**

One of the most important infrastructural innovations in Chinese history was the construction of the so-called “Grand Canal”, an artificial waterway of more than 1,700 kilometers connecting all of China’s major navigable rivers (Yangtze, Huai and Yellow rivers) and linking the main economic heartlands in the south to the political centers placed in the north.

Its construction was started in the late 6<sup>th</sup> century AD, during the Sui dynasty and the project was expanded and finished during the Yuan and Ming periods. The canal played the fundamental role of facilitating the creation of an integrated transport system across most of China.

By the connection of the major river systems, the Grand Canal enabled the continuous transportation of strategic goods such as grain, salt, textiles and reducing

dramatically their transportation costs, enabling the mitigation of the mismatch between the agricultural locations of the south and the political centers of the north.

### **1.1.3. Rise of Maritime Trade in Imperial China (770 BC – 1840 AD)**

The first coastal domestic routes were opened during Spring-Autumn period (770 BC- 476 BC), connecting the Yangtze River Delta with the Shandong peninsula.

The first international shipping routes were opened under the Qin and Han dynasties and were used to link the Shandong Peninsula with Japan, Korea and Rome.

During these times coastal areas remained underdeveloped since most of the silk exports and jewelry imports still occurred by land transport through the Silk Road. The only exception to this underdevelopment is Guangzhou which, due to its connection with the maritime silk road, already became a major port between 475 BC and 221 BC.

During the Sui (581-618 AD) and the Song (960-1279 AD) dynasties, maritime trade faced a rapid growth, reaching India, Arabia and Africa. Exports included silk, porcelain and tea while imports consisted primarily of jewels and medicinal items. Around 1100 AD, roughly sixty percent of China's foreign trades were conducted by sea. Southern ports like Quanzhou, Fuzhou and Guangzhou flourished, supported by technological innovation in shipbuilding.

This expansion was periodically interrupted by state-imposed maritime bans, especially during the Ming dynasty. By imposing those bans, the government tried to reinforce internal stability but often resulted in increased piracy and smuggling. Meanwhile, the inland Grand Canal became the pillar of domestic logistics, moving millions tons of goods per year.

Despite those repeated closures to foreign trade, Chinese merchants maintained a strong maritime presence and the ports established with institutional and logistical advantages -such as Xiamen and Tianjin- were proven to be especially resilient.

The rise of European colonial interest combined with the rise of Japanese piracy, resulted in a ban of foreign maritime trade that was the start of an isolation policy which lasted until the Opium Wars.

#### **1.1.4. Colonial Reconfiguration of China's Port Geography (1840-1949 AD)**

The foreign countries intervention is believed to have provoked a change in port's development in China, seaports gradually started to gain dominance against fluvial ports.

After the Opium Wars, in 1842, the "Treaty Ports System" was launched, they were opened by foreign powers in order to control trade and to serve colonial interests, being more connected with Japanese and Korean ports rather than Chinese hinterlands.

Under these circumstances, the Yangtze River became the trunk line of China's river shipping network, Shanghai port rapidly became the main gateway between the river and maritime routes towards Xiamen, Hong Kong and Dalian. Shanghai kept growing in importance replacing Guangzhou at the top of the hierarchy as the country's major port. Hong Kong also replaced Guangzhou as the main hub for South China.

Fuzhou also developed rapidly achieving the 11.5% of the country's total port traffic in 1868. Dalian also established itself as one of China's major seaports, accounting for the 15% of all of Northeast China's maritime traffic.

Due to the development and the introduction of modern transport modes -such as railways and road- connected to established coastal poles and the introduction of railways along the Grand Canal, inland fluvial ports started to decline in importance. Railway bridges with low height along the Yangtze River, also constrained the passage of large vessels along the river.

#### **1.1.5. Evolution of the Chinese Port System after 1949**

After the establishment of the People's Republic of China in 1949, the Chinese port system was reorganized under a centrally planned economy which prioritized mainly inland development, funds were invested primarily in rail and river transport, with the Yangtze River still being the backbone of China's domestic logistics.

Chongqing, Wuhan and Nanjing served as key regional hubs, while Shanghai kept its dominant position as both a fluvial and maritime gateway, accounting for more than 34% of the country's port traffic by 1959.

Due to the limited international trade and to strategic policies aiming at restricting excessive concentration in coastal areas, foreign-facing seaports experienced stagnation.

This trend radically changed with the introduction of the Open Door Policy in 1978, which positioned China toward an export-oriented economic growth. The government designated coastal cities and Special Economic Zones (SEZs) such as Shenzhen, Xiamen and Tianjin, to spread this transition.

With the Open Door Policy, port development started rapidly growing at an unprecedented pace. By 2009, Shanghai had emerged as China's primary shipping hub, moving more than 600 million tons of cargo, Guangzhou reclaimed its importance in the south. Tianjin, Dalian and Qingdao became dominant ports in the north.

At the same time also inland/fluvial ports experienced a new growth thanks to the modernization of river shipping, especially due to the increased container traffic along the Yangtze. Fluvial cities such as Wuhan, Zhenjiang and Nanjing expanded their roles in the national logistics network while smaller ports also benefited from greater hinterland integration.

## 1.2. Typologies of Ports and their functions

Ports are “multidimensional entities anchored within geography by their site and situation,” and their classification requires a comprehensive analytical framework. Ports are strategic nodes that serve within both national economies and global supply chain, being a fundamental link between maritime and terrestrial transport systems.

Due to the differences across regions in physical geography, technological advancements and trade dynamics, ports are not uniform structures and their structure, operations and functional role can vary.

Four elements define the main characteristics and potential of any port site:

1. Maritime access. It refers to the physical capacity of the site to accommodate ship operations. It includes tidal ranges, channel and berth depths and draft limitations. All those elements are very important to dock a modern cargo ship, a standard Panamax ship (65,000 deadweight tons) requires a draft of almost 12 meters.
2. Maritime Interface. Indicates the amount of shoreline with good maritime access. Containerization has changed the dynamics of port operations and has expanded the requirements of land consumption, so the maritime interface does not only depend on maritime access but also on land available to guarantee the regular operation flow.
3. Infrastructures and Equipment availability. Piers, storage areas, warehouses, equipments such as cranes are all elements needed to efficiently carry on the port site operations. All of them require high levels of capital invested and keeping up with those investments' requirement could be challenging for many port authorities.
4. Land access. This entails efficient inland distribution systems, such as rail unit trains and handling intense heavy truck traffic. Those factors heavily condition a port's ability to effectively function and expand.

All those factors determine the capacity of a port to act as a gateway, defined not only by the size of it but also by factors such as connectivity, adaptability and integration with inland logistics systems.

In today's globalized world, the most competitive ports are those which can efficiently align physical capacity with network efficiency and logistical innovations.

This section identifies five main dimensions through which ports can be categorized in order to better understand their economic function. It concerns physical typology based on their location, transition from break-bulk to container terminals, functional specialization, integration into regional and global transport networks, factors determining competitiveness, such as depth, equipment and accessibility.

Those dimensions can be helpful and offer an analysis of how ports operate and influence the economic performances of regions.

### **1.2.1. Physical Typologies of Ports**

The spatial configuration of ports is rooted in their site, port development is primarily defined by geography and constrained by a set of different natural characteristics of coastal and inland environments.

Three broad physical types of ports exist: river ports, seaports and hybrid ports.

River ports as the name tells are located along navigable inland waterways and historically served as key strategic nodes for redistribution and transshipment. Their proximity to population centers and to industrial and agricultural centers is the main reason of their popularity. However, river ports are strongly constrained by depth limitations, water-level fluctuations and sedimentation, necessitating continuous dredging which leads to high operational costs. Despite these restrictions, modern river ports are still quite important and competitive when integrated into broader supply chain systems. Examples of river ports are Duisburg on the Rhine, St. Louis on the Mississippi and Wuhan on the Yangtze.

Seaports by contrast are situated next to coastlines which are directly connected to international shipping routes and with direct access to the global market. Their advantage lies in the access to deep waterways, which translates into more and bigger ships able to pass by, making them suitable for large international trade. Usually, large seaports are located close to historically densely populated urban areas to give these areas a direct access to global markets. Yet, many seaports struggle because of the limited land availability needed for expansion needs: since ports grow outward along the shoreline, their expansion usually competes with urban development, reducing seaports efficiency and limiting the growth of trade.

Congestion, pollution, and land scarcity can reduce seaport efficiency unless mitigated by inland extensions or satellite terminals.

Hybrid or Estuarine ports are a position between inland and maritime systems, they are located at river mouths or tidal estuaries, their competitive advantage is being able to benefit from the geographical advantages of seaports and from inland reach. These characteristics enable synchronized sea-land operations, in fact these ports are often supported by an efficient logistic system, integrating rail and road networks. However, those intermediate locations also suffer the to tidal variation and siltation and sometimes requiring engineering solutions such as dredging.

### **1.2.2. From Break-Bulk Terminals to Container Ports**

Technological changes have been driving the evolution of ports, especially the shift from break-bulk cargo to containerized transport. This transition does not only have changed the trade dynamics but has also changed the terminal design, port functions and many other dynamics.

The break-bulk era was characterized by cargo being loaded and unloaded manually, translating into ships spending weeks or even more in ports which means long vessel turnaround times and low efficiency.

In 1960s the rules of the game completely changed with the advent of containerization. Container ports require many more advanced equipment such as cranes and straddle carriers, but most importantly this shift also altered the port site selection: growing trade volume and ships becoming bigger translated into needs of deepwater access, land availability and relevant space for yard operations. As a result, many pre-existing ports could not handle the technical and land requirement imposed by containerization, this led to the development of dedicated container terminals, restructuring the geography of maritime logistics.

Container ports also translated into efficiency and a significant growth of trade volume all over the world, in 2022 about 866 million TEUs (Twenty feet equivalent unit, standard measure of container were handled by dedicated container ports, nowadays the dwell time of a containership is approximately 24 hours, about ten times lower than break-bulk cargo ships.

### **1.2.3. Functional Specialization: Monofunctional and Polyfunctional Ports**

Based on the operational goal, infrastructure diversity and the degree of functional specialization, ports can be classified into Monofunctional and Polyfunctional ports.

Monofunctional ports are also called specialized terminals and are those ports which handle a narrow category of goods but usually in large volume. These ports usually deal with bulk commodities, such as oil, coal, iron etc. They are equipped with specialized tools and machinery like piers, pipelines and conveyor systems which are used to transfer and move the commodities involved. Such ports work on economies of scale and vertical integration with extractive industries and energy production industries. Examples include the iron ore port of Port Hedland or the crude oil terminals in the Persian Gulf.

Polyfunctional ports differ from the latter because they support many types of cargo activities, including containers, break-bulk and even cruise and ferry ships. With multiple terminals, each specialized in a different purpose, and with different storage areas, they can adapt to evolving trade dynamics and cargo demands. These ports often serve as regional distribution centers, with the aim to interconnect production, consumption and transshipment functions, being more embedded into urban-industrial logistics systems.

### **1.2.4. Port Regionalization and Transshipment Hubs**

The increased trade volume, larger vessels and the need for inland connectivity gave rise to the concepts of port regionalization and transshipment hubs, which reflect a systemic shift in how ports operate within regional transport networks, taking the functional evolution beyond the role of the terminal.

Port regionalization refers to the integration of ports with inland logistics systems, through dedicated railways or roads. Regionalization has marked the transition from localized terminal operations to network based gateway systems. The creation of inland terminals as extension of the main port allows ports to efficiently handle the increased traffic and all the issues related to freight distribution, erasing the problems of local congestion and land constraints. This phenomenon is advanced in Europe and China, places where institutions and infrastructure funding is strong and facilitate corridor-based freight flow.

Transshipment is the act of unloading cargo from one vessel and loading it into another vessel, usually at an intermediate port called “transshipment hub”. Transshipment hubs emerged to facilitate complex maritime networks by enabling ship-to-ship transfers of container. They operate at the intersections of mainlines maritime routes and regional feeder routes serving as strategic nodes for global connectivity, transshipment hubs allow carriers to optimize vessel deployment and reduce direct port calls. In today’s economy more than 90% of the container traffic is transshipped rather than locally discharged or received. Transshipment hubs require substantial yard space, high crane productivity and rapid vessel turnaround. Examples are Gioia Tauro in Italy, Algeciras in Spain or Tanjung Pelepas in Malaysia.

Both regionalization and transshipment hubs are reflection of today’s increased demand for port operations, where spatial connectivity outweigh the traditional roles of geographic centrality or cargo tonnage.

### **1.3. Ports as facilitators of Trade: the Role of Trade in the Comparative Development Literature**

Ports and maritime trade are tightly linked and mutually dependent: maritime trade without ports is materially impossible while on the other hand, without maritime trade, ports lose their economic role.

Ports infrastructure make possible the realization of ocean-based trade and connect domestic economies to global markets. Doing so they enable the movement of goods over long distances, forming the backbone of global supply chain.

In this context, ports are not only passive transit point but also facilitators of trade integration and engines of economic performance and transformation.

By reducing costs related to international exchanges and due to their in increasing the volume and speed of goods movement, ports help region expand their integration into global trade dynamics translating that into economic benefits and growth, the presence of a port, especially when supported by an efficient system of inland connectivity, can dramatically change the distribution of trade flows, stimulating growth not only in the city where the port is located but also in the surrounding regions.

Ports positively promote the activities of local firms, granting them the access to larger consumer market and exploit comparative advantage.

Many economists with their works explore how maritime access, exposure to trade and historical integration into maritime and trade routes can shape the regions' long-term development and patterns of urbanization, institutional quality and economic growth. The following section reviews some of the main comparative development theories on the role of maritime geography, the importance of port cities and the effects of trade expansion.

#### **1.3.1. Maritime geography and the global distribution of economic activity**

Geography lies at the core of the comparative development literature and is strongly accepted by many of the world's top economists as one of the fundamental causes of differences in prosperity across countries or regions. According to the geography hypothesis, proximity to sea, navigable rivers or natural harbors is usually associated with higher levels of economic activity.

Regions integrated into maritime networks tend to grow faster and more persistently since maritime access lowers trade costs, enlarges market potential and facilitates the accumulation of capital and the diffusion of knowledge.

A major contribution linking the role of trade to the geography hypothesis is given by Henderson, Squires, Storeygard and Weil (QJE 2018), they estimated a model of the global distribution of economic activities and demonstrated how coastal and locations proximate to natural harbors exhibit higher levels of economic activity, using as proxy for economic activity the distribution of lights. The authors argue that first nature characteristics are persistent and almost unchanged, but their values constantly change with technological innovation and development. In fact, it is shown that in early urbanizers, factors affecting agricultural productivity matter relatively more while in late urbanizing countries factors affecting suitability for trade matter relatively more, meaning that as the world and economic dynamics evolve, trade became much more important to achieve higher levels of economic prosperity. This could fit the case of China which is considered to be a late urbanizing country.

Since suitability for trade is strongly related to natural characteristics such as access to sea, navigable waterways and natural harbors, the authors have shown that all those geographic factors can explain part of the global variation in economic activity.

Their theory is useful because it links a theoretically transparent mechanism, such as lowering trade costs with easier coastal access, to outcomes measured consistently across the globe. These results can be directly related to ports activity as one of the key roles of ports is to facilitate access to the sea and facilitate all the operations related to international trade: geography gives an advantage to coastal regions while the efficient activity of ports determine helps exploiting this structural advantage.

### **1.3.2. Atlantic ports, trade and the rise of Europe**

Acemoglu, Johnson and Robinson (2005) in their paper "*The rise of Europe: Atlantic Trade, Institutional Change and Economic Growth*", focus on the growth that Europe experienced between 1500 and 1850 and in particular on the expansion of countries and nations with access to the Atlantic.

In their words, “between 1500 and 1850, the growth of nations with access to the Atlantic, and the growth of Atlantic ports, account for most of the differential growth of Western Europe relative to Eastern Europe. It therefore appears that the rise of Europe between 1500 and 1850 was largely the rise of Atlantic Europe and the rise of Atlantic ports”. Here the authors explain how Atlantic port cities became the primary gateways for commerce, capital and information, concentrating the benefits of maritime trade and translating them into regional prosperity.

The authors then argue that the Atlantic trade routes can generate benefits if and only if these two conditions are satisfied: easy access to the Atlantic and non-absolutist initial institutions. This conclusion underlines how important Atlantic ports were in early globalization dynamics to generate profits, while good institutions were key to exploit and benefit from these profits.

Atlantic port cities like Amsterdam, Antwerp, London and Lisbon were acting as the focal points of trade and financial innovation and acted as engines that reshaped the European economic dynamics.

### **1.3.3. Technological change and historical trade integration**

Geography’s influence in comparative development can also depend on technology, innovations can redesign routes and amplify some regions’ coastal advantages. Pascali (2017) explores the dynamics emerged during the late nineteenth-century maritime revolution, with the focus on the invention of the steamship. Technological innovation in propulsion and navigation set shipping free from the wind patterns, doing so trade distances were altered and countries which used to be far due to wind constraints became relatively closer.

His results reveal that steamship reshaped global trade and gave to many countries which were once upon a time not included into the main maritime trade routes due to wind constraint, the opportunity to create and benefit from the profits coming from their inclusion into international markets.

It is also shown that the countries which benefited the most from the new design of the maritime trade routes, were the countries whose institutions constrained the executive power and secured property rights. This paper explains once again how the institutional channel is crucial: in countries where the elite held uncontrolled authority, the incentives for productive innovation were dampened, while where representative bodies were able to constraint the executive powers, mercantile

groups transformed the new wealth into demand for inclusive rules, stronger contract enforcement and broader access to markets.

This mechanism aligns with the view of Acemoglu, Johnson and Robinson, according to which the Atlantic trade and favorable institutional conditions empowered commercial classes and reshaped the European political landscape.

#### **1.3.4. Trade and institutional change: Medieval Venice as a case of dynamic inclusiveness and later oligarchic closure**

Where Pascali isolates the causal effect of maritime integration on long-run development, Puga and Trefler (2014) open the institutional “black box” by tracing how globalization shocks restructure political power. Their case is Medieval Venice, arguably the pre-modern archetype of a port-city economy. Using newly assembled micro-evidence, such as family participation in the Great Council, galley allocations, merchant contracts, and wealth records, they document a two-stage dynamic. In the initial expansionary phase, surging Mediterranean and Black Sea trade rents diffuse widely through organizational innovations, lowering entry barriers for new merchants and supporting relatively inclusive political participation. Ports, fleets, and maritime law co-evolve with commerce; institutional and economic dynamism reinforce each other.

In the second phase, the very success of trade attracts rent-seeking. As overseas opportunities mature and become more appropriable, incumbent mercantile families consolidate control, culminating in the Serrata of 1297, a constitutional closure that restricts political access and raises economic barriers to entry. The consequences are measurable: concentration of council seats, declining social mobility, and a slowdown in organizational innovation. For comparative development, the lesson is cautionary and directly relevant to port economies: maritime openness can catalyze inclusive growth, but without countervailing checks it can also harden into oligarchic structures that ration access to port rents and choke future dynamism. The Venice narrative thus complements the quantitative literatures on market access by specifying institutional pathways through which trade translates (or fails to translate) into sustained, broad-based development.

### **1.3.5. Exogenous openness and persistent divergence: China's treaty ports**

A third approach in the literature exploits historical episodes in which trade access changes for reasons exogenous to local fundamentals, enabling credible causal inference. Jia (2014) analyzes one such episode in nineteenth-century China: the forced opening of treaty ports after the Opium Wars. The empirical design combines historical data on port status with modern measures of urban outcomes and uses difference-in-differences and related strategies to compare opened ports with otherwise similar cities that remained closed. The results are strikingly consistent with the broader theory: cities that gained privileged maritime access experienced faster industrialization, stronger fiscal capacity, and higher human-capital accumulation, and these advantages persisted long after formal treaty arrangements were dismantled.

Why did the effects last? Jia's evidence points to multiple, mutually reinforcing channels: foreign capital and firms clustered at opened ports; modern commercial and legal institutions were piloted and diffused from these nodes; information networks (newspapers, missions, business associations) took root; and port-linked transport investments expanded hinterland reach. Notably, the persistence holds through regime changes and twentieth-century upheavals, which strengthens the inference that early maritime integration can lock cities into superior trajectories. The Chinese case also connects back to the institutional message of Puga and Trefler: port openness is not destiny. Where institutional capacity and complementary investments are mobilized, ports become platforms for diversified, innovation-intensive growth; where rents are captured narrowly, gains can be transitory or spatially confined. Finally, the results resonate with the broader empirical literature on market access shocks and natural experiments exploiting exogenous variation in maritime distances (Feyrer 2009), shifts in access induced by political borders (Redding and Sturm 2008), and the discrete opening of economies to international trade (Bernhofen, El-Sahli, and Kneller 2016 on Japan). Collectively, these studies underscore the long-run and spatially uneven consequences of trade integration, which are often mediated by port infrastructure, thereby situating the present findings within a well-established comparative framework.

## **SECTION 2: DATA SECTION**

This section describes the set of data used to run the empirical analysis, focusing on describing sources, definitions and descriptive statistics.

The dataset used is cross-sectional and uses as observations the 34 administrative Chinese regions, including the special administrative regions of Hong Kong, Macau and Taiwan.

The year of reference for contemporary economic indicators is 2024. Contemporary economic indicators combined with historical and geographical variable, make it possible to study the relationship between modern ports presence and each region's economic performance. The combination of contemporary and historical data provides a multidimensional perspective on the determinants of long run economic development and its persistency, factors that will be key throughout all of the empirical analysis of Section 3.

### **2.1. Variable Definitions**

The variables employed in the empirical analysis of section 3 are carefully sourced and defined to explain its relevance and role in the identification strategy.

- **GDPmillionUSD.** Refers to the 2024 prices of the Chinese Regional Gross Domestic Product and it is expressed in millions of U.S. Dollars. GDP, defined as the total monetary value of all final goods and services produced within a country's border over a given period of time, is widely recognized as a standard measure of economic activities and it will be key throughout the empirical analysis as it serves as the dependent variable used to assess the impact of ports infrastructure.
- **ModernPorts.** A binary variable with value equal to one if there is the presence of at least one major seaport in the region, zero otherwise. Major seaports are defined as seaports which move more than 1 million TEUs (standard measure of containers) per year. It is the key explanatory variable of the hypothesis that ports infrastructure promote trade by reducing transport costs and enhancing access to global markets, which translates into regional growth.

- **AncientPorts.** A binary variable with value equal to one if a region has historically hosted at least one ancient port, zero otherwise. Ancient ports refer to “Treaty Ports” which were Chinese ports opened by foreign powers to control trade. Modern ports location is often non-random, so I use ancient ports as an instrument to predict their presence, Treaty Ports locations were mainly determined by geographical factors such as natural harbors and navigable waterways or by strategic purposes, rather than endogenous local development.
- **AvgElevation.** This variable captures the mean elevation of each region, it is included as a geographical control variables as according to the literature, elevation directly influences economic development as higher elevation regions may face natural disadvantages due to higher transport costs or agricultural constraints.
- **Ruggedness.** It captures the irregularity of the terrain of each region. According to Nunn and Puga (2012), ruggedness has a negative effect on development because it reduces agricultural productivity, control of water becomes more difficult, it involves higher costs related to infrastructure building and transportation is slower and more costly. They also explain how Africa was an exception to this hypothesis, here the relationship between development and ruggedness seems to be positive since high ruggedness regions helped giving protection to areas raided for slave trades. It helps isolate the effect of ports on GDP from natural topographic constraints.
- **RiverAccess.** A binary variable equal to one if a province contains at least one navigable river through which container ships can pass by. This variable accounts for the role of inland waterways in shaping trade flows and connectivity before the diffusion of modern transport infrastructure. Including this variable into the regression model helps reduce omitted variable bias by controlling for pre-existing transportation and trade related advantages.

Summing up, the variables are organized around three analytical functions. GDP captures the outcome of interest, providing a measure of regional development. Modern port presence represents the treatment variable, with ancient port presence serving as historical instrument to address issues related to

endogeneity. Average elevation, ruggedness, and navigable rivers operate as geographic controls, reducing the influence of natural advantages and ensuring that the estimated impact of ports is not confounded by geography. This systematic construction of variables ensures alignment between theoretical reasoning, data sources, and econometric specification.

## **2.2. Data Sources**

The dataset employed to run the analysis combines data on macroeconomic indicators and geographical factors. Sources range from historical archives, custom geospatial datasets, geographical maps and official statistical yearbooks.

The dataset about the variable measuring regional economic performance, GDP, is sourced from the National Bureau of Statistics of China, it provides official GDP figures in million USD at a regional level in 2024, ensuring consistency across regions.

The binary variable concerning the location of modern seaports location comes from a custom geospatial dataset constructed for research purposes. To construct the dataset, I identified the major seaports of each Chinese region, taking as binary value 1 if a region hosts at least one major seaport which moves more than 1 million TEUs per year. The statistics about the number of TEU moved by each seaport comes from the report “Top Major Ports in China” (GoComet, 2023), which provides an overview of the country’s most relevant hubs.

The ancient ports location comes from the paper “Trade Statistics of the Treaty ports for the period 1863-1872”. These statistics were produced under the control of foreign powers during the late Qing dynasty, listing the location of the ancient treaty ports opened in strategic locations to foster international trade.

Disregarding the trade volume data, the dataset has a binary variable equal to 1 in each region that hosted at least one treaty port in the 1863-1872 period.

Geographic characteristics are measured using global and national spatial datasets of high resolution.

Average elevation has as source the Relief Degree of Land Surface dataset, which provides a detailed description on topography of each region. Using elevation datasets is widely accepted in the comparative development literature since elevation has been proven to have a negative impact on growth and development.

Terrain ruggedness data and figures come from the dataset used in the paper “Walled Cities and Urban Density in China”. The dataset employed computes ruggedness indexes based on the variation in elevation between grid cells.

Finally, the binary variable about river access is constructed from historical hydrographic maps and from the paper “Regional resilience and spatial cycles: Long-term evolution of the Chinese port system”, which describes in detail the ancient and modern river transportation systems. These maps help identifying and provide evidence of waterways navigable by medium and large vessels, which were at the core of the inland transport system of China before the expansion of infrastructures such as railways and highways.

The integration of these heterogeneous sources produces a dataset that is both historically grounded and geographically precise. Economic indicators provide international comparability, archival records anchor the analysis in the geography of historical trade, and spatial datasets ensure that natural endowments are consistently controlled for. This combination of sources provides a solid empirical foundation for investigating the long-run impact of port infrastructure on Chinese regional development.

### 2.3. Descriptive Statistics

<b>Variables</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
<b>GDPmilUSD</b>	34	625095	520985.1	38824	1988764
<b>ModernPorts</b>	34	0.35	0.48	0	1
<b>AncientPorts</b>	34	0.26	0.45	0	1
<b>AvgElev</b>	34	702.21	936.04	5	4500
<b>Ruggedness</b>	34	92.65	58.96	10	250
<b>RiverAccess</b>	34	0.44	0.50	0	1

Table reported above shows the descriptive statistics of the variables employed in the empirical analysis, giving an overview of the main characteristics of the dataset used.

The average GDP across regions is 625.095 million USD, with a significant variation from Tibet (38.824 million USD) and Guangdong (1.988.764 million USD). It is then shown that only in 35% of the Chinese regions there is the presence of a modern seaport location, while ancient port location is documented in only 26% of the regions.

Geographic characteristics differ greatly across regions and the table clearly shows it. Elevation has a mean of 702,21 meters and varies from a max of 4500 meters to coastal regions that are nearly at sea level. Ruggedness also shows great disparity, potentially affecting infrastructure development and trade costs. Navigable rivers are located in 55% of provinces, highlighting that the distribution of natural transport advantages is uneven.

## SECTION 3: EMPIRICAL ANALYSIS

### 3.1 Ordinary Least Squares (OLS)

A starting point in evaluating and assessing the relationships between the presence of port infrastructure and the economic performance of regions is the Ordinary Least Squares (OLS) estimator.

Let  $Y_i$  denote the total GDP in millions of USD of region  $i$ , and  $X_i$  be the binary variable equal to 1 if the region hosts a modern seaport, then the OLS takes the form:

$$Y_i = \beta_0 + \beta_1 X_i + \gamma' Z_i + \varepsilon_i$$

Where:

- $Z_i$  is the vector of control variables capturing geographic controls: river access, average elevation and terrain ruggedness.
- $\varepsilon_i$  is the unobserved error term.
- $\beta_1$  is the parameter of interest, it captures the mean difference in GDP across regions with and without modern ports, conditional on geographic factors.

In this context, the OLS provides an initial estimate of the difference in GDP between region with and regions without modern ports. This result is conditional on basic geographical controls, adding those controls (river access, average elevation and ruggedness) to the analysis is key to isolate the effect of ports infrastructure, reducing the risk of omitted variable bias that could result in a wrong estimation of the effects related to ports presence.

For the OLS estimator to possess its optimal properties, a set of assumptions, the so-called Gauss-Markov condition, must hold. These assumptions are:

1. Linearity, the relationship between the dependent variable and the regressor must be linear in parameters.
2. Exogeneity: the error term is uncorrelated with the regressor.  $E[\varepsilon_i | X_i] = 0$
3. No perfect multicollinearity, regressors must be linearly independent.
4. Homoskedasticity, the error term has constant variance between observations.
5. No autocorrelation, errors must be independent across observations.

If these conditions hold, then the OLS estimator is the best linear unbiased estimator, it minimizes the residual sum of squares and provides the most efficient unbiased estimate of  $\beta_1$ .

In this case, the core identifying assumption, the exogeneity of the regressor, does not hold, there are several reasons to believe that the presence and location of modern ports infrastructures may not be random, it could be that regions which have an higher GDP developed better ports infrastructures through an higher capacity of investment and not vice-versa.

Despite this limitation, the OLS model serves as an important benchmark. It allows for a direct interpretation of the observed correlation between modern ports and regional economic performance. The results from the OLS estimation (presented in Table X) suggest a positive and statistically significant association between port infrastructure and GDP levels. However, given the plausible endogeneity of port location, this estimate likely captures both the true causal effect and spurious correlations due to unobserved confounding.

### **3.2 Instrumental Variables (IV) and Two-Stage Least Squares (2SLS)**

In this context, the OLS provides a direct interpretation of the direct correlation between modern ports and regional economic performance but the exogeneity of the regressor can be highly questionable. The decision to build or maintain a modern port in a specific location can also be correlated to unobservable regional characteristics that affect the economic output and is likely linked with the level of regional GDP.

The endogeneity problem invalidates the interpretation of the OLS coefficient and explains why an instrumental variable (IV) approach is needed to isolate the exogenous variations in the treatment variable.

There are at least three major sources of endogeneity in this setting:

1. Reverse causality: Economic development may lead to the construction or upgrading of port infrastructure. Richer regions have greater fiscal capacity, political influence, and demand for logistics infrastructure, making them more likely to receive investment in modern ports.

2. Omitted variable bias: Unobservable characteristics—such as historical trade intensity, colonial legacies, access to skilled labor, or early industrialization—may affect both the presence of a port and GDP. Even after conditioning on coarse geographic factors, these latent characteristics can confound the relationship.
3. Measurement error: If the binary indicator for modern port infrastructure does not perfectly capture port intensity or operational quality, classical measurement error may attenuate the OLS estimates, pushing them toward zero.

All these three sources of endogeneity imply that the OLS coefficient  $\beta_1$  may be biased and inconsistent estimating the causal effect of modern ports on regional GDP. To address this problem, I implement an instrumental variable approach using the historical location of ancient ports as a source of exogenous variation in modern ports locations.

### **3.2.1. The instrumental variable: ancient ports as a source of historical exogeneity**

The core idea is to exploit the historical presence of ancient ports, specifically the presence of a Treaty port as an instrument for the location of modern ports.

Treaty ports were established during the Qing dynasty and mostly following the Opium wars, their location was determined by several factors such as navigability, maritime routes proximity and foreign powers' strategic interests and not by factors like GDP and development. The use of a historical instrument has deeper implications for the interpretation of the results. Unlike OLS, which captures the conditional correlation between modern ports and GDP, the IV strategy aims to estimate the causal effect driven by an exogenous source of variation. Moreover, by leveraging history as a source of identification, the approach aligns with a broader tradition in comparative development economics that uses persistent historical shocks (e.g., colonial borders, missionary activity, early trade routes) to uncover structural relationships.

In this case, the historical presence of ports serves not only as an econometric instrument, but also as a meaningful proxy for path dependency: a way to trace how institutional and geographic legacies interact with contemporary infrastructure and development dynamics.

The instrument  $\omega_i$  is a binary variable equal to 1 if region  $i$  hosted at least one Treaty port during the era 1842-1900, this historical status is plausibly not related to contemporary determinants of economic output, especially after controlling for basic geographical characteristics.

The exclusion restriction, which is key in every IV approach, requires that the ancient port presence affects current GDP and current economic development only through its effect on modern port infrastructure. This assumption is not directly tested but its plausibility is boosted by the temporal distance between Treaty port era and the present, by the fact that not every modern port evolved from an ancient port and by the inclusion of geographic controls to account for the persistency of first-nature advantages.

The IV strategy provides the methodological core of this empirical study. By using ancient ports as a source of historical exogeneity and implementing a robust two-stage least squares design, I can identify the causal impact of modern port infrastructure on regional economic development. The validity of the exclusion restriction is supported both theoretically and through robustness checks. The first-stage results confirm the instrument's strength, and the 2SLS framework offers a clear and interpretable estimate: the increase in GDP (in level terms) that can be causally attributed to the presence of a modern port, for regions historically predisposed to maritime trade.

### 3.2.2. The 2SLS estimation procedure

The instrumental variable regression is implemented through the Two-Stage Least Squares (2SLS) method. The method proceeds in two stages:

First stage: estimate the endogenous treatment variable, the modern port presence as a function of the instrument.

$$X_i = \alpha_0 + \alpha_1 \omega_i + v_i$$

Where:

$X_i$  is a binary variable equal to 1 if a region hosts a modern seaport.

$\omega_i$  is the historical instrumental variable, an indicator of ancient ports location.

$v_i$  is the error term.

This stage isolates the component of modern port location that is explained by the instrument, so explained by historical presence of ancient ports and not by contemporary economic indicators. The value  $X_i$  captures the instrumented variation in modern ports presence throughout Chinese regions.

Second stage: used to estimate the present economic outcome using the predicted treatment variable.

Let  $Y_i$  denote the total GDP in millions of USD of region  $i$ , and  $X_i$  be the binary variable equal to 1 if the region hosts a modern seaport, then the second stage takes the form:

$$Y_i = \beta_0 + \beta_1 X_i + \gamma' Z_i + \epsilon_i$$

Where:

$Z_i$  is the vector of control variables capturing geographic controls: river access, average elevation and terrain ruggedness.

$\epsilon_i$  is the unobserved error term.

$\beta_1$  is the parameter of interest, it captures the mean difference in GDP across regions with and without modern ports, conditional on geographic factors.

$X_i$  being constructed from the exogenous variable  $\omega_i$  is uncorrelated with the error term  $\epsilon_i$ , and so the 2SLS coefficient  $\beta_1$  is consistent to measure the causal effect of modern ports on regional GDP of Chinese regions.

The 2SLS can also be written as the ratio of covariances:

$$\beta_1 = \frac{Cov(\omega_i, Y_i)}{Cov(\omega_i, X_i)}$$

This helps explain how the instrument allows to measure the changes in GDP correlated with variation in port presence, the latter is induced by the historical variable  $\omega_i$ .

Since both the instrument and the endogenous regressor are binary, the 2SLS regression shows the average effect of the presence of modern ports on regional

GDP of those regions whose presence of modern port was influenced by the presence of ancient ports, and in this case by the presence of Treaty ports. In this case the 2SLS recovers a Local Average Treatment Effect (LATE), if we believe that the monotonicity assumption is satisfied because of the fact that no region which had an ancient port in the past is less likely to have a modern port.

## SECTION 4: RESULTS AND INTERPRETATION

### 4.1. Ordinary Least Squares Regression Results

Table 1: OLS Regression Results

	GDP in million USD (1)	GDP in million USD (2)	GDP in million USD (3)	GDP in million USD (4)	GDP in million USD (5)
Modern Ports	584664.0*** (159268.5)	579933.0*** (163854.2)	520644.7*** (174318.2)	553202.6*** (183925.6)	565498.7*** (186264.0)
RiverAccess		-28386.43 157702			-42473.99 (160875.6)
AvgElevation			-82.69 (90.33)		-236.23 (191.17)
Ruggedness				-540.74 (1513.2)	2935.79 (3187.02)
Constant	418743.0*** (94619.56)	432936.2*** (124296.0)	499403.8*** (129472.4)	479945.4** (196307.5)	338140.3* 238854.6
R-squared	0.2963	0.2971	0.3148	0.2992	0.3347
Adj. -R	0.2743	0.2517	0.2706	0.2540	0.2429
observations	34	34	34	34	34

Notes: Standard error estimates are reported in parentheses.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

Table 1 presents the Ordinary Least Squares regression results and provides evidence of the role of modern seaports in shaping the economic outcomes of Chinese regions today. The estimated coefficient of the modern port variable (ModernPorts) is positive, economically large and significant at 1 percent level, indicating a strong correlation between the presence of modern ports and the level of regional GDP. The latter coefficient estimation is shown in Column 1, here the baseline model results are shown, the coefficient suggests that the presence of a modern ports increases in average the GDP of a region by 584,664 million US dollars. This huge result highlights the economic benefits associated with modern ports development.

In Columns 2 to 5, additional geographic controls are added and introduced into the regression, the results are shown to be remarkably stable and statistically significant at 1 percent level, with values ranging from 520644.7 million US dollars to 579933.0 million US dollars. This persistence across regression results shows that the relationship observed in the model is driven by a mechanism directly linking the ports infrastructures to regional economic performance.

As discussed above the inclusion of geographic controls does not alter the main findings and more importantly these factors do not exhibit statistically significant effects on GDP levels in each of these regression models. For example, RiverAccess, the control for navigable rivers, theoretically expected to enhance and boost regional trade opportunities and economic performance, in this model is not statistically significant and it is associated with negative coefficient values (-28836.43 million USD in Column 3 and -42473.99 in Column 5) which translates into lower levels of regional GDP, suggesting that the development of maritime infrastructures may have overshadowed the traditional role of river transportation systems. Likewise, AvgElevation, the variable of control for the average elevation of each Chinese region, added into the model as a proxy for logistical constraints given by first nature characteristics, shows not statistically significant, small and negative coefficients (-82.69 in Column 3 and -236.23 in Column 5), indicating that once modern ports are considered, elevation is not a decisive determinant of economic performance. Finally, Ruggedness, another variable of control for the degree of irregularity of the soil in each region and it is used to capture the obstacles to transportation and the fragmentation of the regional markets, its coefficient shift from negative values (-540.74 million USD in column 4) to positive values (2395.79 million USD in column 5), remaining statistically insignificant and supporting the theory that the impact of modern ports largely dominates other geographical frictions.

Overall, the insignificance of these geographic controls should not be interpreted as evidence of their intrinsic irrelevance, but rather as an indication that, once modern port infrastructure is accounted for, traditional geographic constraints lose their explanatory power.

From a statistical point of view, the R-squared which captures the explanatory power of the regression, ranges from 0.29 to 0.33. These values are modest in absolute terms but meaningful considering the relatively small sample of

observations. More importantly, the incremental explanatory power achieved through the inclusion of modern ports demonstrates that these infrastructures capture a substantial portion of the cross-sectional variation in regional economic performance. The values of the adjusted R-squared, which corrects the previous coefficients for the model complexity, range from 0.24 to 0.27, suggesting that these results reflect genuine structural relationships.

These findings show several important key insights. They validate the main hypothesis that modern port infrastructures are drivers of regional economic development because they facilitate the movements of goods and people, attract higher investments and industrial activity levels, by enabling greater integration into domestic and international trade networks. Second, the robustness of the coefficients across different specifications provides confidence that this effect is an enduring and central feature of China's regional growth dynamics. Third, the insignificance of the geographical controls suggests that while physical geography may historically have shaped economic development, in the modern Chinese context its importance is being progressively overlapped by the transformative impact of infrastructure investment, particularly in maritime transport. This follows the broader comparative development literature, according to which the role of infrastructures is slowly overcoming the geographical constraints to economic development.

## 4.2. Instrumental Variable Regression Results

Table 2: Instrumental Variables Regression Results

	Modern Ports (1)	GDP in million USD (2)	GDP in million USD (3)	GDP in million USD (4)	GDP in million USD (5)	GDP in million USD
Ancient Ports	0.88***					
Modern Ports		571132.2*** (223317.1)	566228.5** (202617.0)	494888.2** (223317.1)	524991.6** (242990.8)	568746.3** (245933.9)
RiverAccess			-30502.21 (158789.1)			-42266.56 (161203.1)
AvgElevation				-88.04 (94.91)		-236.4 (191.4)
Ruggedness					-651.8 (1637.8)	2951.2 (3276.8)
Constant	0.12** (0.06)	438706.5*** (134053.4)	357393.3*** (109822.9)	512254.7** (147036.9)	500195.5** (227035.5)	335621.1*** (269388.8)
R-squared	0.660	0.2962	0.2969	0.3144	0.2987	0.3347
Adj. R	0.649	0.2742	0.2515	0.2701	0.2534	0.2429
observations	34	34	34	34	34	34

Notes: Standard error estimates are reported in parentheses.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

This table presents the first and second stage of a two-stage least squares (2SLS) regression.

Table 2 presents the result of the Two-Stage Least Squares regression and clearly shows the important relationship between economic performance in Chinese regions and the ports presence. As explained in Section 3 of the paper, the OLS regressions discussed above may suffer endogeneity concerns and problems related to omitted variable bias, here the instrumental variable regression makes it possible to exploit the historical distribution of ancient ports as a source of exogenous variation in modern ports presence, allowing to reduce concerns related to endogeneity and omitted variable bias. Main idea behind the use of ancient ports as instrumental variable, is that historical instruments are usually uncorrelated with determinants of modern days economic performance indicators such as GDP, while remaining important as main determinants for the placement of modern ports infrastructures. This way it is possible to divide the role of modern ports in affecting

regional GDP from the role of other pre-existing economic activities or regional policies preferences.

In Column 1 it is presented the first stage of the 2SLS, the results provide that the instrument is both significant and powerful. The coefficient associated with ancient ports is significant at 1 percent level and has a value of 0.88 which means that there is a meaningful and strong correlation between the historical presence of ports and the locations of modern ports: a region with a modern port infrastructure has an 88 percent possibility to have hosted an ancient port in the past, this suggest that even after centuries the presence of an ancient port is highly correlated with the prediction of a modern port location. The strength of this first stage ensures that the second stage estimation can be interpreted with no problems about weak instrument.

Column 2 shows the baseline model of the second-stage, the coefficient associated with the presence of modern port is statistically significant at 1 percent level and has a value equal to 571132.2 million US dollars, meaning that regions hosting a modern port infrastructure has really large advantages in economic prosperity.

In Columns from 3 to 6, I run the second-stage regression while adding geographic controls and show how the impact of modern ports on regional GDP remains large and statistically significant even after accounting for these geographic controls. The values associated with modern ports range from 494888.2 million USD and 568746.3 million USD. Results are similar to the ones presented in the OLS regression, strengthening the theory that the relationship observed there is not coming from omitted variable bias or s the result of reverse causality: modern ports are drivers of higher regional GDP and are not being located in more prosperous regions.

The fact that the effect of modern ports remains large and significant even after controlling for geographical variables, highlights the robustness of the findings. The coefficients associated with geographic controls are negative and not statistically significant almost everywhere throughout the model, this shows that topographic constraints and the inland river transportation system do not play a decisive role in the economic performance and development of a region once the availability of a port infrastructure is considered.

The first stage regression has an R-squared of 0.66 and an adjusted R-squared equal to 0.649, so the explanatory power of this stage is high and suggests that the variation in modern port presence is almost fully explained by the historical presence of ancient ports, reinforcing and showing the strength of the instrument. The explanatory power of the second stage is similar to the values of the OLS model and has an R-squared ranging from 0.29 to 0.33 while the adjusted R-squared ranges from 0.24 to 0.27.

It is important to clarify that also the IV approach has some intrinsic limitations: it relies on the assumption that ancient ports influence modern days GDP only through their impact on modern ports infrastructures. This exclusion restriction can be possible due to the time gap between Treaty ports' era and today's era, but it cannot be directly tested. Nonetheless, the robustness of the results in both OLS and IV regression support the idea that the instrument is valid.

## SECTION 5: CONCLUSIONS

The 2SLS results follow a long literature about the role of infrastructures in shaping long-run economic performance. Donaldson in his paper “*Railroads of the Raj: Estimating the impact of transportation infrastructure*” demonstrates that the railroad system built during colonial India had a significant impact on economic development of the country by reducing transportation costs and expanding the market integration throughout the country. In a similar way, Hornbeck and Rotemberg in their paper “*Railroads, reallocation, and the rise of American manufacturing*” explained how the railroad system affected positively the long-run economic development of the United States. The evidence coming from these papers and from what I have shown throughout my thesis show these findings: the historical presence of infrastructures influences long-run economic performance directly through their role in reducing trade costs and enlarging regions market access, but also indirectly by enhancing agglomeration economies or knowledge spillovers.

The results coming from the econometric models, OLS and 2SLS, display an extraordinary effect associated with the presence of modern ports on regional GDP: regions with modern port infrastructures have, on average, GDP levels that are 500 billions USD higher than regions that do not host modern ports infrastructures. This incredible result means that ports are not marginal contributors to economic growth but are central and act as engines that drive economic growth and performance. Trade and logistics facilitation cannot alone explain the extraordinary effect of modern ports on regional GDP. The scale of this effect is due to the fact that infrastructures like ports do not only facilitate trade and reduce transportation costs, but they also reshape, alter and enhance the roles of the fundamental causes of development identified by the comparative development literature: geography, institutions and culture.

### **5.1. Ports and Geography: Amplifying First-Nature Advantages**

The role of geography in shaping economic activities around the world has been a central theme across the development literature. Jared diamond in his book “*Guns, Germs and Steel*” demonstrated how geographical endowments-such as availability

of domesticable plants and animals, latitude and diseases-gave advantages to certain areas of the world, influencing the timing of the Neolithic revolution and so the emergence of complex institutions.

This key role of geography has been later pushed by Dell, Jones and Olken (2012), their paper offers an empirical analysis of the causal role of geography, they demonstrated that geographical characteristics such as temperature and precipitations, have effects on growth: they estimated that a 1°C rise in temperature reduces growth by 1.3-1.5 percentage points.

Furthermore, Storeygard and co-authors in their paper "*Global Spatial Distribution of Economic Activity: Nature, History and Role of Trade*" uses satellite data on nighttime lights as a proxy for economic activities and shows how geography explains almost the 58% percent in variation of lights across the world. Storeygard demonstrates also how in early urbanizing countries, economic activity remains more spatially aligned with areas with more agricultural suitability, while in late urbanizing countries, economy is more concentrated in trade accessible areas.

These contributions, help us explain how regions of the world with "better" geographical endowments- such as coastal access, temperate climates or fertile land- have enjoyed structural advantages that led to earlier urbanization, greater market integration and greater economic activities.

Infrastructures like ports or railroads are the mechanisms through which geography can be translated into persistent advantages. In this case coastal access alone is not enough to drive forward economic prosperity and development. Only through the role of ports, coastal regions can efficiently exploit this intrinsic advantage given to them by geography: ports transform geographic potential into economic reality.

Building a port means connecting the region to global shipping routes and global markets, attracting firms and investments in these high potential regions. Inland regions even when developing advanced transportation systems like railroads or highways, remain structurally disadvantaged without direct maritime access.

## **5.2. Ports and Institutions: Laboratories of Governance and State Capacity**

Acemoglu, Johnson and Robinson in their paper "*Reversal of Fortune*" show that countries that were relatively rich in 1500 are relatively poor today: e.g. Incas and

Aztecs were among the richest in 1500 and today their areas are among the poorest in the world.

This reversal of fortune took place in the 1800s, during the times of Industrial Revolutions. Since geographical endowments are not changed, it is not possible that geography has shaped long-run economic growth.

The authors argue that what really matters for long-run economic growth is the role of the institutional regimes imposed during colonization: in richer places European colonizers established extractive institutions, characterized by weak property rights, long-run economic performance has been remarkably poor. By contrast, in poorer places colonizers imported property rights institutions, characterized by constraints on powers and incentives to innovate, economic performance kept growing.

According to their theory the reversal took place in 1800 because with the transition from agriculture-based economies to manufacturing based economies, growth became increasingly dependent on innovation and secure property rights. As a result, formerly poor regions with stronger property rights institutions were better positioned to capitalize on the Industrial Revolution.

This institutional persistence is explained also by Luigi Pascoli in his paper "*The Wind of Change: Maritime Technology, Trade and Economic Development*" throughout the paper the author investigates how the introduction of the steamship revolutionized global trade. The author argues that only countries with pre-existing property rights institutions were able to benefit and transform into economic prosperity the new maritime technology.

These findings explain the importance of institutional quality: geography and technology can generate potential gains, but institutional quality is key to the Institutions constitute another pillar of comparative development.

Ports have the ability to directly affect the quality of institutions in a region. A region that historically developed around a port is forced to create and develop better institutions. Jia in his paper "*The legacies of forced freedom: China's treaty ports*" explains that regions in which treaty ports were established, became centers of customs innovation, fiscal extraction and legal experimentation. He continued by arguing that even after the collapse of the treaty ports' system, these port cities had an advantage in institutional quality that led to higher industrialization and urban growth. The 500 billion US dollars advantage retained by regions with the presence of at least one major seaport is not a reflection of trade openness but also

a reflection of the effects related to better institutions developed to efficiently and fully benefit from the new trade volumes and openness.

### **5.3. Ports, Culture, and Human Capital: Engines of Cosmopolitanism and Learning**

The third fundamental cause of development is widely recognized to be culture and human capital, with culture defined as the differences in beliefs, attitudes and preferences of the people.

Treaty ports and similar infrastructures are not only gateways for goods but also gateways of people, ideas, innovation and technology. Port cities may have attracted and interacted with different cultures, creating cosmopolitan and investment-friendly environments. By doing so these regions more likely adapted to technological changes and the new high demand for technical knowledge stimulated the formation of educational institutions such as schools, universities or technical institutes. These institutions formed and trained all the new generations and the children born in this environment were raised with different professional goals and education possibilities, leading to higher levels of human capital which is proven to be a key driver of growth.

In this context, ports can be seen not only as enhancers of trade but also as engines of cosmopolitanism, learning and education. This channel has a persistence path, even when political shocks slow trade down, these regions still gain from the advantages given to them by higher culture and higher levels of human capital.

Thus, the enormous GDP effect estimated in this thesis is not surprising. Ports amplify cultural openness and human capital accumulation in ways that endure across generations. They are not just gateways to markets; they are engines of cosmopolitanism and learning.

### **5.4. Conclusions: Ports as Amplifiers of Fundamental Causes**

What emerges from this thesis is that ports are not only facilitators of trade, but they are amplifiers of all fundamental causes of growth: they amplify first nature advantages, they help develop better institutions and stimulate the growth of higher levels of human capital. This multidimensional effect helps explain why the extraordinary magnitude of the effect of modern ports presence on regional GDP

levels is plausible and it is the result of the persistence of all these causes over decades and centuries. Ports are an example of how all the three fundamental causes of development can interact and generate persistent advantages in some regions.

In this case I tried to demonstrate how geography sets the stage and determine the location of ports, institutions are key to exploit the geographical advantages by transforming a natural harbor in a key trade hub and culture influences how societies interact with the opportunities received from the new port system.

The interplay of these three factors means that ports are not just physical infrastructures, but developmental nodes where geography, institutions, and culture converge, creating long-lasting trajectories of regional prosperity or stagnation.

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