Shipwrecked by Rents

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Abstract

The trade route between Manila and Mexico was a monopoly of the Spanish Crown for more than 250 years. The ships that sailed this route — the Manila Galleons, were "the richest ships in all the oceans", but much of the wealth sank at sea and remains undiscovered. We introduce a newly constructed dataset of all of the ships that travelled this route, and construct a model showing how monopoly rents that allowed widespread bribery would have led to inefficient cargo loading and delayed ship departure, which increased the probability of shipwreck beyond normal levels. Empirically, we demonstrate not only that ships that sailed late were more likely to shipwreck, but also that the effect is stronger for galleons carrying more valuable, higher-rent, cargo. This sheds new light on the relationship between, and social costs from, monopoly rents and corruption.

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1 Introduction

In 2011, underwater archaeologists discovered the remains of the *San Jose*, a galleon sunk near Lubang Island, Philippines, on July 3rd 1694. It was one of 788 galleons that traversed the route between Manila and Acapulco between 1565 and 1815 as part of the Manila Galleon trade — the longest, most profitable, and most celebrated colonial-era trade route. This paper investigates the unique case of the shipwrecks along the Manila Galleon trade route to shed new light on the relationship between monopoly rents and corruption, and the social costs they generate.

The *San Jose* carried a huge amount of silks and spices, over 197,000 works of Chinese and Japanese porcelain, 47 chests full of objects of worked gold, and hundreds of other chests containing precious stones and objects, the total value of which was recorded as 7,694,742 pesos or almost $450 million in today's money.[1] The *San Jose* was hardly the only galleon to have sunk over the almost 250–year long course of the Manila Galleon trade; 99 ships or 12.6% of all galleons were shipwrecked (either sunk or so heavily damaged by storms that they could not make the voyage). On the outward journey between Manila and Acapulco 20% of galleons suffered this fate. For a comparison, approximately 2.45% ships were lost in the Spanish Atlantic route that linked Mexico with Spain between 1550 and 1650.[2] A second comparison that helps to assess the magnitude of the puzzle is the Dutch East India trade, where around 3.5% of the ships sank while traveling between the Netherlands and Asia during a similar period (1595-1795).[3]

Why did the *San Jose* and so many other Manila Galleons experience a high rate of shipwreck? There are two proximate causes. First, galleons were often loaded with cargo beyond its capacity, which compromised their stability and made them more likely to capsize. The *San Jose's* cargo, for instance, was three times the legal limit. Second, the galleons often departed past the official deadline, which meant that they sailed during the perilous monsoon season. These, however, beg a deeper question: Why did the galleons often exceed the safe limits imposed by law?

In this paper, we demostrate, analytically and empirically, that the monopolistic structure of the Galleon trade induced inefficient cargo loading, which led to higher-than-normal rates of shipwreck.

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[1] See *ORRV Team Discovers Two Shipwrecks in the Philippines* (2011) who estimate the value to be over $500 million in 2011 dollars. For details of our estimate of $450 million, see Appendix 6,

[2] See Chaunu and Chaunu (1956); Chaunu (1960). He finds evidence of 84 ships that either sunk or run aground in the Atlantic route. The median yearly number of ships in the late 16th to early 17th centuries was 34.

[3] See Bruijn et al. (1987). Note the measure of shipwreck we use for the galleon trade is more expansive than that used for the Dutch East India trade. But even if we employ a more restrictive definition and just focus on ships lost at sea we find that the loss rate of Spanish ships on the Manila to Acapulco route was three times greater.

Restrictions on the number of ships and voyages were put in place because merchants in Spain wanted to limit the number of Asian goods entering American and European markets. This meant that these goods would fetch very high prices. In exchange for transporting such valuable cargo from Manila to Acapulco, ship officials could then extract large bribes from the merchants in Manila. This induces them to violate safety limits – they either load cargo beyond the galleon's capacity, or they depart after the sailing deadline, or both. The consequence is that the galleon faces a much greater risk of shipwreck once it starts sailing.

The Manila Galleon trade was the most lucrative single voyage in the early modern world—"the richest ships in all the oceans" (Schurz, 1939, 1). The entire economy of Spain's Philippine colony rested on the galleon trade—on the profits realized from the sale of Asian goods in Acapulco and from the silver stipend sent back on the returning ships. The best available estimates suggest that total GDP in the Spanish empire (excluding Milan and southern Italy) in 1700 was approximatively \$13.016 billion (1990\$) (Arroyo Abad and van Zanden, 2016). Given this, a back of the envelope calculation suggests that the value of the *San Jose*'s cargo was equal to around 1.5% of the GDP of the entire Spanish empire.[4] That ship officials risked overloading the ships and sailing into the monsoon season implies that the bribes were very large.

Scholars disagree whether bribes impose an additional cost in the form of queues and delays or if to the contrary, bribery "greases the wheels". Myrdal (1968, 952) observed that in corrupt countries "often delay is deliberately contrived so as to obtain some kind of illicit gratification". On the other hand, Lui (1985) explores the relationship between queuing and bribery and demonstrates that bribery is a form of price discrimination. Queuing can therefore be efficient if the size of the bribe is linked to the opportunity cost of the briber.[5] A more recent approach by Grossman and Helpman (1994, 2001), Bernheim and Whinston (1986a,b), and Dixit et al. (1997) is to model bribe-taking as a first-price menu auction in which principals offer an agent a menu of bribes in exchange for some share or allocation of a good (see Salanié, 2005). In these models, bribes and the corresponding allocation are efficient, as "equilibrium requires that the auctioneer sell the good to the individual who values it most highly" (Bernheim and Whinston, 1986b, 2).

We build on this class of models and show that the equilibrium allocation of a ship's cargo space

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[4] Specifically, we convert our estimate of the value of the cargo into 1990\$ to make it comparable to the estimates provided by Arroyo Abad and van Zanden (2016) for Spain, Mexico, and Peru. We employ our own back of the envelope estimate of Philippine GDP based on Maddison (2003). The cargo of the San Jose was worth approximately 201m 1990\$ or 1.5% of total GDP.

[5] See discussion in Bardhan (1997, 1323).

can in fact be *inefficient*. Merchants (principals) each offer bribes to a ship official (agent) in exchange for an allocation of cargo space. Ordinarily, if the value of the cargo is sufficiently low, the bribes are small, and the official does not want to risk shipwreck and loads within safe limits. Bribery and cargo loading are efficient. However, very valuable cargo – as those in the monopolistic Manila Galleon trade, induce moral hazard on the part of the agent. Because merchants can now afford to pay very large bribes, the official risks higher rates of shipwreck, and her loading effort is too much in that either the ship's capacity is exceeded, or its departure is delayed, or both.

The model then predicts that the higher the value of the cargo, the more likely that the official exceeds the safe limits imposed by law, and the higher the probability of shipwreck. We conduct several empirical tests of this prediction using a unique new dataset of the universe of ships that sailed between Manila and Acapulco between 1565 and 1816. First, we demonstrate that there is a robust positive relationship between sailing from Manila past the official deadline and the probability of shipwreck, that is not fully explained by running into storms or typhoons, or other factors such as the experience of captains, and the age or type of ship. We also consider other explanations that might have been associated with late departures, based on our reading of the historical literature. Other factors such as the arrival date of the previous ship, the threat of pirate or enemy vessels, or the volume of Chinese merchants arriving in Manila do not affect the relationship between late departures and shipwrecks.

Second, we test whether a ship that sailed late and carried cargo that was likely beyond capacity was also more likely to end in shipwreck. We do this by comparing the relationship between a late departure and shipwreck among high–tonnage versus low–tonnage ships. All else equal, the latter would have been more likely to be overloaded when sailing late, as its physical capacity was smaller. We find that the relationship is indeed stronger for low–tonnage ships.

Third, we show that in periods when the value of the cargo would have been higher, the relationship between a late departure and shipwreck is stronger. For example, following a failed voyage – to make up for the losses, and the unmet demand for the lost goods, the value of succeeding cargo would have been higher. The value of the cargo would also have been higher when silver flows were higher, or after 1640, when the limits on the number of ships was more strictly enforced. All results indeed suggest that in periods of relatively higher value of cargo, a late departure more strongly predicts shipwreck.

We make several contributions to the literature on rent-seeking and corruption.[6] First, by revealing

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[6] For surveys see Aidt (2003), Rose-Ackerman and Palifka (2016), Rose-Ackerman (2011), Rose-Ackerman and Søreide (2011), Olken and Pande (2012) and Fisman and Golden (2017). As discussed by Aidt (2016) the literatures on rent-seeking and corruption have proceeded largely on parallel tracks, though substantively they overlap considerably. Here we posit a particular relationship between monopoly rents and bribery.

a costly, unintended consequence, i.e. higher-than-normal rates of natural disasters like shipwrecks, the combination of monopoly rents and bribery is shown to be socially inefficient.[7] Historians have suggested that the Manila Galleon trade was a natural monopoly, and that the sheer costs and inherent dangers involved in the voyage acted as high fixed costs that had to be offset by high profits (see Baskes, 2005). To the contrary, the monopoly regulations themselves systematically *increased* the risks of the voyage. Had trade been liberalized, cargo space would not have been limited, and ship officials would not have been able to extract very large bribes from them. In turn, this would have reduced moral hazard. It would have been easier for ship officials to adhere to safety limits, because when one ship would reach capacity, there would be another ship to transport the remaining cargo. Overall, each ship would carry cargo within capacity and would sail on time. There would be lower chances of shipwreck. In contrast, the monopolistic structure of the galleon trade made cargo so valuable, and moral hazard so rampant, that ship safety regulations were routinely violated. The likelihood of shipwreck was thus 'inefficiently' high – above what normal factors like the weather, the general condition of the ship, and the competency of crew members, could account for.

A second contribution is to measuring the costs of rent-seeking and corruption. Though a large literature has built on the insights of Tullock (1967), Krueger (1974),Murphy, Shleifer and Vishny (1993), and Shleifer and Vishny (1993), measuring these costs remain challenging. A survey of the empirical literature on rent-seeking concludes that "its measurement is very problematic" (Del Rosal, 2011, 300). The costs of corruption are also difficult to measure. Novel papers have used microlevel data and causal identification in specific contexts such as the benefits of public office and political connections in Indonesia (Fisman, 2001) and India (Fisman et al., 2014); leakages from public projects in Indonesia Olken (2006, 2007), in Uganda (Reinikka and Svensson, 2004), in India (Niehaus and Sukhtankar, 2013); the relationship between corruption and culture (Fisman and Miguel, 2007); and extortion along trucking routes in Indonesia (Olken and Barron, 2009). In a similar, innovative spirit, we capture the social cost of corruption in the Manila Galleon trade in terms of high rates of shipwreck, and relate it to the size of monopoly rents from the trade.

Third, we provide evidence that corruption contributes to a higher rate of natural disasters. Ambraseys and Bilham (2011) find that 83% of deaths from building collapse due to earthquakes in the last 30 years occurred in corrupt countries. Nellemann and Interpol, eds (2012) estimate that 50-90% of the wood from developing countries are from illegal logging. Overloaded cargo resulting from bribery at

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[7] Rose-Ackerman (1978) argued that competition would reduce corruption. Ades and Di Tella (1999), however, show that in some cases competition can actually increase corruption.

airports has also been cited as a cause of many airline crashes.

We also contribute to the literature on colonial empires. The insight that colonial trading regimes were a rich source of rents to insiders, but imposed high costs on society, predates Adam Smith (1776).[8] Ekelund and Tollison (1981, 1997) applied these insights to the mercantilist and colonial regimes of early modern England, France, and Spain. From a macro-perspective, the long-run costs of colonial regimes has been the subject of a large literature since Acemoglu et al. (2001). But few empirical studies have examined how colonial trading regimes functioned.[9] One exception is Alvarez-Villa and Guardado (2020) who study the immediate and long-run consequences of both legal and illegal trade. An old literature associated Spain's colonial regime with its absolutist institutions at home (e.g. North, 1990, 102-103). While recent research disputes this characterization, rent-seeking was an endemic problem as studied by Drelichman (2005, 2007, 2009); Charotti et al. (2022), and Spanish political institutions were not uniquely absolutist or unconstrained in the 16th and early 17th centuries (Henriques and Palma, 2019).

We offer new insights into the political economy of the Spanish colonial empire.[10] More specifically, we analyze a most vital part of the empire – the Manila Galleon trade. The seminal historical study of the Manila Galleon trade is Schurz (1939) and subsequent scholarship relies heavily on his original archival work (e.g Legarda, 1967, 2017; Giraldez, 2015). Historians have since stressed the extent of rent-seeking associated with this trade (Brading, 1971; Walker, 1979; Garner and Stefanou, 1993). More recently, economic historians have focused on the silver flows between the Philippines and Mexico and how this contributed to inflation in Europe (Bauzon, 1981; TePaske, 1983; Flynn and Giráldez, 1995; Alvarez, 2012; Abad and Palma, 2021). In contrast, we are the first to systematically study the trade between the ports of Manila and Acapulco, and how it generated inefficient rent-seeking and corruption.[11]

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[8] In a modern context, Krueger (1974) applied Tullock's (1967) concept of rent-seeking to study inefficient trading regimes in developing and middle-income countries. Within the United States, there is also evidence that the costs of corruption vary with the degree of regulation (Johnson, LaFountain and Yamarik, 2011; Johnson, Ruger, Sorens and Yamarik, 2014).

[9] Within the economic history literature, Rei (2011, 2013, 2018) considers and contrast the organization of the Portuguese and Dutch merchant empires. But she does not consider the Spanish colonial empire or the Manila galleons trade.

[10] This empire was largely based around the extraction of precious metals, particularly silver (Abad and Palma, 2021). Legal trade was characterized by (i) being limited to a small number of ports; (ii) the periodic sailing of heavily guarded fleets; and (iii) the collusion of merchant guilds in Seville, Mexico City and Lima.This trading scheme operated until 1776, when reforms were introduced to liberalize commerce, allowing alternative ports and elites across the Empire to participate in the imperial trade (Fisher, 1982). For the Philippines, the reforms led to the creation in 1785 of a Filipino mercantile company (Real Compañia de Filipinas) that was eventually permitted to trade with regions beyond that of Acapulco, though these reforms did not come into actual effect until the 1790s (Schurz, 1939, 57-60). Ellingsen (2021) estimates the long-term benefits of the relaxation of these regulations by the Bourbon Reforms in the late 18th century.

[11] There is also a growing literature examining the institutions and organizations in the Age of Sail. Exploiting novel

2 The Institutional Setting

Our focus is on the period between 1565 and 1815, the era of the Manila Galleon trade. In this section we outline the salient historical details required to understand the incentives facing merchants, ship captain, governors, and viceroys during this period.

Our main source is Schurz (1939). This unique source is the product of 27 years of archival research in the early 20th century and many of these original archives are no longer accessible. In particular, Schurz had access to the log books of the Manila galleons which have subsequently been lost (see Burt, 1990, 1635).[12] For this reason, subsequent scholarship on the Manila Galleon trade remains reliant on it.

2.1 Historical Background

A major motivation for Spanish colonial expansion was access to the products of Asia, especially the manufactured goods, including textiles and porcelain of China and Japan. The conquest of Cebu in 1565 and occupation of Manila in 1571 were motivated by this demand for Asian products. While the Philippines did not provide the spices or gold that the initial Spanish conquerors hoped for, it did enable the establishment of a trade route between Asia and their American colonies.

The route was a royal monopoly until the end of the 18th century. For the majority of the period of our study, Spain's colony in the Philippines could only legally trade with Acapulco, a natural harbor of no other economic or political significance (Schurz, 1917, 18).

The trade proceeded as follows. In May, merchants from China and other parts of Asia, arrived in Manila in small ships laden with silks, textiles, lacquer wear, china, and jewelry. Merchants in Manila then purchased these goods, either on credit or with the proceeds from the previous trade. The goods were then loaded on to the galleon for transport to Acapulco. Once the galleon was loaded, it would depart, ideally in time to miss the rougher waters that were associated with the change of seasons in late July – the monsoon season.

The journey from Manila to Acapulco took between 5 and 7 months but on occasion lasted as long as 8 months. The galleons left Manila and then sailed south east, following a convoluted and hazardous

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data on shipwrecks in the Spanish empire, Brzezinski, Chen, Palma and Ward (2019)d assess the real effects of these monetary shocks to the European economy. There are also studies of the British navy (e.g.Allen (2002, 2011); Benjamin and Thornberg (2007)). Voth and Xu (2019) examine patronage institutions within the British navy, and find that a seemingly inefficient institution was effective at selecting naval commanders.

[12] The search for the lost log books is described by Burt (1990, 1635) who concludes "that almost all of the original log books have been lost to the ravages of time. In all probability, most of the original log books for eastbound voyages that may have been written, were stored in Manila where the heat, humidity, insects, and possibly wartime activities have destroyed them." World War II, the Japanese occupation and the American Bombing of Manila in 1945 may have contributed to the destruction of these documents.

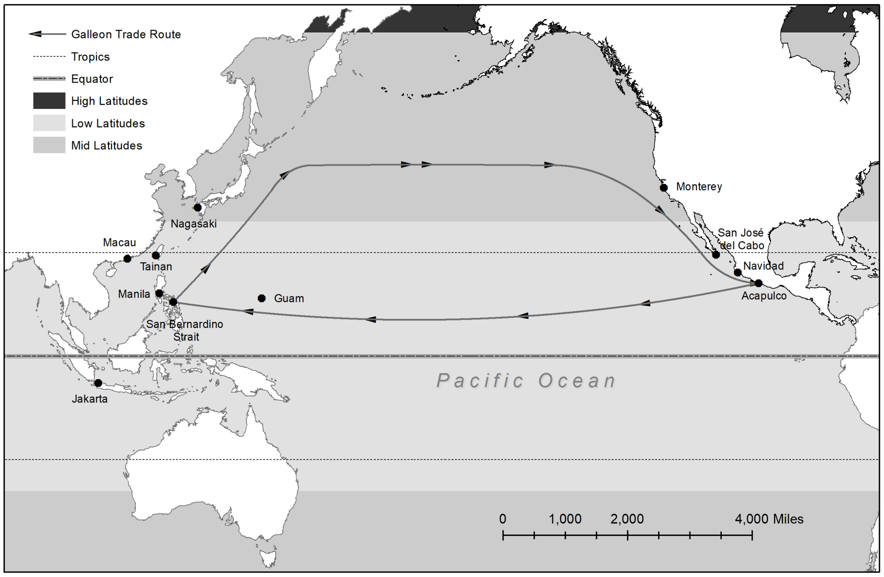

Figure 1: The Route of the Manila Galleons

path through the archipelago before sailing northeast. This was known as the Embocadero route. The remainder of the journey followed the Kuroshio current, which starts on the east coast of Taiwan and goes northeast past Japan—and then joined the North Pacific Current. We depict the entire voyage in Figure 1 and provide a snapshot of the Embocadero route in Figure 2. The ships would arrive in Acapulco between December and January in time for trade fairs that ended by February. The return journey from Acapulco to Manila, which carried silver as payment for the goods, was shorter: on average 4 months. It followed the north equatorial current that flows east-to-west between about 10 degrees latitude and 20 degrees latitude north.

2.2 The Cargo and the Boleta

On the Manila–Acapulco voyage, the cargo comprised manufactured goods, largely from China, but also from Japan, and other parts of Asia. Chinese textiles, particularly silks, were greatly valued both in Mexico and in Europe. Chinese porcelain were better quality than anything produced in Europe and highly demanded. These goods were taken to Manila by numerous Chinese merchants, predominately operating from Canton and Macao. On the Acapulco-Manila voyage, the main cargo was silver, though in addition to it, American goods such as cochineal, seeds, sweet potato, tobacco, chocolate, and fruits accompanied Spanish products like swords, olive oil and wine (Mejia, 2022). The Manila Galleons therefore increased the diversity of products available to consumers in Europe, the Americans and Asia.

The Manila Galleons were among the largest ships on the oceans. This was for economic reasons: "[a] vessel of seven hundred tons was much more cost-effective than one of three hundred; the larger ship, with a crew of eighty or ninety, would demand stores of foodstuffs and other supplies that would only occupy 10 percent of its capacity: the necessity for fifty or sixty men on the smaller vessel would need 13 to 15 percent of the storage space" (Giraldez, 2015, 123). Nonetheless, despite their huge carrying capacity, "[c]argo space on the Acapulco galleon was one of the most eagerly sought-after commodities in Manila" (McCarthy, 1993, 168).

Space on each galleon was scarce due to the monopolistic and highly regulated nature of the trade. These regulations reflected the incentives facing political decision makers in Spain. The galleons were owned by the crown and the cost of their construction was borne by the royal treasury. The galleon trade was intended to generate profits to encourage the settlement of Spanish merchants in Manila and to support the costs of the Spanish colony in the Philippines. But influential merchants in Seville who wished to monopolize Mexican markets lobbied to curtail the volume of goods taken from Manila to Mexico (Bonalian, 2010, 83-99). Consequently, the number of voyages was limited by law. From 1593 onwards, only two galleons per year were allowed to leave Manila for Acapulco. (No other ships were permitted to sail this route.) In 1640, this was further restricted to one galleon per year. The size of the galleons was nominally limited to 300 tonnes, though this limit was ignored, and eventually raised. The value of the outgoing cargo from Manila was limited to 250,000 pesos. The value of silver from Mexico was limited to 500,000 pesos (and this included the subsidy to support the costs of government in the Philippines).[13]

The limit on the value of goods leaving Manila was enforced as follows. First, cargo space on the outgoing galleon was assigned by the Distribution Board (*junta de repartimiento*).[14] Second, to calculate how many goods could be transported on the galleon, the ship's hold was measured and the volume of space divided into equal shares (bale or *fardo*). Each bale was divided into four packages or *piezas*—average size 2.5 feet in length, 2 feet in width, 10 inches in depth. The cargo space divided into 4,000 shares each corresponding to a *pieza*. Each *pieza* had a corresponding *boleta* — a ticket the holder of which was entitled to one (*pieza*) cargo space in the galleon. Based on official values, one *boleta* should have been worth 125 pesos ($500,000 \div 4000$).

Historians are unanimous that this monopolistic system generated opportunities for percolation,

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[13] For conversions to pesos to modern dollars see Appendix 6.

[14] This board included the Governor, the senior judge of the *Audiencia*, the fiscal (attorney-general), two members of the City Council, and the Archbishop. In 1768 this was changed to a *consulado* composed of merchants.

rent-seeking and corruption: "'[b]y nature this system became subject to abuse by imperious governors and a horde of speculators" and full of "abuse and privilege" (McCarthy, 1993, 169). Fish comments that it "had become a commonly held practice for individuals to falsify the value of the goods they shipped to Acapulco . . . Illegal goods were also hidden from the authorities in a variety of ways" (Fish, 2011, 289-290). Government regulations intended to limit overloading "were ignored in Manila" (Fish, 2011, 288)

2.3 Loading Capacity

The limit on the number of legal cargo, i.e. *pieza* with *boleta*, was routinely exceeded. The actual number of *pieza* carried by ships appears to have varied considerably: some ships were said to regularly contain 6-7,000; the *San Jose*, however sank with 12,000 *piezas* onboard. If the ship was carrying far in excess of the official limit, the safety of his ship was put at risk. This is because it would compromise the stability of the ship.

The distribution of cargo was critical. According to Fish (2011, 285): "it was necessary to prepare the cargo in a precise manner to conform to the weight allowances of the vessels. Every bale, crate and package, would eventually be evenly distributed and stowed aboard the galleon in its precise location in the hold, or above on the decks to maintain the integrity of the vessel". The lowest decks were filled with ballast. Stability required a certain ratio between cargo and ballast. Additional cargo threatened stability if it led to this ratio being violated. Fish (2011, 285) notes that there were numerous cases where "ships listed to starboard or port upon leaving Cavite or sank soon after departing from their mooring" due to "unevenly distributed cargo or a lack of sufficient ballast below the hold of the ship".[15]

Ships with high poop decks like the Manila Galleons were particularly vulnerable to capsizing because if the upper stories of the ships were overloaded with cargo this would raise the metacenter of the vessel. If the cargo shifted during a voyage or was improperly loaded this could unbalance the vessel which was, as Fish (2011, 281) notes "a dangerous situation for the galleon, as it could easily list to port or starboard and sink during a storm or rough seas".

Scientific understanding of hydrostatic stability and other principles of naval architecture was limited

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[15] The principles of hydrostatic stability explain why the volume and distribution of cargo (as well as it sheer weight) can compromise ship stability. Understanding this requires the concept of a metacenter. The metacenter is the point of intersection between a vertical line through the center of buoyancy of the ship and a vertical line through the new center of buoyancy when the body is tilted, which must be above the center of gravity to ensure stability (see Biran and López-Pulido, 2014). Ship stability is measured by the vertical distance between the center of the mass of a loaded ship and its metacenter—its metacentric height. Both an excess or an overly small metacentric height affect stability. Particularly dangerous is a *negative* metacentric height which would result from cargo being loaded so that the center of the ship's mass lives above the metacenter. In this case, "the ship will be unstable and, when displaced slightly from the vertical, will continue to roll into a position of permanent heel known as loll" (McGrail, 1989, 354).

until the late-18th century (Ferreiro, 2007). The seamen of the Manila galleon trade would have had only an intuitive understanding of the relationship between ship stability and the volume, weight, and distribution of cargo. This would have been based on loose rules of thumb, and absent a modern understanding of hydrostatic stability, it was have been easy to over-estimate how much cargo could be safely stowed. We discuss this in Appendix D.

Nevertheless, the dangers of the voyage were understood. There were reserve ships on hand. One in Manila and after 1630, one also in Acapulco. While on average, Spanish galleons were expected to serve for around 30 years, ships on the Pacific route only lasted around 6 years (McCarthy, 1995, 15). As the loss rate of ships on the Manila to Acapulco voyage was so high, shipbuilding became one of the Philippine colonies major industries (McCarthy, 1995, 155).

The problem of overloading was known to contemporaries. In 1604, it was so apparent that King Phillip III decreed that:

> "Galleons should not be overloaded and they must be reinforced as necessary. Because of overloading, many ships in the Philippines trade route have been lost, costing lives and funds. It is better to prevent this and we mandate that ship tonnage limits be observed . . . we strongly caution against the overloading of ships, as it increases the risk of being lost due to mishaps. We recommend for ships to be in a condition to withstand sea torments and enemies." (*Recopilacion de leyes de los reinos de las indias*, 1841, 125-126)

Yet, more than a century later the problem persisted. King Ferdinand VI observed in 1752 that passages and crew had been "innocent victims of the barbarous greed of those who wish to use all of the space on the ship for their cargo" (quoted in Schurz, 1939, 257). As Schulz puts it:

> "Every cubic inch of space available in the hold was crammed with merchandise' . . . Bales and chests were piled in the cabins and passage-ways and along the decks. They were stowed in the compartments reserved for necessary stores and supplies and in the power-magazine itself, while a flotilla of rafts, laden with water-tight bales, was sometimes dragged after the galleon, to be hoisted on the deck was the sea was high" (Schurz, 1939, 184).

Similarly, McCarthy notes that as the cargo was so tightly packed, with the most valuably and vulnerable satins and silks wrapped inside cheap fabrics, "[c]lose inspection was thus quite impracticable and violations of the 250,000 peso *permiso* routinely went unpunished" (McCarthy, 1993, 176).

2.4 The Departure

In addition to being overloaded, galleons often sailed late. The optimal departure from the port of Cavite was in June. Leaving on time was critical because the galleons had to clear the Philippine isles before the start of the monsoon season, between July and October (Giraldez, 2015, 126). Departing in June also assured the most favorable winds.[16] The chances of running into bad weather increased dramatically after mid-July. Schurz (1939, 352) writes that "A galleon that left Manila after the middle of July was practically certain of running into rough weather within the next three months of her voyage".

The route taken by the Manila Galleons sailing to Acapulco was dangerous. The main danger was along the Embocadero route — the vicinity of the Philippine isles along the "winding channel that connected Manila to the Embocadero" where "Squalls and currents tossed the galleon on a course that was full of sandbanks, rocks, and low-level islands with days of fog presenting additional perils to navigation" (Giraldez, 2015, 126-7). In particular, there was a reef close to Lubang Island and rips and eddies between Mindoro and Maricaban (Figure 2). Once past this, there was a zone of storms and variable winds that posed a further danger, often obligating ships to return to port.

Everyone at that time knew that by sailing late, captains risked shipwrecks along the Embocadero route. In fact, because the risks were widely known, there were numerous proposals to change this route. Schurz (1939, 224) observes that "the route up the west coast of Luzon should have been much safer and quicker than that by the Embocadero" and would have reduced the risk of a failed voyage.[17] However, this alternative was rejected by merchants in Manila. The reason given was that it would have necessitated a significantly earlier departure, which would have made it difficult to load a lot of cargo.

Nonetheless, despite the risks of late departure being widely known, attempts to ensure a timely departure were all unsuccessful. By royal edicts passed in 1618, and then reiterated in 1620 and 1624, the ship was required to leave Manila by June 30th. A law of 1773 modified this official departure date to early July. Despite this, departures remained routinely late.

2.5 Shipwrecks and Returned Ships

A voyage failed if the ship was lost at sea, or returned to port too damaged to continue its voyage. These returns to port were known as *arribadas* and, as Giradez outlines, they were considered to be

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[16] Specifically the winds "pushed the galleon from Cavite to the Strait of San Bernardino–the *Embocadero* in colonial times—where the expected monsoon would propel it northward" (Giraldez, 2015, 126).

[17] Schurz (1939, 226) writes: "The successful navigation of the passage largely depended on the galleon's clearing from Manila earlier than was customary".

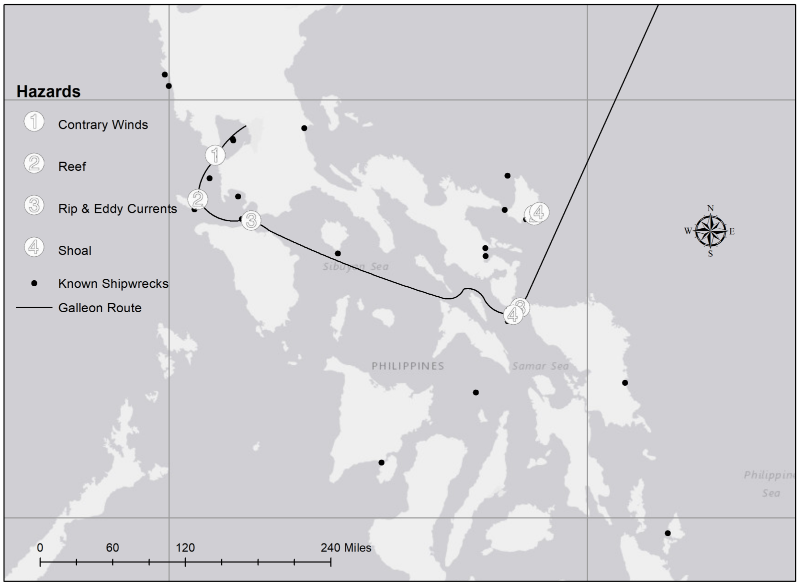

Figure 2: The main hazards on departing Manila via the Embocadero route & locations of known shipwrecks (Bennett, 2010). Ships severely damaged on en route from Manila often returned to port. In contrast, a ship wrecked out in the Pacific was more likely to be declared lost.

almost as disastrous as a complete shipwreck:

> “The return of galleon to the Philippines was a human and economic catastrophe. Usually, the vessel was greatly damaged, and many onboard died. Storms tangled the galleon’s masts and rigging; heavy seas broke the rudder and opened up leaks, ruining the cargo. In emergencies, bales and other merchandise were thrown overboard to lighten up the ship. Finally an arribada was nearly as damaging as a shipwreck. Even if the bales of silk could be kept undamaged until the following year, a double landing was not permitted or sometimes, for lack of space, not possible” (Giraldez, 2015, 130-131).[18]

Of the 410 individual voyages from Manila to Acapulco, 20% were either shipwrecked or returned to port. Of the 378 individual voyages from Acapulco to Manila 4.5% were either shipwrecked or returned to port.

Qualitative accounts suggest that rent-seeking may have been responsible for ships being overloaded and departing late. Since cargo space in the galleon was limited, officials could earn rents by extracting

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[18] Similarly, Schurz (1939, 261) notes that usually “the cargo had greatly deteriorated or was totally ruined if much water had entered the hold. It was also customary to throw overboard part of the merchandise in order to lighten the ship”.

extra payment or bribes from merchants in exchange for loading their cargo. There is thus an incentive to load too much cargo — that is, beyond the permitted capacity of the galleon. Since loading took time, this could have also pushed departure dates beyond the legal deadline.

Indeed, observers at the time understood the link between rent-seeking behavior, late departures, and shipwrecks. In the early 19th century, as new systems were being devised to replace the monopoly of the Manila Galleons, a local friar Martinez de Zuniga (1893, 268-269) explicitly emphasized that the core problem was the rent-seeking behavior from the governor (and the captain he appointed): "This [new] arrangement has taken away from the governor the right to appoint this official, a loss of power which they resented very much. But this move, I believe, will rebound to the benefit of the commerce because of the fewer ships would be lost, as the commanders would be more intelligent, and better trained for their jobs, and also because, being used to punctuality, the galleons will leave on schedule. This did not happen before because the commander, who is an intimate friend of the governor, delayed the galleon's departure . . . This delay has resulted in many subsequent losses". As far back as the 16th Century, Pedro (1908, 76) had already manifested his worries about the relationship between late departures, shipwrecks and the governor's involvement: "Prostrate at your Majesty's feet, I desire to beg one thing, in which lies the wealth and prosperity of this land, or its destruction. Your royal Majesty can remedy it—although it be at the loss of his office to the governor of these islands; for in no other way is there any relief, either with royal decrees or orders from your Majesty—or in any other way—by your Majesty ordering the said governor that the ships sail from this port for New Spain by St. John's or St. Peter's day".

No quantitative evidence has ever been marshaled to investigate this. In the next section, we present a model that formally establishes that late departures are associated with too much, or inefficient, cargo loading, which then leads to higher chances of shipwreck. In Section 4, we introduce a new dataset of voyages, ships, storms, and underlying weather conditions for the eastern and western Pacific, and confirm that there is indeed a robust empirical relationship between late departures and failed voyages. We then provide several tests of the mechanism underlying this relationship.

3 A Model of Ship Cargo Loading and Departures

Our model is a variant of the first-price menu auction, lobbying framework in Grossman and Helpman (1994, 2001), and its origins in Bernheim and Whinston (1986a,b) and Dixit et al. (1997), in which principals offer a 'menu' of bribes to a common agent in exchange for a share or an allocation of, e.g., total public spending. In our context, merchants (principals) pay bribes to a ship official (agent) in exchange for a share in the galleon's total cargo space, but the result is qualitatively similar — by pitting the merchants against each other, the ship official is able to bid up the bribes up to the value of the cargo, and therefore extract the full surplus.

The important difference is that while bribe payments in first-price menu auctions have been shown to be efficient, in our model they can be inefficient. We show that when the value of the cargo is sufficiently high, there is moral hazard on the part of the agent. Specifically, the ship official loads cargo up to a point that would be unsafe, causing a higher-than-normal probability of shipwreck. Thus too much cargo is loaded, more than the efficient level.

In turn, moral hazard is possible for two (related) reasons. Primarily, the action of the ship official is unobservable — when the merchant pays the official to load her cargo, the former cannot how many pieces of cargo have already been loaded and, therefore, whether the probability of shipwreck would already be higher than normal. The problem is compounded because each merchant also generates an externality — her cargo contributes to the total load and may thus contribute to overloading and a higher probability of shipwreck. We show, in fact, that if loading were perfectly observable, or if merchants can collude to fully internalize the cost of shipwreck, the equilibrium becomes efficient. The official still extracts the full surplus as bribes, but cargo loading is at safe levels and, hence, shipwreck rates are reduced to normal.

We construct an environment that closely resembles the actual institutional details of the Manila Galleon trade. Specifically, there are two types of players: (i) the ship official in charge of cargo loading, e.g. the captain, possibly in connivance with other officials, and (ii) a large number, N, of merchants. The N merchants are divided into holders of legal boleta of finite size N_1, and those who do not have such legal rights to have their cargo loaded, of much larger size $N_2 > N_1$. Thus, $N = N_1 + N_2$. For convenience, let each merchant have one cargo with price V, and assume that it takes one time period to load a cargo. Thus, t also denotes the total number of cargoes that could have been loaded as of period t.

The ship official faces three restrictions set by law: (1) to load only legal cargo; (2) not to load beyond the ship's capacity $\bar{N}$; (3) and to sail by the deadline $\bar{t}$ so as to avoid the monsoon season. Restrictions (2) and (3) are meant to keep the probability of shipwreck to some minimum, 'normal', level $\bar{\rho}$. One can then think of $\bar{\rho}$ as the 'efficient' rate of shipwreck, and $\bar{N}$ and $\bar{t}$ are regulations intended to prevent inefficient cargo loading that would raise the probability of shipwreck beyond the 'normal' rate.

Since t indexes the number of cargoes that could have been loaded as of t, the sailing deadline $\bar{t}$ can be interpreted as a type of cargo limit, distinct from the physical limit $\bar{N}$. We allow $\bar{N}$ to be greater than or less than $\bar{t}$. For instance, it is reasonable to suppose that a higher tonnage ship would be more likely to face $\bar{N} > \bar{t}$, and a lower tonnage ship $\bar{N} < \bar{t}$, since the former has a larger physical capacity. It would thus be more likely to surpass $\bar{t}$ before it does $\bar{N}$.

Violating any of the restrictions entails costs. There is a cost k_1 for each illegal cargo, k_2 for each cargo beyond the ship's capacity, and k_3 for each cargo loaded beyond the deadline. The probability ρ that the galleon shipwrecks increases with k_2 and k_3. In particular, the probability of shipwreck increases (at a decreasing rate) beyond the normal rate $\bar{\rho}$ for each cargo that exceeds the ship's limit $\bar{N}$, and each cargo loaded past the sailing deadline $\bar{t}$.

To make this explicit, let $\mathbb{1}_2$ be an indicator variable equal to 1 whenever k_2 is incurred, and $\mathbb{1}_3$ an indicator variable equal to 1 whenever k_3 is incurred. Define $T_2^S \equiv \sum_{t=1}^{S} t\mathbb{1}_2$, $S < N$, as the number of cargo loaded as of period S that are above the limit $\bar{N}$, and $T_3^S \equiv \sum_{t=1}^{S} t\mathbb{1}_3$ the number of cargo loaded as of S after the deadline $\bar{t}$. Then the probability of shipwreck when sailing at period S is $\rho^S = \bar{\rho} + \omega(T_2^S, T_3^S)$, where $\omega(0,0) = 0$ and ω are increasing at a decreasing rate both in $\mathbb{1}_2$ and in $\mathbb{1}_3$. Thus, e.g., $\omega(1,0) > \omega(0,0)$ and $\omega(2,0) - \omega(1,0) < \omega(1,0) - \omega(0,0)$. Similarly, $\omega(0,1) > \omega(0,0)$ and $\omega(0,2) - \omega(0,1) < \omega(0,1) - \omega(0,0)$.[19] Note that if $\bar{N} < \bar{t}$, then $\omega(1,0)$ is the smallest (non-zero) value that ω can take since $\bar{N}$ would be surpassed first before $\bar{t}$. Analogously, if $\bar{N} > \bar{t}$, then $\omega(0,1)$ is the smallest (non-zero) value that ω can take. We bound these values: $\omega(1,0) > \frac{1-\bar{\rho}}{1+\bar{N}}$ and $\omega(0,1) > \frac{1-\bar{\rho}}{1+\bar{t}}$.[20]

A game is played by the ship official (e.g. the captain) and the set $N = N_1 + N_2$ of merchants, in which the following events occur at each time period $t = 1, 2, \ldots, N$:

1. A merchant, randomly drawn from N, arrives at port, and offers the ship official bribe b in exchange for loading her cargo, which the official accepts or rejects.
2. The ship official chooses to set sail ($\psi = 1$) or not ($\psi = 0$). If $\psi = 1$, the game ends.

The decision to set sail is distinct from the decision to load cargo. The official can reject one bribe and wait for another merchant who can pay a higher bribe. Thus, a merchant at t pays a bribe that at

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[19] We are agnostic as to the relative effect of loading beyond $\bar{N}$ or beyond $\bar{t}$ - e.g., $\omega(1,0)$ can be less than, greater than, or equal to $\omega(0,1)$. One possible justification for $\omega(0,1) > \omega(1,0)$ is to account for any temporal cost of playing the game, which would increase the likelihood of departure delay, without necessarily adding to the total number of loaded cargo.

[20] Thus, the smaller the limits $\bar{N}$ and $\bar{t}$ are, the larger the effect of the first cargo that is above the limit. This implies, for instance, that a low tonnage ship would be worse at handling an extra cargo than a high tonnage ship—that one extra cargo would increase the probability of shipwreck of the low tonnage ship much more than it would the high tonnage one.

least matches the official's reservation utility at t, which reflects the official's expected bribe offer from another merchant at $t+1$. We elaborate on this mechanism by constructing an equilibrium in which the official sets sail at some time period $T < N$, and accepts bribes and loads cargo at each period $t \leq T$, while each merchant at $t \leq T$ pays positive bribe amounts.

3.1 The Decision to Set Sail

We proceed by backward induction. For the official to choose $\psi_T = 1$ at time T, it must be that the expected payoff from setting sail at T is at least as large as that from not sailing. The expected payoff from sailing is what the official gets to keep should the voyage successfully reach its destination — the sum of all the bribe payments she has accepted as of T.[21] The expected payoff from sailing at T is, thus, $a \equiv (1-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}})$, where $\mathbb{1}_{\mathbb{1}}$ is an indicator variable equal to 1 whenever an illegal cargo is loaded, $\mathbb{1}_{\mathbb{2}}$ and $\mathbb{1}_{\mathbb{3}}$ are as previously defined, and $\rho_T = \bar{T} + \omega(T_2^T, T_3^T)$ is the probability of shipwreck as of T.[22] On the other hand, if the official chooses to wait, i.e. $\psi_T = 0$, she expects to obtain bribe payment $\bar{b}_{T+1}$ in exchange for loading the cargo of the $(T+1)$th merchant, with the probability of shipwreck $\rho_{T+1} = \bar{\rho} + \omega(T_2^{T+1}, T_3^{T+1})$. Thus, the expected payoff from not sailing at T is $b \equiv (1-\rho_{T+1})(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}}) + (\bar{b}_{T+1} - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}})$.

The official sets sail at T if $a \geq b$ which, re-arranging and letting bind with equality, gives her expected payoff (at $T+1$) upon sailing at T: $\bar{b}_{T+1} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}})}{1-\rho_{T+1}} + k_1\mathbb{1}_{\mathbb{1}} + k_2\mathbb{1}_{\mathbb{2}} + k_3\mathbb{1}_{\mathbb{3}}$.

Notice then that at T, the official can only calculate her expected payoff at $T+1$ because she can only form an expectation about the type of merchant who would arrive at $T+1$. Denote as $b_{T+1,1} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}})}{1-\rho_{T+1}} + k_2\mathbb{1}_{\mathbb{2}} + k_3\mathbb{1}_{\mathbb{3}}$ the bribe payment if the $(T+1)$th merchant is a legal one (i.e. from set N_1), and $b_{T+1,2} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{\mathbb{1}} - k_2\mathbb{1}_{\mathbb{2}} - k_3\mathbb{1}_{\mathbb{3}})}{1-\rho_{T+1}} + k_1 + k_2\mathbb{1}_{\mathbb{2}} + k_3\mathbb{1}_{\mathbb{3}}$ if illegal (i.e. from set N_2). Denoting the probability that a legal merchant arrives in period $T+1$ as μ_{T+1}, then another expression for the expected value of b_{T+1} is $\bar{b}_{T+1} = \mu_{T+1} b_{T+1,1} + (1-\mu_{T+1}) b_{T+1,2}$, or[23]

$$\bar{b}_{T+1} = b_{T+1,1} + (1-\mu_{T+1})k_1. \tag{1}$$

This is the minimum amount of bribe that the official would want from the $(T+1)$th merchant — below this, she would not be willing to wait and would thus prefer to sail. In turn, if she expects to earn this

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[21] It is trivial to include the value of any cargo that the official personally owns – doing so would not alter the results.

[22] For ease of notation, we exclude subscript t from $\mathbb{1}_{\mathbb{1}}$, $\mathbb{1}_{\mathbb{2}}$ and $\mathbb{1}_{\mathbb{3}}$, but it should be obvious that these are time-varying.

[23] The probability μ_{T+1} can be obtained by letting $t = T+1$ and applying the following formula derived in the Appendix: $\mu_t = \sum_{x=1}^{t} a_{t-x}(\frac{N_1-t+x}{N_1+N_2-t+1})$, where each term in the summation is the joint probability of drawing a legal merchant in all $(t-x)$ periods, with $\frac{N_1-t+x}{N_1+N_2-t+1}$ the probability that a legal merchant is drawn in the $(t-x)$th period, and a_{t-x} the joint probability that a legal merchant is drawn in the periods prior to the $(t-x)$th period.

from the $(T+1)$th merchant, the Tth merchant would have to match this in order to get the $(T+1)$th merchant's cargo space. That is, the expected bribe at $T+1$ is the official's reservation utility that a merchant who comes at period T has to match in order to induce the official to load her cargo, rather than wait for the $(T+1)$th merchant's cargo.

3.2 Bribe Payments

Moving backward in the game, i.e. given $b_{T+1,1}$, μ_{T+1}, one can then solve for the bribe payment that the official would demand at T. If the Tth merchant is a boleta-holder, then for the official to accept her bribe, the merchant should offer an amount $b_{T,1} - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 \geq \bar{U}_T$, where $\bar{U}_T \equiv \mu_{T+1}b_{T+1,1} + (1-\mu_{T+1})b_{T+1,2} = b_{T+1,1} + (1-\mu_{T+1})k_1$ is the reservation utility that the official demands to be satisfied by a merchant arriving at T. If the Tth merchant is illegal however, then the official would want bribe payment $b_{T,2} - k_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 \geq \bar{U}_T$.

Letting these conditions bind with equality such that $b_{T,1} = \bar{U}_T + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and $b_{T,2} = \bar{U}_T + k_1 + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and writing out the expression for $\bar{U}_T$ in each, give the following:

$$F_{T,1} = b_{T,1} - \Big[(1-\mu_{T+1})\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,1} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big)$$
$$+\mu_{T+1}\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,1} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big] - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 = 0\ ; \tag{2}$$

and:

$$F_{T,2} = b_{T,2} - \Big[(1-\mu_{T+1})\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,2} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big)$$
$$+\mu_{T+1}\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,2} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big] - k_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 = 0 \tag{3}$$

Equations (2) and (3) thus solve for $b_{T,1}$ and $b_{T,2}$, respectively. In fact, one can also go backward iteratively by lagging the time subscripts in (2) and (3) to solve for $b_{t,1}$ and $b_{t,2}$ for each t.[24] Note that because illegal merchants have to compensate the official for incurring cost k_1, $b_{t,2} > b_{t,1}$.

However, while the official would ideally want to receive bribe $b_{t,1}$ or $b_{t,2}$ at t, any merchant can only afford to pay bribes up to the price V of the cargo. Thus, the actual bribe that a legal and illegal

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[24] Given $b_{T,1}, b_{T,2}$, the official's reservation utility at $T-1$ is $\bar{U}_{T-1} = \mu_T b_{T,1} + (1-\mu_T)b_{T,2}$ and, thus, $b_{T-1,1} = \bar{U}_{T-1} + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and $b_{T-1,2} = \bar{U}_{T-1} + k_1 + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ which, when expanded, give equations (2) and (3), with subscript T replaced by $T-1$ and subscript $T+1$ replaced by T.

merchant arriving at t pay are, respectively:

$$\bar{b}_{t,1} = \min(b_{t,1}, V) \tag{4}$$

$$\bar{b}_{t,2} = \min(b_{t,2}, V) \tag{5}$$

3.3 Equilibrium

Before providing the equilibrium of the game, the following result is useful.

Lemma 1. *Both $b_{t,1}$ and $b_{t,2}$ are increasing in t.*

All proofs are in Appendix 2.

Since $b_{t,1}$ and $b_{t,2}$ keep increasing in t, there will be a time period $T+1$ at which $\bar{b}_{T+1}$, the minimum amount of expected bribe that the official will require in order to wait for the $(T+1)$th merchant, will be greater than V. The following equilibrium is thus obtained.

Proposition 1. *In equilibrium, the bribe amount paid to the official at each time period t is given by $(\bar{b}_1 = V, \bar{b}_2 = V, \ldots, \bar{b}_T = V)$, the official's decision to sail at each t is given by $(\psi_1 = 0, \psi_2 = 0, \ldots, \psi_T = 1)$, and the departure time T is such that $\bar{b}_{T+1} > V$. The official extracts the full surplus, VT, as bribes.*

In other words, each merchant that arrives before the galleon departs, whether legal or illegal, pays the maximum bribe V. [25] With T merchants or cargo, total bribes are VT, which means the official gets the full surplus. This is consistent with theoretical results on first-price menu auctions when there are multiple principals but a single agent. With a large number of merchants (principals) vying for limited space in the galleon, the ship official (agent) is able to pit them against each other, thereby extracting all the surplus and earning V from each merchant. In addition, Proposition 1 establishes that the official sets sail when the amount of bribe that would compensate her for the probability of shipwreck becomes unaffordable — higher than V, for any merchant that comes in the next period.

The next two results formally establish that the higher the price V of the cargo, the more likely is the galleon overloaded and late and, hence, the more likely it is to be shipwrecked.

Proposition 2. *The higher the price V of each cargo, the more likely that the galleon departs late and is overloaded. Specifically, there exist threshold values $V_1 < V_2 < V_3$ such that:*

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[25] The ship official does not discriminate between legal and illegal merchants because the official bears the cost k_1 of loading illegal cargo. Since all merchants can then pay the full price V, the official is able to extract this from any merchant. There is no evidence that holders of legal boletas complained about extortionary bribes to officials in Manila—in fact, often, higher officials were implicated in the corruption scheme. Officials in Acapulco inspected the merchandise and ascertained whether illegal cargo were loaded, for which the captain would be liable.

1. *if* $V < V_1$*, the galleon departs before the deadline* $\bar{t}$*, carrying total cargo below the limit* $\bar{N}$*.*

2. *if* $V_1 \leq V < V_2$*, the galleon departs before the deadline* $\bar{t}$*, carrying total cargo at the limit* $\bar{N}$ *if* $\bar{N} < \bar{t}$*; otherwise, if* $\bar{N} > \bar{t}$*, it departs on the deadline, carrying total cargo below the limit.*

3. *if* $V_2 \leq V < V_3$*, the galleon departs at or before the deadline* $\bar{t}$*, carrying total cargo beyond the limit* $\bar{N}$ *if* $\bar{N} < \bar{t}$*; otherwise, if* $\bar{N} > \bar{t}$*, it departs after the deadline, carrying cargo below or at the limit.*

4. *if* $V_3 \leq V$*, the galleon sails after the deadline* $\bar{t}$*, carrying total cargo above the limit* $\bar{N}$*.*

Since the official always earns a bribe for each cargo loaded, she would want to keep loading cargo for as long as the merchant can pay the bribe—that is, for as long as the merchant can afford to compensate the official for the marginal expected loss from a shipwreck. After some point, the probability of shipwreck and, thus, the expected marginal loss, would be too high for any merchant to compensate. For very large V, however, this point is reached more slowly precisely because the merchant is able to pay a higher bribe V and compensate for a larger expected marginal loss from shipwreck. Hence, the official is able to load more cargo, going beyond both the safe limit of the ship and the deadline.

This, then, increases the probability of shipwreck. That is:

Corollary 1. *The higher the price* V *of each cargo, the higher the probability of shipwreck.*

3.4 Risk Aversion

The results are robust to risk-aversion of the players. To see this, one can intepret V as the expected price of a cargo and let a risk-averse merchant derive concave utility $U(V)$ over V. Similarly, let a risk-averse ship official derive concave utility over her expected bribe from an arriving merchant $T+1$, such that $\bar{b}_{T+1}$ is a concave function of $b_{T+1,1} + (1-\mu_{T+1})k_1$ (recall equation (1).

The key insight is that equilibrium bribes will be set at the merchant's maximum willingness to pay (MWP), whatever it is, and the ship official sets sail when no other merchant can afford to pay MWP. Thus, the model can accommodate any specification of MWP, including the risk-aversion case in which MWP would be equal to the merchant's utility $U(V)$. In equilibrium, the official extracts the MWP of each merchant – that is, she gets bribes equal to MWP at each time period until T, and sets sail when no other merchant would be able afford to compensate her for staying for one more period, i.e. when $\bar{b}_{T+1} > MWP$.

A general version of Proposition 1 is thus given by the following.

Proposition 3. *In equilibrium, the bribe amount paid to the official at each time period* t *is given by* $(\bar{b}_1 = \bar{b}_2 = \ldots, \bar{b}_T = MWP)$*, the official's decision to sail at each* t *is given by* $(\psi_1 = 0, \psi_2 = 0, \ldots, \psi_T = 1)$*, and the departure time* T *is such that* $\bar{b}_{T+1} > MWP$*. The official extracts the full surplus,* $MWP \times T$*, as bribes.*

This implies that Proposition 2 and Corollary 1 still hold for risk-averse players, where $MWP = U(V)$ and $\bar{b}_{T+1}$ is some concave function of $b_{T+1,1} + (1 - \mu_{T+1})k_1$. They also hold for any other case in which MWP is increasing in V. Thus:

Corollary 2. *Let* MWP *be increasing in the price* V *of each cargo. Then the higher* V *is, the more likely that the galleon departs late and is overloaded, and the higher probability of shipwreck.*

Note, then, that our main results are generalizable to any case in which the merchant's maximum willingness to pay is increasing in the price V of the cargo. This includes the case when the merchants or the official are risk-averse, but can accommodate others for as long as MWP is increasing in V.

Of course, we have assumed that all merchants have the same MWP, but we show in section 6 that relaxing this assumption generates similar results.

3.5 Moral Hazard

The results reveal that there is a possibility of moral hazard on the part of the official – that is, of loading above the limits $\bar{N}, \bar{t}$. However, this only occurs for sufficiently high values of the cargo (i.e. $V > V_1$ in Proposition 2). When cargo values are low, the official loads within limits, and the equilibrium is efficient. Even though the official takes bribes – in fact, the entire surplus VT, this is a mere transfer from the merchants, and no social loss is incurred. Because there is no overloading or late departure, the probability of shipwreck is only at the normal rate $\bar{\rho}$. The loading effort of the official does not lead to higher-than-normal, 'inefficient', rates of shipwreck.

In contrast, when cargo values are high, merchants can pay bribes that are high enough to induce the official to load cargo beyond the limits, thereby raising the probability of shipwreck above the normal rate. That the official can now engage in moral hazard is due to the fact that the merchant cannot observe the loading of the cargo and, therefore, cannot know whether the ship is overloaded. In addition, the merchant does not internalize the fact that her own cargo contributes to the total load and therefore possibly increase the probability of shipwreck beyond the normal rate for all other merchants. In fact, in the following we demonstrate that if loading were perfectly observed, or when externalities were internalized, the equilibrium would be efficient. There would be no cargo loading beyond limits and, in addition, while the official still extracts the full surplus, the surplus would be smaller and, hence, the total amount of bribes would be lower.

Suppose, then, that loading is perfectly observable such that a merchant arriving at t knows whether the existing load has surpassed either of the ship's limits, $\bar{N}$ or $\bar{t}$, and by how much. Thus, a merchant at t knows the probability ρ_t that the galleon will shipwreck, and knows that if the ship official loads her cargo, her expected value is $(1-\rho_t)$V. In this case, the t^{th} merchant's maximum willingness to pay MWP is $(1-\rho_t)V$.

Now, every merchant that arrives at and before either first limit is reached, i.e. $\min(\bar{N},\bar{t})$, faces the normal probability of shipwreck $\bar{\rho}$. Meanwhile, every merchant arriving after $\min(\bar{N},\bar{t})$ faces a probability of shipwreck higher than $\bar{\rho}$. Thus, any merchant arriving at $t_{\bar{\rho}} \leq \min(\bar{N},\bar{t})$ has MWP equal to $(1-\bar{\rho})V$, while each succeeding merchant arriving thereafter, i.e. at $t_{\bar{\rho}+1}, t_{\bar{\rho}+2}, ...$ has MWP lower than $(1-\bar{\rho})V$. In fact, $(1-\bar{\rho})V > (1-\rho_{\bar{t}+1})V > (1-\rho_{\bar{t}+2})V > ...$, since the probability of shipwreck keeps increasing for every cargo loaded after $t_{\bar{\rho}}$.

We thus know that up to $t_{\bar{\rho}}$, the maximum bribe that the official can extract is $(1-\bar{\rho})V$. From Lemma 1, there will be a time period at which no merchant can afford to sufficiently compensate the official, and that is when the official requires a bribe amount more than $(1-\bar{\rho})V$. But if her required bribe is more than $(1-\bar{\rho})V$, then it is certainly more than $(1-\rho_{\bar{t}+1})V$, more than $(1-\rho_{\bar{t}+2})V$, etc. This means that it never pays for the official to wait to sail after $\bar{t}_{\bar{\rho}}$, for then no one can afford to pay her required bribe. At and before $\bar{t}_{\bar{\rho}}$, the official can keep extracting $(1-\bar{\rho})V$. Thus, $\bar{b}_1 = \bar{b}_2 = ... = \bar{b}_T = (1-\bar{\rho})V$, where $T = t_{\bar{\rho}}$.

Because the official sails at $T = t_{\bar{\rho}}$, then neither limit $\bar{N}$ nor $\bar{t}$ is surpassed. There is no overloading nor late departure, and the probability of shipwreck is at the normal level $\bar{\rho}$. Since each merchant pays $(1-\bar{\rho})V$, the official gets total bribes equal to $(1-\bar{\rho})VT$, which is the entire surplus.

The following result establishes this formally.

Proposition 4. *If all cargo loading is perfectly observable, the galleon sails on time and is not overloaded. The official extracts the full surplus,* $(1-\bar{\rho})VT$*, as total bribes.*

The same efficient equilibrium is obtained when, instead, we let merchants collude to internalize the total cost of shipwreck. To see this, note that the merchants' joint surplus is $W \equiv (1-\bar{\rho})V + V\Big((1-\rho_{\bar{t}+1}) + (1-\rho_{\bar{t}+2}) + ... + (1-\rho_T)\Big)$. Assuming that all merchants share equally in the surplus, a single merchant's maximum willingess to pay is thus $\frac{W}{T}$. Note, though, that $\frac{W}{T} \leq (1-\bar{\rho})V$ – each merchant beyond $\bar{t}$ incurs ρ greater than $\bar{\rho}$, which drags down the average payoff $\frac{W}{T}$ to less than $(1-\bar{\rho})V$. Now the official knows that if she sails when her required bribe is above $(1-\bar{\rho})V$, then no merchant can pay since any merchant is only willing to pay up to $\frac{W}{T}$. Thus, the official sails when her required bribe is already above $(1-\bar{\rho})V$, i.e. T is such that $\bar{b}_{T+1} > (1-\bar{\rho})V$. In this case, every cargo loaded is within the time limit $\bar{t}$ and capacity limit $\bar{N}$. The same equilibrium is obtained, as if loading were perfectly observable. That is:

Proposition 5. *If all merchants can collude to maximize their joint surplus, then the galleon sails on time and is not overloaded. The official gets full surplus,* $(1-\bar{\rho})VT$, *as total bribes.*

Note, then, that in the first-best (no moral hazard) equilibrium, not only is cargo loading efficient, but total bribes are also lower. This is because each merchant either perfectly knows or internalizes the cost of shipwrecks, and therefore wants to have her cargo loaded only if the probability of shipwreck is normal, i.e. at $\bar{\rho}$. The expected value of her cargo is thus $(1-\bar{\rho})V$, which means she is willing to pay bribes only up to $(1-\bar{\rho})V$, rather than V.

3.6 Adverse Selection

We have thus far assumed that merchants are identical – they each have cargo whose worth is V or, more generally, MWP. But suppose there are now two types of merchants corresponding to two different MWPs. One type has high MWP, set at V, and the other type with low MWP, set at θV, $\theta \in (0,1)$, with q the proportion of high types, and $(1-q)$ of low types, in the population of merchants N. A merchant knows his MWP, but is unable to signal this to the captain.

It can be shown that Proposition 1 still holds exactly – each merchant pays bribe amount equal to V, and the ship official sails when $\bar{b}_{T+1} > V$. Since sailing occurs when $\bar{b}_{T+1} > V$, Proposition 2 and Corollary 1 also hold exactly. This means, however, that there is adverse selection against the low-type merchants, as they cannot afford to pay V. In summary:

Proposition 6. *All the cargo of high MWP-type merchants will be loaded, while no cargo of low MWP-type merchants will be loaded. The official extracts the full surplus,* VT, *as total bribes. The higher the proportion* q *of high types, the more likely that the galleon departs late and is overloaded.*

We provide the proof here to demonstrate the intuition. From Lemma 1 we know that at some point, the bribe amount that the official would require from a merchant would not be affordable, that is, beyond the merchant's MWP. Thus, the official sets sail when $\bar{b}_{T+1} > MWP$. Consider the MWPs of a high type and a low type, respectively V and θV. We know that if the required bribe amount $\bar{b}_{T+1}$

has surpassed V, then it has surpassed θV, since $V > \theta V$. In this case, it is certain that no remaining merchant can pay the bribe, and the official should set sail. The issue is if $\bar{b}_{T+1}$ has just surpassed θV, would there be periods in which it would still be below V? That is, would there remain high MWP-types to wait for? In other words, is $\theta V < \bar{b}_{T+1} < V$ possible?

It turns out this is not possible because if at T, the high MWP types have not yet been exhausted, then there is at least one merchant that can afford V which allows the official to extract V. Thus, $\bar{b}_T = V$. But this means (from Lemma 1), that in the next period, the required bribe to induce the captain to load one more cargo is now unaffordable by anyone, i.e. $\bar{b}_{T+1} > V$. (If it was just affordable at T, it will be unaffordable at $T + 1$.)

Now if the official can extract V at T, i.e. there is at least one high MWP type at the last period T, then it can extract V at $T - 1, T - 2, ...$ since there will certainly be high MWP types in the earlier periods. Thus, in equilibrium, the official extracts V as bribe from each merchant, and sets sail when $\bar{b}_{T+1} > V$, exactly as in Proposition 1. This implies that the official is able to wait for all the merchants who can pay V, which means all the high MWP types are exhausted.

Note that the official does not need to know the number of high MWP types, or whether there are still some of them that remain at each period. Because he knows there are merchants that can afford V, he keeps asking for V until V is no longer enough compensation for him to wait for the next cargo. Note, then, that because merchants competitively bid for cargo space, their types are revealed. Those who can pay V can outbid those who can only pay θV, and the cargo of the high MWP types get loaded first. But after they are all loaded, no other cargo is worth waiting for, as no other merchant can do better than paying bribe V. Obviously, this occurs slower when there are many high type merchants. Thus, when q is large, the total number of cargo is high, which makes it more likely to surpass the limits $\bar{N}$ and $\bar{t}$.

Thus, with heterogenous merchants, adverse selection always occurs. Moral hazard may also occur, that is, when the number of high-MWP merchants is sufficiently high.

4 Empirical Tests

We have formally established the existence of an inefficient ship cargo-loading equilibrium, the outcome of which is a probability of shipwreck that is higher than normal. Proposition 2 establishes that this is more likely to occur when the value of the cargo is high, since this induces the ship official to undertake too much loading. In equilibrium, either the physical capacity of the ship is surpassed, or the departure of the ship is delayed, or both.

In turn, these results suggest that the Manila Galleon trade was inefficient, since the goods traded and loaded on to the galleon would have been very valuable. No ship other than the galleon was allowed to transport goods from Asia to Europe and the Americas and, in addition, the number of galleons that could travel in a given year was restricted. Because the trade was monopolistic, and there was large demand for the goods, prices were kept high.

Proposition 2 and Corollary 1 imply that for sufficiently high cargo values, the galleon departs late and faces a higher probability of shipwreck. Thus, one can show that the Manila Galleon trade was inefficient by empirically demonstrating that, conditional on controlling for the ordinary causes of shipwrecks, late departures were systematically related to the probability of shipwreck. The counterfactual is that, absent this relationship, shipwreck rates would have been at some normal rate and, therefore, trade would have been efficient.

We discuss our data and identification strategy below.

4.1 Data and Identification Strategy

We combine several unique datasets which provide us with detailed information about every voyage made between the Philippines and Mexico during the era of the Manila galleon trade. Our main source is Manila Galleon Listing (Cruikshank, 2013). We supplement this with information from the Spanish language website, La América española and from Three Decks, a prominent web resource for researching naval history during the Age of Sail.[26]

From these sources, we assemble a database that includes the universe of ships that sailed on the Manila–Acapulco route and the Acapulco–Manila route during the entire period between 1564-1815. For every voyage that each ship made to Manila and to Acapulco, we have information on the dates of departure and arrival. This allows us to construct two panel datasets that include both ship fixed effects and voyage fixed effects — one for all Manila–Acapulco voyages which comprise our main sample, and another for all Acapulco–Manila voyages which we use as a placebo sample. Ship fixed effects capture unobserved ship specific characteristics. Voyage fixed effects allow us to exploit within variation for ships on their first, second, third, (. . . etc.) voyage.[27]

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[26] These sources are in turn compiled from a host of other sources that we list, contrast, and discuss in Appendix 4.

[27] Since we know the year when the ship made its first voyage, we can also estimate the age of the ship (in years), and control for it in specifications that exclude ship fixed effects. We also report results that include year fixed effects. However, when we do this we lose many observations since usually there was only one Manila–Acapulco voyage and one Acapulco–Manila voyage per year (especially after 1650). We also try specifications with 50–year and century fixed effects, as well as those that omit ship and voyage fixed effects.

We know whether the ship safely arrived at its destination, or if it was lost at sea or heavily damaged and returned to port (*arribada*). The majority of shipwrecks occurred within the Philippine peninsular as that was the most dangerous part of the route. As such in the majority of cases, the ship could be retrieved—often with severe damage and loss of cargo and crew—so we do not distinguish between ships that were shipwrecked and returned to port and those that were entirely lost at sea. All these we treat as failed voyages. We then construct a binary variable, Failed Voyage, as our dependent variable.

For our independent variable of interest, we construct indicators for whether a ship departed late. By royal edicts, the departure deadline for the Manila–Acapulco voyage was initially set to June 30, and later extended to early July since almost no ship could make the June 30 deadline. As discussed in section 2, the deadlines were imposed so that the ships would depart Manila well before the monsoon season. The worst part of the season actually begins in mid–July, and for this reason, we use a July 15 cut-off for our main results. In the Appendix we also use different cut-off dates, both earlier and later than July 15, as well as adopt a continuous measure of lateness by using the exact day in the year on which the ship sets sail.[28]

Overall 1/5 or 20% of voyages failed. This can be decomposed into the proportion of departures that failed that left on time and the proportion of departures that failed that left late. 17% of on-time departures resulted in a failed voyage. 22.5% of late departures resulted in a failed voyage.

We control for a host of covariates, which together determine the normal probability of shipwreck. An important control is the sea temperature of the Pacific. Sea temperature is a major determinant of the risk of a tropical storm as when the water is warm it is more likely to evaporate raising the chances of a storm. We make use of reconstructed temperature data in Western and Eastern Pacific from Tierney et al. (2015). Data quality is always an issue in historical papers. Reconstructed climatic data is widely used by empirical social scientists and are viewed as highly credible (Anderson et al., 2017; Waldinger, 2022).

Storms and weather conditions are harder to measure prior to the 20th century. To capture the presence of storms and typhoons we leverage two separate types of data: (i) data on presence of typhoons from Garcia-Herrera et al. (2007) and supplemented by Warren (2012); (ii) whether or not a storm is mentioned in the ship logs collated by Cruikshank (2013). The former was originally collected by the Spanish Jesuit Miguel Selga in the early 20th century and is a reliable source for the presence of typhoons in the vicinity of the Philippine archipelago. The second source of data relies on the ship

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[28] We also have information on the difference in days between the departure of the ship and the arrival—to the departing port—of the previous ship, which we use to control for alternative explanations offered by Schurz (1939)

logs of the galleons themselves. While this means that it is a highly credible and direct source, we are cautious about interpreting the coefficient on this variable as it is likely to be upwards biased (storms that did not cause the voyage to fail may have been less likely to be recorded).

We also collect data on other threats mentioned in Cruikshank (2013) including pirates, buccaneers, and the English, French, or Dutch. We use Wikipedia to construct measures of conflicts involving the Spanish empire—specifically, we account for conflicts with England, the Dutch Republic, other Southeast Asian societies, and within the Philippines.

Another set of possible confounders are the characteristics of the ship captain. In particular, we would be concerned if captains who were more likely to be shipwrecked were also more likely to leave late for other reasons. Fortunately, this is not a major concern in this setting as the decision to set sail was made by the governor in collusion with other officials rather than the captain in isolation.[29] Nevertheless, the competency of the ship captain and crew is mentioned by some historians as a potential explanation for shipwrecks, since compared to service in the Atlantic, the voyage between Manila and Acapulco was more dangerous and arduous.[30]

Thus, to proxy for the competency of captains, we construct a novel dataset of ship captains. We code a captain as experienced if he satisfies either of the following criteria: (i) he is mentioned as experienced or highly able in either Schurz (1939) or other sources (see Appendix B); (ii) he has previously made more than one trip across the Pacific. For robustness, we also include proxies for other factors that could have influenced the selection of the captain, including the identity of the governor of the Philippines at the time, the identity of the viceroy, and the identity of the king of Spain.

We also consider other variables mentioned in the historical literature that might have affected the departure dates of the Manila–Acapulco galleons. Yuste (2007, 33) mentions two alternate hypotheses: (i) the Chinese-Philippine trade was erratic and created uncertainty about the source of goods that would have to be transported in the Galleon towards Mexico; ii) Merchants lacked sufficient funds to embark into the Pacific trade, and had to borrow from pious foundations to do so, a procedure that was slow.[31] To address the first issue, we draw from the information available in Chaunu (1960) to construct a rich set of variables that measure the buoyancy of trade with China, Japan, and other parts

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[29] Schurz (1939, 252): "Those governors who, like Salcedo, who in spite of these obstacles, always sent out the galleons on time were held in high esteem in the islands".

[30] For example, Schurz (1939, 257) writes: "[t]he incompetence of officers and seamen played its part, too, in the disasters of the line. Pilots were sometimes ignorant of the very essential of their craft and all to little acquainted with the difficult course which the galleons had to follow".

[31] Religious corporations were the principal credit source in the Hispanic world. In Manila, they became specialized in investing in maritime trade loans. See Yuste (2004); Mesquida (2019)

of Asia, which could have affected the volume of goods to be transported to Acapulco and, hence, the time it took to load them on to the galleon. To address the second issue, we control for the arrival of the Acapulco–Manila galleon that carried silver payment for the previous batch of cargo, which would have contributed to the settlement of payments and debts in Manila. Alternatively, we also control for other potential issues such as idiosyncratic affairs by including the identity of the governor, and the presence of pirates and periods of war and conflict.

Lastly, we replicate all our analyses using our placebo sample of all voyages from Acapulco to Manila. The cargo from these voyages consisted mainly of silver, as payment for the goods transported from Manila to Acapulco, and therefore did not provide the same incentives to overload and depart late. Of course, the Acapulco–Manila route was less perilous than the Manila–Acapulco one. It is thus no surprise that shipwrecks were less common for ships that departed from Acapulco — see Figure A.2.[32] However, what is important is whether there is a relationship between late departures and failed voyages, and we find no evidence of this using the placebo sample.

Appendix 4 (Data Appendix) lists all the variables used in this paper, along with details of how they were constructed, and all sources of data. Appendix Tables A.2 and A.3 provide summary statistics for the journey between Manila and Acapulco and Acapulco and Manila, respectively.

4.2 Late Departures and Failed Voyages

We run regressions based on the following specification:

$$\text{Failed Voyage}_{i,v} = \alpha + \beta_1 \text{Late}_{i,v} + \mathbf{X}_{i,v}\gamma + \Lambda_i + \Gamma_v + \epsilon_{i,v} \tag{6}$$

where Failed Voyage$_i$ refers to a ship i wrecked or returned to port (*arribada*) during voyage v. Λ_i are ship fixed effects and Γ_v are voyage fixed effects. The coefficient of interest is β_1. Standard errors are clustered at the ship level in our benchmark specifications; Appendix Table A.21 reports over clustering approaching. All specifications include ship fixed effects and voyage fixed effects.[33] The vector $\mathbf{X}_{i,v}$ includes controls for typhoons, the average temperature in the Western and the Eastern Pacific, storms, the age of the ship, and whether the captain was experienced.

We first use our panel data of all Manila–Acapulco voyages. The binscatter plot in Figure 3 illustrates a positive bivariate relationship between a late departure and the probability of a failed voyage.

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[32] The figures also shows there are no visible time trends in the data. We confirm stationarity and the absence of unit roots in Appendix F.

[33] Regressions reported in Table A.5 include year fixed effects, but use far fewer observations as there is usually just one Manila–Acapulco, and one Acapulco–Manila, voyage in any given year. In Table A.16, we include 50–year and century fixed effects. For completeness, we also report results without ship and voyage fixed effects in Table A.9.

Table 1: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.232^{***}	0.228^{***}	0.236^{***}	0.240^{***}	0.237^{***}	0.238^{***}
	(0.0825)	(0.0829)	(0.0751)	(0.0747)	(0.0731)	(0.0744)
Typhoon		0.0351	-0.00380	-0.00260	-0.00439	0.000463
		(0.0734)	(0.0706)	(0.0714)	(0.0713)	(0.0729)
Storm			0.319^{***}	0.313^{***}	0.322^{***}	0.322^{***}
			(0.0986)	(0.101)	(0.0991)	(0.0988)
Western Pacific Temperature				-0.0358	-0.0666	-0.0615
				(0.206)	(0.203)	(0.205)
Eastern Pacific Temperature				-0.0766	-0.0543	-0.0522
				(0.0829)	(0.0802)	(0.0808)
Years passed since first voyage					0.0557^{*}	0.0551^{*}
					(0.0298)	(0.0301)
Experienced Captain						-0.0331
						(0.0639)
Constant	0.0506	0.0477	-0.00556	-0.000398	-0.0172	-0.00996
	(0.0670)	(0.0680)	(0.0634)	(0.0697)	(0.0663)	(0.0678)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	250	250	250	250
Adjusted R^2	0.034	0.031	0.112	0.110	0.134	0.131

This table establishes a positive relationship between late departures from Manila and failed voyages. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1 reports results from estimating (1) by OLS — a linear probability model.[34] We first report, in column 1, the bivariate relationship between a late departure and whether a ship was wrecked or returned to port. Next, we include controls for the presence of typhoons (column 2) and then control for the mention of a storm in the ship records (column 3). In column (4) we also control for temperature in the western and eastern Pacific. Column 4 is our benchmark specification. The coefficient of interest remains comparable across specifications and remains similarly robust when we sequentially include controls for the number of years since the ship's first voyage and the experience of the captain (columns (5) and (6)). The number of years since the ship's first voyage is a proxy for the age of ship and for whether or not the ship's condition has deteriorated over time, making shipwreck more likely. We explore this in more detail in Appendix A.3a. This last covariate is important as one concern is that less competent or inexperienced captains may have also sailed later. We discuss this more below.

In our benchmark analysis, we report results using ship fixed effects and voyage fixed effects. We report results without either ship or voyage fixed effects in Appendix Table A.9.[35] An alternative

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[34] To account for possible serial correlation across voyages, in Appendix F we perform several exercises to rule out the presence of time trends, unit roots, and serial autocorrelation in our variables of interest.

[35] When omitting ship fixed effects, we can test whether ship size was responsible for shipwrecks at least on the

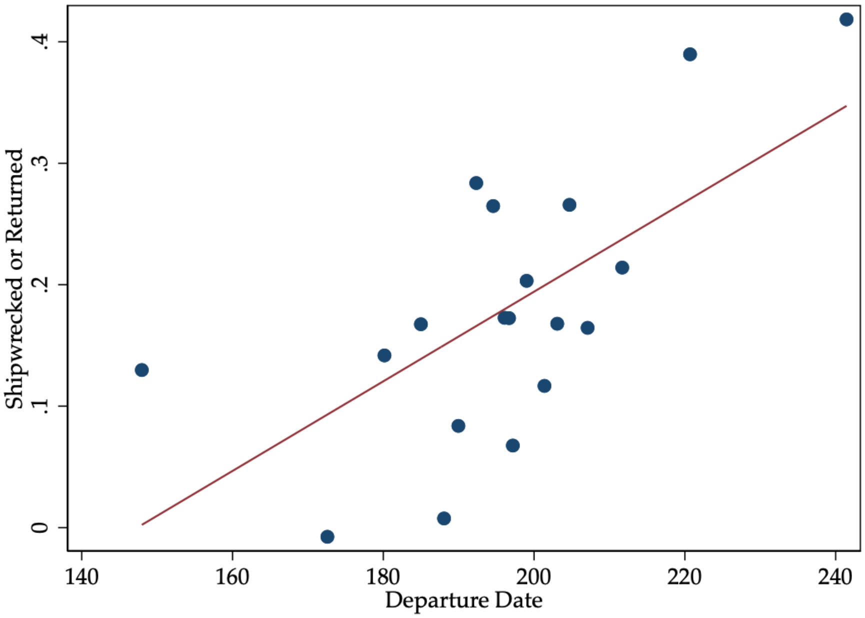

Figure 3: A binscatter plot of the relationship between departure date and a failed voyage. Controls include the presence of a storm, pirate threats, typhoons, temperature in the Eastern and Western Pacific and captain experience, and ship and voyage fixed effects.

empirical specification is to use ship fixed effects and year fixed effects (Appendix Table A.5). We obtain comparable results. The effect of the coefficient on late actually increases to around 0.5. However, we lose many observations since there were many years when only one ship left Manila and we are unable to include covariates that are perfectly collinear with year such as the weather and the number of typhoons.[36] We report alternative specifications in the Empirical Appendix including those using departure date as our explanatory variable (Appendix Table A.4), different approaches to clustering our standard errors (Appendix Table A.21), and using an inverse probability weighting model (Appendix Table A.6.

Another possible concern is that ships which previously experienced shipwrecks or returns may have been more likely to subsequently experience a failed voyage. In particular, previously damaged ships may have been both more likely to experience shipwrecks and more likely to sail late due to the need for repairs. We find no evidence of such a relationship. Nonetheless, to further address this concern, in

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Manila–Acapulco route, as Rei (2011, 128) makes this argument in comparing Portuguese and Dutch ships during the 16th and 17th centuries. Appendix Table A.18 establishes that there is no relationship between the size of the ship and the probability of a shipwreck using either the average size of the ship or the median size of the ship.

[36] We report results from estimating (1) by logit and probit in Appendix Tables A.7 and A.8. These are consistent with what we obtain using a linear probability model and we prefer the latter for ease of interpretation.

Appendix Table A.10 we report results just for ships making their first voyages (columns (1)-(2). We also show that our results hold when we exclude all ships that had previously failed a voyage (columns (5)-(6). In both cases, we obtain very similar results.

Thus far we have presented results where we sequentially introduce relevant covariates. To address potential concerns about covariate selection, we also also follow Urminsky et al. (2016) and estimate a double lasso. This alternative approach provides a statistical means of selecting variables for inclusion. It proceeds by first identifying variables that predict the dependent variable and then separately identifying those that predict the independent variable. The second step is important, because exclusion of a covariate that is a modest predictor of the dependent variable but a strong predictor of the independent variable can also generate omitted variable bias. The results of this double lasso are reported in Table A.14. *Late* departure remains a strong predictor of a failed voyage and the magnitude of the coefficient on *Late* is comparable to what we obtain in our baseline regressions.

Taken together, these exercises suggest that our main findings are robust to the inclusion of an exhaustive array of available covariates. Nonetheless, as omitted variable bias is always a potential concern in non-experimental settings, in Table 2 we employ the approach suggested by Cinelli et al. (2020).[37]

Specifically, we take the coefficient from column (6) of Table 1 and we ask how strong confounding would have to be to overturn our results. To do this we use the software developed by Cinelli et al. (2020). A robustness value (RV) of 24% means that if confounding explains less than 24% of the residual variation in the treatment (Late) and less than 24% of the variation in the residual variance in the outcome (shipwrecked), then it cannot be large enough to overturn the treatment effect. An $RV_{\alpha=0.05}$ of 11% states that confounding would have to explain more than 11% of the residual variation in both Late and Shipwrecked in order to render our estimates insignificant at the 5% level. These results suggest that it is unlikely that there are unobservable variables that have sufficient explanatory power to reduce the coefficient on Late meaningfully.

In contrast, when we examine the voyages from Acapulco to Manila we find no relationship between a late departure from Acapulco and a failed voyage even with the least restrictive bivariate specification (Table 3, column (1)). This is consistent with our expectations since these voyages only carried silver as payment for the goods from Asia, and there is no incentive to load more silver than necessary.

The effects we find are not simply the effects of sailing later generically. Rather they are explicitly

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[37] This approach is similar in spirit to that suggested by Altonji et al. (2005) and Oster (2019). We also implement Oster's approach as a further robustness check in Appendix Table A.22.

Table 2: Sensitivity Analysis Following Cinelli and Hazlett (2020)

Outcome: Failed Voyage						
Treatment	Estimate	SE	t Value	$R^2_{Y\approx D\mid\mathbf{X}}$	RV	$RV_{\alpha=0.05}$
Late	0.2385	0.0717	3.3246	7%	24 %	11 %
$df = 146$, Bound(Z as strong as Storm): $R^2_{Y\approx D\mid\mathbf{X}} = 10\%$, $R^2_{Y\approx Z\mid\mathbf{X}} = 0.09\%$						

This table reports formal sensitivity analysis following Cinelli et al. (2020).

the effects of sailing past the deadline. Indeed we find that departure date has no relationship between the probability of a failed voyage for ships that left on-time (Appendix Table A.24). Moreover, among those ships who sailed late, every additional delay was associated with a greater probability of failure (Appendix Table A.25).

Finally, we control for other factors that historians have deemed relevant.

Governor discretion Due to the sheer distance from Spain, McCarthy (1993) likened the discretionary power of the governor of the Philippines to that of a king. Among the most important areas of discretion was the governor's right to choose the captain of the galleon. This discretionary power may be relevant if some types of governors systematically appointed incompetent captains, as this would increase both the likelihood of not meeting the departure deadline and of a failed voyage.

In our baseline analysis (Table 1) we control directly for captain experience. Nonetheless, to address concerns that some governors might have chosen less competent captains, we exploit variation in the type of governor. When the governor died, months or longer could go by before a new one was appointed by the King of Spain because of the vast distances involved and the slow speed of communications. An interim governor was then selected by the royal audiencia (the interim governor). However, this process also took some time, so while deliberations were being made, a senior member of the royal audiencia automatically became de facto governor (the audiencia governor). Thus, we can distinguish whether the governor was appointed by the King, or an interim governor, or an audiencia governor. When we estimate a lasso with *Late* as the dependent variable, we do not find that ships sailed later periods when the governor was either an interim governor or appointed by the audiencia (Appendix Table A.14). In Appendix Table A.17 we find no differences by the type of governor; across specifications the estimated coefficient on *Late* remains unchanged.

It is important to note that allegations of corrupt governors appointing corrupt captains would not bias the effect of late departure on failed voyage since, precisely in our model, a late departure is associated with bribe-taking. The fact that adding the type of governor as control does not change the point estimates of *Late* supports the qualitative evidence presented by historians that corruption was endemic rather than specific to any one governor.[38]

Determinants according to Schurz Schurz (1939, 252) lists three possible explanations for why the galleon sails late: (i) "[t]he necessity for awaiting the return of the Acapulco galleon, with the proceeds of the previous years' sale"; (ii) the possible threat of pirates or Dutch, English, or French ships; and (iii) delays or issues with the arrival of Chinese ships in Manila. Governor Basco y Vargas reported this as the reason for the late departure in 1783 (Schurz, 1939, 251).[39]

We employ several proxies for these factors that Schurz hypothesizes to be important determinants of whether the galleon sails late from Manila (see below). In Appendix Table A.15, we show that with one exception, none of these proxies are significantly correlated with our measure of late departure.[40] Nevertheless, for good measure, we verify whether the exclusion of these factors — the late arrival of the Acapulco galleon, the threat of pirates or Dutch, English, or French ships, and the arrival of goods from China and Asia, could have biased our estimated coefficients of *Late*.

(i) Late arrivals. To account for the late arrival of the galleon from Acapulco, we construct a measure based on information in Cruikshank (2013) and other sources, and add it as a control variable (*Arrival Date*).[41]

We report results in Table 4. The estimated coefficient on arrival date is negative and precisely estimated. This is contrary to expectations. If Schurz's hypothesis were correct, i.e. that a late departure of a Manila–Acapulco galleon is due to the late arrival of the Acapulco–Manila galleon, then a late arrival would have a non-negative effect on the probability of a failed voyage. Indeed, we find that late arrivals are not associated with late departures (Appendix Table A.14). Moreover, in all specifications, the estimated coefficients on *Late* remain largely unchanged. Thus, while we cannot rule out the possibility that the arrival date of the Acapulco–Manila galleon has an independent effect on the probability of a

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[38] Schurz (1939, 185) notes that the officials sent to govern the Philippines were "for the most part very fallible men. They were either too venal to resist the advantage of an interested collusion in the violation of the laws or powerless to withstand the unanimous sentiment of the community they governed".

[39] As summarized by McCarthy (1993, 169): "Logistically, it was a challenge to dispatch the galleons on schedule. Goods arriving from China had to purchased and allocated among the Spaniards. This process was complicated by the occasional lateness or non-arrival of the sampans (small Chinese boats)".

[40] The presence of conflicts with England and the total number of conflicts appear to be positively correlated with late departures.

[41] One could think of the arrival date of the galleon from Acapulco as providing a source of exogenous variation in the departure date of the galleon from Manila. However, our interest is in the endogenous component of late departure — why officials willingly allowed the galleon to depart late, and so we do not pursue an instrumental variable strategy. See discussion in 3.1.

Table 3: Acapulco to Manila: No Relationship Between Late Departure and a Failed Voyage

	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.119	0.0937	0.0975	0.0808	0.0803	0.0803
	(0.0962)	(0.0977)	(0.0995)	(0.102)	(0.102)	(0.106)
Typhoon		0.159	0.169	0.182	0.181	0.185
		(0.115)	(0.114)	(0.112)	(0.112)	(0.114)
Storm			-0.0520	-0.0573	-0.0546	-0.0548
			(0.0812)	(0.0818)	(0.0809)	(0.0808)
Western Pacific Temperature				-0.274**	-0.263**	-0.272**
				(0.129)	(0.126)	(0.132)
Eastern Pacific Temperature				-0.0459	-0.0454	-0.0456
				(0.0495)	(0.0488)	(0.0487)
Years passed since first voyage					0.00595	0.00533
					(0.0121)	(0.0122)
Experienced Captain						0.0264
						(0.0741)
Constant	-0.0368	-0.0266	-0.0348	-0.0565	-0.0530	-0.0619
	(0.0649)	(0.0563)	(0.0508)	(0.0618)	(0.0653)	(0.0677)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	196	196	196	196	196	196
Adjusted R^2	0.067	0.109	0.110	0.119	0.116	0.113

This table demonstrates that there is no relationship between late departures from Acapulco and failed voyages. The controls are the same as in Table 1. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

failed voyage, it does not reduce the explanatory power of a late departure.

(ii). Conflicts & Pirates. Pirates and privateers (particularly English and Dutch privateers) frequently targeted the Manila Galleons, as these ships were seen as the greatest prize on the ocean (see Gerhard, 1960; Lane, 2016). It might be reasonable to suppose that galleon officials would delay departure of the galleon in order to avoid such threats, but would this have also affected the probability of a failed voyage? The presence of pirates or the ships of rival naval powers is mentioned by Cruikshank (2013). This allows us to control for when the Manila Galleon was threatened by pirates, privateers or the vessels of an enemy power. We also collect information on whether Spain was at war, specifically if there was a battle or conflict with England and Netherlands as Spain was at war frequently during the 16th, 17th, and 18th centuries.

Pirates are not in general associated with late departures. But we do find some evidence that overall conflicts and particularly conflicts with England were associated with later departures (Appendix Table A.14). In Table 5 we introduce controls for the presence of pirates and privateers (column 1). Next we control for conflicts in Southeast Asia (column 2). Third, we control for conflicts with England

Table 4: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage Controlling for Arrival Date

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.222**	0.218**	0.227***	0.233***	0.231***	0.231***
	(0.0857)	(0.0870)	(0.0770)	(0.0767)	(0.0747)	(0.0757)
Arrival Date	-0.000805***	-0.000802***	-0.000800***	-0.000826***	-0.000754***	-0.000749***
	(0.000231)	(0.000234)	(0.000216)	(0.000222)	(0.000214)	(0.000216)
Typhoon		0.0296	-0.00924	-0.0110	-0.0118	-0.00879
		(0.0710)	(0.0675)	(0.0686)	(0.0689)	(0.0705)
Storm			0.319***	0.315***	0.322***	0.322***
			(0.0936)	(0.0959)	(0.0942)	(0.0941)
Western Pacific Temperature				0.0638	0.0296	0.0320
				(0.224)	(0.216)	(0.219)
Eastern Pacific Temperature				-0.0870	-0.0676	-0.0663
				(0.0836)	(0.0805)	(0.0815)
Years passed since first voyage					0.0461	0.0458
					(0.0304)	(0.0308)
Experienced Captain						-0.0200
						(0.0674)
Constant	0.105	0.102	0.0489	0.0812	0.0602	0.0640
	(0.0712)	(0.0719)	(0.0668)	(0.0732)	(0.0682)	(0.0690)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyages FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	250	250	250	250
Adjusted R^2	0.077	0.074	0.155	0.155	0.170	0.167

This table shows that the relationship between a late departure from Manila and a failed voyage is unaffected by including the date of arrival of the previous ship. The controls are the same as in Table 1. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(column 3) as English captains frequently targeted, and on occasion captured, Manila galleons. Fourth, we control for the conflict with the Dutch Republic—Spain's perennial enemy during the 16th and 17th centuries. Finally we control for both conflicts within the Philippines (column 5) and then all conflicts (column 6). Only the latter is positively related with failed voyages. More importantly, the point estimates for *Late* remain largely unchanged.

(ii). Trade with China and Asia. Any delay in the arrival of Chinese and other merchants to Manila might have affected the departure date of the galleon, as it is the goods bought from these merchants that were loaded onto the galleon. Data on the arrival data of these merchants does not exist. Nonetheless, it is possible to use available data as, albeit imperfect, proxies. Specifically, the greater the number of ships from China, the larger the possible delays involved in loading the galleons. All else equal, a larger volume of cargo would have taken longer to load and could thus have made late departures more likely. In Table 6 we use data from Chaunu (1960) to control for the trade with Chinese and other merchants who brought their goods from China and elsewhere across East Asia to sell in

Table 5: Manila to Acapulco: Late Departure and a Failed Voyage Controlling for Pirates and War

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.241***	0.241***	0.234***	0.235***	0.240***	0.219***
	(0.0750)	(0.0755)	(0.0790)	(0.0737)	(0.0731)	(0.0755)
Storm	0.313***	0.309***	0.310***	0.316***	0.314***	0.303***
	(0.101)	(0.101)	(0.101)	(0.102)	(0.100)	(0.1000)
Typhoon	-0.00282	0.00446	-0.00770	-0.0130	0.00298	-0.0108
	(0.0719)	(0.0692)	(0.0717)	(0.0717)	(0.0696)	(0.0723)
Western Pacific Temperature	-0.0338	-0.0210	-0.0529	-0.0570	-0.0622	-0.0788
	(0.210)	(0.205)	(0.204)	(0.206)	(0.212)	(0.194)
Eastern Pacific Temperature	-0.0770	-0.0695	-0.0794	-0.0861	-0.0761	-0.0815
	(0.0828)	(0.0818)	(0.0834)	(0.0842)	(0.0818)	(0.0829)
Pirates or Buccaneers	-0.0125					
	(0.0984)					
Sea Conflicts		0.0428				
		(0.0646)				
Conflicts with England			0.0427			
			(0.0768)			
Conflicts with Dutch				0.121		
				(0.0999)		
Conflicts in the Philippines					0.0831	
					(0.0871)	
Total Conflicts						0.116*
						(0.0695)
Constant	0.000693	-0.0109	-0.0109	-0.0283	-0.0195	-0.0671
	(0.0697)	(0.0711)	(0.0715)	(0.0726)	(0.0740)	(0.0768)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	250	250	250	250
Adjusted R^2	0.106	0.108	0.108	0.114	0.110	0.124

This table shows that the relationship between late departure from Manila and a failed voyage is unaffected by controlling for pirates and other war-related threats. The other control variables are the same as in Table 1. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Manila. Specifically, we include variables that capture the total number of ships arriving (columns 1-2) and the number of ships from China (column 3-4). Finally, we include information on the assessed tax value of the goods either from China (column 5) or in total (column 6).

As this data is not available for the entire period of analysis, our number of observations shrinks accordingly. Nonetheless, in all specifications, the estimated coefficient on *Late* remains positive. None of the estimated coefficients of the proxies for the volume of goods are statistically significant.

4.3 Mechanism

We provide additional evidence for inefficient cargo loading by testing the mechanism that generates it. First, the model shows that loading is done in exchange for bribes, and that greater loads are associated with larger bribes. If this is true, then if the official is somehow prevented from taking bribes, there is

Table 6: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage Controlling for the Volume of Asian Trade

	Shipwrecked or Returned to Port				
	(1)	(2)	(3)	(4)	(5)
Late	0.148*	0.169**	0.145*	0.176**	0.172*
	(0.0869)	(0.0831)	(0.0865)	(0.0871)	(0.0875)
Storm	0.263**	0.261**	0.236**	0.289***	0.286***
	(0.118)	(0.113)	(0.110)	(0.105)	(0.107)
Typhoon	0.0599	0.0368	0.0590	-0.0108	-0.0161
	(0.0731)	(0.0783)	(0.0754)	(0.0792)	(0.0781)
Western Pacific Temperature	0.245	0.264	0.293	-0.0997	-0.130
	(0.243)	(0.256)	(0.239)	(0.258)	(0.255)
Eastern Pacific Temperature	-0.0827	-0.0857	-0.0744	-0.100	-0.104
	(0.114)	(0.113)	(0.113)	(0.0899)	(0.0911)
Ships Total	-0.00740				
	(0.00480)				
> Mean N. Ships		-0.136			
		(0.0828)			
Chinese Ships			-0.00632		
			(0.00549)		
Tax Value Chinese Ships				-0.00000499	
				(0.00000604)	
Tax Value Total					-0.00000632
					(0.00000434)
Constant	0.227*	0.133	0.181	0.0819	0.135
	(0.123)	(0.0951)	(0.114)	(0.120)	(0.121)
Ship FE	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes
Observations	174	174	172	197	197
Adjusted R^2	0.126	0.122	0.109	0.114	0.125

This table shows that the relationship between a late departure from Manila and a failed voyage is unaffected by including the date of arrival of the previous ship. The controls are the same as in Table 1. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

less incentive from loading, and the likelihood of inefficient loading is smaller. We thus examine periods during which there was greater oversight and, hence, opportunities for bribe-taking were limited. Schurz (1939) describes these periods.

We have shown that the Crown was aware of the problem of bribe-taking leading to overloading and late departures. How could the Crown limit this? The only way the Crown could attempt to limit corruption was through an extraordinary inspection known as a *visita.* The *visitador* was directly responsible to the king and hence could overrule local officials. The most famous *visitador* was Pedro de Quiroga y Moya who was sent to investigate corruption and bribe-taking in the port of Manila (1635-1640) (Schurz, 1939, 187-188).[42] Another period where there was comparatively more oversight

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[42] Schurz (1939, 188) notes that following the end of Quiroga's inspection period "commerce gradually resumed the comparative serenity and laxity that had prevailed before the incorruptible Quiroga's harsh irruption into its sphere".

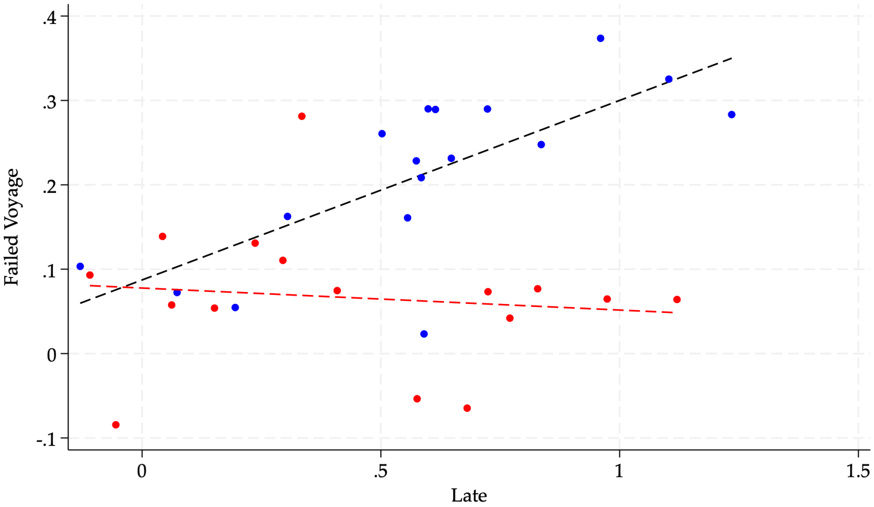

Figure 4: The relationship between late and failed voyage by periods of oversight. This figure overlays two binscatters: (black/blue for periods when there was no heightened oversight; red for periods when there was heightened oversight; we use 20 bins). We include controls for temperature, storms, typhoons, captain experience, and age of ship.

of the loading of the gallons was during the governorship of Campo y Coiso and Valdes who assigned two independent overseers to monitor the loading of the ships (Schurz, 1939, 181). This policy was suspended because of opposition from the merchants of Manila.

We first show that periods of oversight were associated with fewer late departures (Appendix Figure A.4). Next, we split the sample according to whether or not there was more oversight according to Schurz (1939). We find suggestive evidence that during these years of heightened oversight, the relationship between late departures and failed voyages is much weaker. We visualize this in Figure 4.

As further evidence of the mechanism underlying inefficient cargo-loading, we test two other predictions that emanate from Proposition 2. First, we show that ships that are both physically overloaded and sail late are more likely to be shipwrecked than those that are late but not overloaded. We do not have data on the amount of cargo loaded, but we can proxy for whether or not the physical capacity of the ship is surpassed by comparing low and high-tonnage ships. Given the same departure time and, thus, the same amount of time to load cargo, a low-tonnage ship is more likely to load beyond its physical capacity than a high-tonnage ship. Thus, a low-tonnage ship that is late is also more likely to be physically overloaded. Since, in the case of low-tonnage ships, a late departure is correlated with physical overloading, we can expect a stronger positive relationship between a late departure and a failed voyage.

A second prediction is that the higher the value of the cargo, the stronger the relationship between

Table 7: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Testing the Model

	Shipwrecked or Returned to Port			
	Low Tonnage (1)	High Tonnage (2)	Prior Trip = 1 (3)	Prior Trip = 1 (4)
Late	0.306**	0.177	0.433*	0.249**
	(0.149)	(0.106)	(0.224)	(0.0949)
Hausman Test for Equality of Coefficients (p values)	0.0000		0.0000	
Constant	-0.0749	0.174**	0.0391	0.102
	(0.119)	(0.0822)	(0.199)	(0.0735)
Ship FE	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes
Observations	121	129	54	196
Adjusted R^2	0.162	0.042	0.445	0.079
	Higher Silver Flows (5)	Lower Silver Flows (6)	Before 1640 (7)	After 1640 (8)
Late	0.300**	0.158	0.0880	0.235***
	(0.129)	(0.114)	(0.125)	(0.0881)
Hausman Test for Equality of Coefficients (p values)	0.000		0.000	
Constant	-0.0391	0.101	-0.00934	0.0960
	(0.124)	(0.0850)	(0.144)	(0.0685)
Ship FE	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes
Observations	97	153	45	205
Adjusted R^2	0.114	0.101	0.156	0.035

This table split the sample based on periods for which our model predicts the relationship between late departures and failed voyages should be stronger. Columns (1)-(2) compare low to high tonnage vessels. Columns (3)-(4) compare voyages that followed on years where there had been no successful voyage. Columns (5)-(6) compares periods when silver production was high relative to when it was low. Columns (7)-(8) compares the period after 1640 to the period before. For each comparison we estimate a seemingly unrelated regression (SUR) estimator and report the corresponding p values rejecting the equality of coefficients across specifications. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

a late departure and a failed voyage. Moreover, this should be even stronger for ships that sailed late that were also physically overloaded. To test this, we construct several proxies for the value of the cargo. One of these proxies makes use of the fact that the value of the cargo was especially high in the year *following* a failed voyage. From the historical literature, we know that a failed voyage was an economic disaster for the merchants and citizens of Manila (e.g. McCarthy, 1993, 182). The value of cargo in the next voyage would be higher (both due to a desire to recoup previous loses and because the marginal value of Asian goods in Mexico and Europe would be higher). We therefore expect that in the year following a failed voyage (or if there was no voyage for some other reason), the relationship between sailing late and a failed voyage would be stronger.

By tonnage To test the first prediction, we split the sample into ships with estimated high and low tonnage based on whether they are above or below the mean tonnage of all ships in our sample. The resulting two samples that we obtain are balanced on other characteristics (see Appendix Figures A.6 and A.8. Importantly, low–tonnage ships were no more likely than high–tonnage ones to experience shipwrecks or returned voyages (Appendix Figure A.5). Next, in Table 7, columns (1)-(2) we look at how tonnage affects the relationship between late and failed voyages. We find a much larger coefficient on *Late* for the low–tonnage sample compared to the high–tonnage. To test for whether the coefficients are statistically distinct from one another we take a seemingly unrelated (SUR) estimation approach. Using the standard Hausman test for cross-model hypotheses, we always reject the null that the two coefficients are statistically indistinguishable.

By value To test the second prediction, we conduct several tests.

First, we create a variable that records whether the previous year's voyage either had a shipwreck or was forced to return to port, in which case the value of the cargo in the present voyage would have been higher. We expect the effect of late departure to be larger in these cases. The results in Table 7 confirm this (Columns (3)-(4))

Next, the value of the cargo might have been higher in periods when the economy of Mexico was more buoyant. We find evidence that the coefficient on *Late* is larger in periods when silver production was greater (columns (5)-(6)).

Finally, we contrast the period after 1640 with that before 1640, as it was in 1640 that the number of ships that could travel between Manila and Acapulco was restricted to one, which made trade even more monopolistic. Thus, cargo shipped in the period after 1640 would have been more valuable than those shipped before 1640, which implies that the relationship between a late departure and a failed voyage would have been stronger. That the estimated coefficient for the post-1640 period is much larger than for the pre-1640 period supports this prediction (columns (7)-(8)). We report balance on other characteristics between samples in Appendix Figures A.7 and A.9 . Overall the different samples are balanced.

Together, all our empirical results provide evidence that the Manila Galleon trade was inefficient. Galleons faced more than the normal perils of sea voyage – they were shipwrecked by rents.

5 Conclusion

The Manila Galleon trade was the longest and most valuable trade route in the preindustrial world. It linked together Spain's global empire for more than two and a half centuries. The profits associated with this trade were legendary; but so were the dangers.

This paper is the first quantitative study of the Manila Galleon trade, and provides evidence that it was inefficient. It introduces a unique new dataset containing the universe of ships that sailed between Manila and Acapulco between 1565 and 1815 and a host of climatic, geographic and geopolitical control variables. We find that ships that left late were approximately 20% more likely to either be shipwrecked or returned to port. There is no relationship between late departures and failed voyages in trips from Acapulco to Manila.

This relationship holds when control for the presence of storms, typhoons, and the temperature of the Western and Eastern Pacific. It also remains strong when we account for the experience of captains, and the age of the ship. We further show that its magnitude does not change when we account for alternative explanations given by historians, including the date at which the ship coming from Mexico arrived, the presence of pirates and foreign enemies, and the number and value of the ships and cargo coming from China or the rest of Asia.

To understand why a systematic relationship between late departures and failed voyages is indicative of an inefficient equilibrium, we have constructed a formal model in which ship officials extract bribes from merchants in exchange for loading their cargo on to the galleon. When the value of the cargo is high, as when trade is monopolistic, merchants can pay higher bribes. This induces officials to load more cargo, up to an inefficient point, at which either the galleon is physically overloaded, or sails late into the monsoon season, or both. It is inefficient because it increases the probability of shipwreck beyond normal levels.

To test this mechanism, we derive two additional predictions. First, for smaller ships, the relationship between a late departure and a failed voyage would be larger, since they likely would have been physically overloaded as well. Second, since the incentive to overload and to sail late is greater when the value of the cargo is higher, the relationship between late departures and shipwrecks would also be stronger.

Empirically, we indeed find that the relationship between a late departure and a failed voyage is greatest for ships with below the mean tonnage. We also find that it is stronger for ships that followed on a previously failed voyage and during periods when we expect the value of the cargo to be higher—i.e. during the era when the number of ships that could travel between Manila and Acapulco was restricted to one. We find some evidence that the relationship disappears after trade in Manila was fully liberalized and opened to ships of other nations. Taken together, the results provide evidence that monopoly rents and bribe-taking, and the associated overloading and late departures, explain the higher-than-normal, inefficient, failure rate of voyages in the Manila Galleon trade.

Not only is ours the first quantitative study of the Manila Galleon trade — to the best of our knowledge, it is the first empirical study of corruption and shipwrecks. From a historical perspective, it highlights a previously ignored cost of the colonial trading regime in the Spanish empire.

While this historical setting is unique, the lessons from rent-seeking in the Manila Galleon trade are generalizable. First, it shows how individually rational rent-seeking behavior have potentially disastrous social consequences. Second, the mechanisms responsible for shipwrecks in the Galleon trade are likely operative in other settings.

References

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

Abad, Leticia Arroyo and Nuno Palma, "The Fruits of El Dorado: The Global Impact of American Precious Metals," in R. Doblado and A. Garcia-Hiernaux, eds., *Globalization in the Early Modern Era: An Iberian American Perspective*, Palgrave Basingstoke 2021.

Acemoglu, Daron, Simon Johnson, and James A. Robinson, "The Colonial Origins of Comparative Development: An Empirical Investigation," *The American Economic Review*, December 2001, *91* (5), 1369–1401.

Ades, Alberto and Rafael Di Tella, "Rents, Competition, and Corruption," *American Economic Review*, September 1999, *89* (4), 982–993.

Aduarte, Diego, *Historia De La Provincia Del Santo Rosario De Filipinas, Iapon Y China, De La Sagrada Orden De Predicadores*, Zaragoza: Casa Domingo Gascon, 1693.

Aidt, Toke S., "Economic analysis of corruption: a survey," *Economic Journal*, November 2003, *113* (491), 632–652.

_ , "Rent seeking and the economics of corruption," *Constitutional Political Economy*, 2016, *27* (2), 142–157.

Allen, Douglas W., "The British Navy Rules: Monitoring and Incompatible Incentives in the Age of Fighting Sail," *Explorations in Economic History*, April 2002, *39* (2), 204–231.

_ , *The Institutional Revolution*, Chicago: Chicago University Press, 2011.

Altonji, Joseph G., Todd E. Elder, and Christopher R. Taber, "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools," *Journal of Political Economy*, 2005, *113* (1), 151–184.

Alvarez, Luis Alonso, "La ayuda mexicana en el Pacifico: socorros y situados en Filipinas, 1565-1816," in Carlos Marichal and Johanna von Grafenstein, eds., *El secreto del imperio espanol: los situados coloniales en el siglo XVIII*, Mexico City: El Colegio de Mexico, 2012, pp. 251–294.

Alvarez-Villa, Daphae and Jenny Guardado, "The long-run influence of institutions governing trade: Evidence from smuggling ports in colonial Mexico," *Journal of Development Economics*, May 2020, *144*, 1024–53.

Ambraseys, Nicholas and Roger Bilham, "Corruption kills," *Nature*, 2011, *469* (7329), 153–155.

Anderson, R. Warren, Noel D. Johnson, and Mark Koyama, "Jewish Persecutions and Weather Shocks, 1100-1800," *Economic Journal*, 2017, *127* (602), 924–958.

Arteaga, Fernando, "Seeds of Secession: The Political Economy of Spain and its Colonies in the Late Bourbon Period," 2020.

Bardhan, Pranab, "Corruption and Development: A Review of Issues," *Journal of Economic Literature*, 1997, *35* (3), 1320–1346.

Baskes, Jeremy, "Risky ventures: Reconsidering Mexico's colonial trade system," *Colonial Latin American Review*, 2005, *14* (1), 27–54.

Bauzon, Leslie, *Deficit Government: Mexico and the Philippine Situado, 1606-1804*, Tokyo: The Centre for East Casian Cultural Studies, 1981.

Benjamin, Daniel K. and Christopher Thornberg, "Organization and incentives in the age of sail," *Explorations in Economic History*, April 2007, *44* (2), 317–341.

Bennett, Tom, *Shipwrecks of the Philippines*, Wales: Happy Fish Publications, 2010.

Bernabeu, Salvador, *El Pacífico ilustrado: Del lago espanol a las grandes expediciones*, Madrid: Mapfre, 1992.

_ , ed., *Juan Francisco Bodega y Quadra, El descubrimiento del fin del mundo (1775-1792)*, Madrid: Alianza Editorial, 1990.

Bernheim, B Douglas and Michael D. Whinston, "Common Agency," *Econometrica*, July 1986, *54* (4), 923–942.

Bernheim, B. Douglas and Michael D. Whinston, "Menu Auctions, Resource Allocation, and Economic Influence," *The Quarterly Journal of Economics*, 1986, *101* (1), 1–31.

Bienes de Difuntos: Juan Pardo de Losada Quiroga

***Bienes de Difuntos: Juan Pardo de Losada Quiroga**, 1625.*

Biran, Adrian B. and Rubén López-Pulido*, Ship Hydrostatics and Stability, 2nd ed., Amsterdam: Elsevier, 2014.*

Blair, Emma Helen and James Robertson, eds*, The Philippine Islands, 1493-1803: Explorations by Early*

Navigators, Vol. 18 1904.

— **and** — **, eds***, The Philippine Islands, 1493-1898: Relating to China and the Chinese, Vol. 21 1915.*

Bonalian, Mariano*, "El Pacifico Hispanoamericano: Politica Comercial Metropolitana y Trafico Asiatico entre Filipinas, Mexico y Peru (1680-1784)." PhD In History Dissertation, El Colegio de Mexico, Mexico City 2010.*

Borah, Woodrow*, Early Colonial Trade and Navigation between Mexico and Peru, Berkeley: University of California Press, 1954.*

Brading, David*, Miners and Merchants in Bourbon Mexico, 1763-1810, Cambridge: Cambridge University Press, 1971.*

Bruijn, J.R., F.S. Gaastra, and I. Shoeffer*, Dutch-Asiatic Shipping in the 17th and 18th Centuries, Vol. 1 of* Rijks Geschiedkundige Publicatien*, The Hague: De Minister van Onderwijs en Wetenschappen, 1987.*

Brzezinski, Adam, Yao Chen, Nuno Palma, and Felix Ward*, "The vagaries of the sea: evidence on the real effects of money from maritime disasters in the Spanish Empire," Working Papers 0170, European Historical Economics Society (EHES) November 2019.*

Burt, Wayne V*, "The search for the Manila Galleon log books," Bulletin of the American Meteorological Society, 1990, 71 (11), 1630–1636.*

Carta del obispo de Nueva Segovia Miguel de Benavides informando del estado de las islas

Carta del obispo de Nueva Segovia Miguel de Benavides informando del estado de las islas, 1598.

Charotti, Carlos J., Nuno Palma, and João Pereira dos Santos, "American Treasure and the Decline of Spain," January 2022. University of Manchester, Economics Discussion Paper Series, EDP-2201.

Chaunu, Huguette and Pierre Chaunu, *Séville et l'Atlantique, 1504-1650*, Vol. 6, Paris: Ecole Pratique des Hautes Etudes, 1956.

Chaunu, Pierre, *Les Philippines et le Pacifique des Iberiques (XVI,XVII,XVIII). Introduction Methodologique et Indices dactivite*, Paris: Sevpen, 1960.

Choi, In, "Unit root tests for panel data," *Journal of International Money and Finance*, 2001, *20* (2), 249 – 272.

Cinelli, Carlos and Chad Hazlett, "Making sense of sensitivity: extending omitted variable bias," *Journal of the Royal Statistical Society Series B*, February 2020, *82* (1), 39–67.

— **, Jeremy Ferwerda, and Chad Hazlett**, "SENSEMAKR: Stata module to provide sensitivity tools for OLS," Statistical Software Components, Boston College Department of Economics April 2020.

Colin, Oswald Sales, *El Movimiento Portuario de Acapulco El Protagonismo de Nueva Espana en la relacion con Filipinas. Plaza y Valdes*, Mexico City: Plaza y Valdez Editores, 2000.

Consulta sobre encomienda a Fernando de Angulo

Consulta sobre encomienda a Fernando de Angulo*, 1722.*

Cruikshank, Bruce*, "Manila Galleon Listing," 2013.*

de Zuniga, Joaquin Martinez*, Estadismo de las Islas Filipinas, o mis viajes por este pais 1893. Compiled by W. E. Retana.*

Diaz-Trachuelo, Maria Lourdes*, De la Compania Guipuzcoana de Caracas a la Compania de Filipinas, Bilbao: Laida, 1989.*

Dixit, Avinash, Gene M Grossman, and Elhanan Helpman*, "Common Agency and Coordination: General Theory and Application to Government Policy Making," Journal of Political Economy, August 1997, 105 (4), 752–769.*

Drelichman, Mauricio*, "All that glitters: Precious metals, rent seeking and the decline of Spain," European Review of Economic History, December 2005, 9 (03), 313–336.*

— *, "Sons of Something: Taxes, Lawsuits, and Local Political Control in Sixteenth-Century Castile," The Journal of Economic History, September 2007, 67 (03), 608–642.*

— *, "License to till: The privileges of the Spanish Mesta as a case of second-best institutions," Explorations in Economic History, April 2009, 46 (2), 220–240.*

Ekelund, Robert B. and Robert D. Tollison*, Mercantilism as a Rent-Seeking Society, College Station, Texas: Texas A & M University Press, 1981.*

— **and** — *, Politicized Economies, College Station, Texas: Texas A & M University Press, 1997.*

Eldredge, Zoeth and E.J. Molera*, The March of Portola and the Discovery of the Bay of San Francisco. Log of the San Carlos., San Francisco: Reception Committee of The California Promotion Committee, 1909.*

Ellingsen, Sebastian*, "Long-Distance Trade and Long-Term Persistence," 2021.*

Ferreiro, Larrie D.*, Ships and Science: The Birth of Naval Architecture in the Scientic Revolution, 1600-1800, Cambridge MA: MIT Press, 2007.*

Fish, Shirley*, The Manila-Acapulco Galleons: The Treasure Ships of the Pacific with an Annotated List of the*

Transpacific Galleons 1565-1815, Milton Keynes: Authorhouse, 2011.

Fisher, John, *Commercial Relations Between Spain and Spanish America in the Era of Free Trade, 1778-1796, Liverpool: Liverpool University Press, 1982.*

_ , *Economic Aspects of Spanish Imperialism in America, 1492-1810, Liverpool: Liverpool University Press, 1992.*

Fisman, Raymond, *"Estimating the value of political connections," American Economic Review, 2001, 91 (4), 1095–1102.*

_ **and Edward Miguel**, *"Corruption, Norms, and Legal Enforcement: Evidence from Diplomatic Parking Tickets," Journal of Political Economy, December 2007, 115 (6), 1020–1048.*

_ **and Miram A. Golden**, *Corruption: What Everyone Needs to Know, Oxford: Oxford University Press, 2017.*

_ **, Florian Schulz, and Vikrant Vig**, *"The Private Returns to Public Office," Journal of Political Economy, 2014, 122 (4), 806–862.*

Flynn, Dennis O and Arturo Giráldez, *"Born with a" silver spoon": The origin of world trade in 1571," Journal of World History, 1995, pp. 201–221.*

Garcia-Herrera, Ricardo, Pedro Ribera, Emiliano Hernandez, and Luis Gimeno, *"Northwest Pacific typhoons documented by the Philippine Jesuits, 1566–1900," Journal of Geophysical Research: Atmospheres, 2007, 112 (D6).*

Garcia, Rolando R, Henry F Díaz, Ricardo García Herrera, Jon Eischeid, María del Rosario Prieto, Emiliano Hernández, Luis Gimeno, Francisco Rubio Durán, and Ana María Bascary, *"Atmospheric circulation changes in the tropical Pacific inferred from the voyages of the Manila galleons in the sixteenth–eighteenth centuries," Bulletin of the American Meteorological Society, 2001, 82 (11), 2435–2456.*

Garcia-Torralba, Enrique, *Navios de la Real Armada 1700-1860, Madrid: Fondo Editorial de Ingeniería Naval, 2016.*

Garner, Richard and Spiro Stefanou, *Economic Growth and Change in Bourbon Mexico, Gainesville, FL: University Press of Florida, 1993.*

Gentil, Guillaume Le, *"Voyage dans les mers de l'Inde, fait par ordre du Roi, a l'occasion du passage de Venus, sur le disque du Soleil," 1779.*

Gerhard, Peter, *Pirates of the Pacific, 1575-1742, Lincoln and London: University of Nebraska Press, 1960.*

Gifford, Matthew Julian, *"Everything is Ballast: An Examination of Ballst Related Practices and Ballast Stones from the Emanuel Point Shipwrecks." PhD dissertation, The University of West Florida 2014.*

Giraldez, Arturo, *The Age of Trade: The Manila Galleons and the Dawn of the Global Economy, Rowman & Littlefield, 2015.*

Grossman, Gene M and Elhanan Helpman, *"Protection for Sale," American Economic Review, September 1994, 84 (4), 833–850.*

Grossman, Gene M. and Elhanan Helpman, *Special Interest Politics, Vol. 1 of* MIT Press Books, *The MIT Press, 2001.*

Guiot, Joel and Christopher Corona, *"Growing Season Temperature in Europe and Climate Forcings Over the Past 1400 Years," Plos One, April 2010, 5 (4), 1–15.*

Henriques, António and Nuno Palma, *"Comparative European Institutions and the Little Divergence, 1385-1800," Working Papers 0171, European Historical Economics Society (EHES) November 2019.*

Johnson, Noel D., Courtney L. LaFountain, and Steven Yamarik, *"Corruption is Bad for Growth (even in the United States)," Public Choice, 2011, 147 (3), 377–393.*

_ **, William Ruger, Jason Sorens, and Steven Yamarik**, *"Corruption, Regulation, and Growth: an Empirical Study of the United States," Economics of Governance, 2014, 15 (1), 51–69.*

Krueger, Anne O, *"The Political Economy of the Rent-Seeking Society," American Economic Review, June 1974, 64 (3), 291–303.*

Lane, Kris, *Pillaging the empire: Global piracy on the high seas, 1500-1750, New York and London: Routledge, 2016.*

Legarda, Benito, *"The Philippine economy under Spanish rule," Solidarity, November-December 1967, 2 (10), 1–21.*

_ , *"Two and a half centuries of the galleon trade," in "European Entry into the Pacific," Routledge, 2017, pp. 337–365.*

Lui, F. T., *"An equilibrium queuing model of bribery," Journal of Political Economy, 1985, 93 (4), 760–781.*

Maddison, Angus, *The World Economy: Historical Statistics, Paris, France: OECD, 2003.*

Marichal, Carlos, *"The Spanish-American Silver Peso: Export Commodity and Global Money of the Ancien*

Regime, 1550-1800," in Steven Topik, Carlos Marichal, and Zephyr Frank, eds., From Silver to Cocaine: Latin American Commodity Chains and the Building of the World Economy, 1500-2000, Durham, NC: Duke University Press, 2006, pp. 25–52.

Maroto, Isabel, *"The Art of Shipbuilding in Spain's Golden Century," in Ian Inkster and Angel Calvo, eds., European Technologies in Spanish History, Vol. 30 of* History of Technology*, Bloomsbury, 2011, pp. 79–94.*

McCarthy, William J, *"Between policy and prerogative: Malfeasance in the inspection of the Manila galleons at Acapulco, 1637," Colonial Latin American Historical Review, 1993, 2 (2), 163.*

McCarthy, William J., *"The Yards at Cavite: Shipbuilding in the Early Colonial Philippines," International Journal of Maritime History, 1995, 7 (2), 149–162.*

McGrail, Sean, *"The Shipment of Trade Goods and of Ballast in Antiquity," Oxford Jounral of Archaeology, 1989, 8 (3), 353–358.*

Mejia, Javier, *"The economics of the Manila Galleon," Journal of Chinese Economic and Foreign Trade Studies, 2023/11/25 2022, 15 (1), 35–62.*

Mesquida, Juan, *"Pious Funds across the Pacific (1668–1823): Charitable Bequests or Credit Source?," The Americas, 2019, 75 (4), 661–697.*

Morga, Antonio De, *Sucesos de las Islas Filipinas, Mexico City: Casa de Geronymo Balli, 1609.*

Murphy, Kevin M., Andrei Shleifer, and Robert W. Vishny, *"Why Is Rent-Seeking So Costly to Growth?," The American Economic Review, 1993, 83 (2), 409–414.*

Myrdal, G., *Asian drama: an inquiry into the poverty of nations, Vol. II, New York: Random House, 1968.*

Nellemann, Christian and Interpol, eds, *Greeen Carbon, Black Trade: Illegal loggin, tax fraud and laundering in the world's tropical forests United Nations Environmental Programme 2012.*

Niehaus, Paul and Sandip Sukhtankar, *"Corruption Dynamics: The Golden Goose Effect," American Economic Journal: Economic Policy, November 2013, 5 (4), 230–69.*

North, Douglass C., *Institutions, Institutional Change, and Economic Performance, Cambridge, UK: Cambridge UP, 1990.*

Nowacki, Horst and Larrie D. Ferreiro, *"Historical Roots of the Theory of Hydrostatic Stability of Ship," in M. Almeida Santos Neves, V. Belenky, J. de Kat, K. Spyrou, and N. Umeda, eds., Contemporary Ideas on Ship Stability and Capsizing in Waves. Fluid Mechanics and Its Application, Vol. 97 Springer Dordrecht 2011, pp. 141–180.*

Olken, Benjamin A., *"Corruption and the costs of redistribution: Micro evidence from Indonesia," Journal of Public Economics, 2006, 90 (4), 853 – 870.*

_ , *"Monitoring corruption: evidence from field experiments in Indonesia," Journal of Political Economy, 2007, 115 (2), 417–452.*

_ **and Patrick Barron**, *"The Simple Economics of Extortion: Evidence from Trucking in Aceh," Journal of Political Economy, 2009, 117 (3), 417–452.*

_ **and Rohini Pande**, *"Corruption in Developing Countries," Annual Review of Economics, 2012, 4 (1), 479–509.*

ORRV Team Discovers Two Shipwrecks in the Philippines

ORRV Team Discovers Two Shipwrecks in the Philippines, April 2011.

Oster, Emily, "Unobservable Selection and Coefficient Stability: Theory and Evidence," *Journal of Business & Economic Statistics*, 2019, *37* (2), 187–204.

Pedro, San Pablo, "Compulsory Service by the Indians," in Emma Helen Blair and James Robertson, eds., *The Philippine Islands, 1493–1898*, Vol. 19 1908, pp. 75–76.

Perez-Maillana, Pablo, *Spain's Men of the Sea: Daily Life on the Indies Fleets in the Sixteenth Century*, Baltimore: John Hopkins Press, 2005.

Pineda, Sebastian, "Philippine Ships and Shipbuilding," 1619.

Recopilacion de leyes de los reinos de las indias

Recopilacion de leyes de los reinos de las indias, *Madrid: Boix Editores, 1841.*

Rei, Claudia, *"The organization of Eastern merchant empires," Explorations in Economic History, January 2011, 48 (1), 116–135.*

_ , *"Incentives in Merchant Empires: Portuguese and Dutch Labor Compensation," Cliometrica, 2013, (7), 1–13.*

_ , *"Merchant Empires," in Claude Diebolt and Michael Haupert, eds., Handbook of Cliometrics, Vol. II, Springer, 2018.*

Reinikka, Ritva and Jakob Svensson, *"Local Capture: Evidence from a Central Government Transfer Program in Uganda*," The Quarterly Journal of Economics, 05 2004, 119 (2), 679–705.*

Rosal, Ignacio Del, *“The Empirical Measurement of Rent-Seeking Costs,” Journal of Economic Surveys, 2011, 25 (2), 298–325.*

Rose-Ackerman, Susan, *Corruption: a study in political economy, New York: Academic Press, 1978.*

_ , *internationl Handbook on the Economics of Corruption, Vol. I, Cheltenham, UK: Edward Elgar, 2011.*

_ **and Bonnie J Palifka**, *Corruption and government: Causes, consequences, and reform, Cambridge: Cambridge University Press, 2016.*

_ **and Tina Søreide**, *internationl Handbook on the Economics of Corruption, Vol. II, Cheltenham, UK: Edward Elgar, 2011.*

Ruiz, Josu, *“Arquitectura y Tecnologia en el Diseno del Estandar Mercante Bergantin.” PhD in Marine Sciences, Universidad de Cantabria, Santander 2010.*

Salanié, Bernard, *The Economics of Contracts, 2nd edition ed., Cambridge MA: MIT Press, 2005.*

Schurman, Jacob Gould, George Dewey, Elwell Stephen Otis, Charles Denby, and Dean Worcester, *“Report of the Philippine commission to the President. January 31, 1900,” Technical Report 1900.*

Schurz, William Lytle, *“The Manila Galleon and California,” The Southwestern Historical Quarterly, 1917, 21 (2), 107–126.*

_ , *The Manila Galleon, New York: E.P. Dutton, 1939.*

Selga, Miguel, *Charts of Remarkable Typhoons in the Philippines 1902 – 1934. Catalogue of Typhoons 1348 –1934, Manila: Manila Weather Bureau, 1935.*

Shaw, William, *The History of Currency, 1252-1894: Being an Account of the Gold and Silver Moneys and Monetary Standards of Europe and America, Together with an Examination of the Effects of Currency and Exchange Phenomena on Commercial and National Progress and Well-being, London: Clement Wilson, 1896.*

Shleifer, Andrei and Robert W. Vishny, *“Corruption,” The Quarterly Journal of Economics, 1993, 108 (3), 599–617.*

Smith, Adam, *An Inquiry into the Nature and Causes of the Wealth of Nations, Oxford: Clarendon Press, 1776.*

TePaske, John, *“New World Silver, Castile, and the Philippines, 1590-180,” in John Richards, ed., Precious Metals in the Later Medieval and Early Modern World, 1983, pp. 425–446.*

_ , *A New World of Gold and Silver, Leiden: Brill, 2010.*

Tierney, Jessica E., Nerilie J. Abram, Kevin J. Anchukaitis, Michael N. Evans, Cyril Giry, K. Halimeda Kilbourne, Casey P. Saenger, Henry C. Wu, and Jens Zinke, *“Tropical sea surface temperatures for the past four centuries reconstructed from coral archives,” Paleoceanography, 2015, 30 (3), 226–252.*

Tullock, Gordon, *“The Welfare Costs of Tariffs, Monopolies, and Theft,” Western Economics Journal, 1967, pp. 224–32.*

Urminsky, Oleg, Christian Hansen, and Victor Chernozhukov, *“Using Double-Lasso Regression for Principled Variable Selection,” 2016. Mimeo.*

Voth, Hans-Joachim and Guo Xu, *“Patronage for Productivity: Selection and Performance in the Age of Sail,” CEPR Discussion Papers 13963, C.E.P.R. Discussion Papers August 2019.*

Waldinger, Maria, *“The Economic Effects of Long-Term Climate Change: Evidence from the Little Ice Age,” Journal of Political Economy, 2022, 130 (9), 2275–2314.*

Walker, Geoffrey, *Spanish Politics and Imperial Trade, 1700-1789, Bloomington, IN: Indiana University Press, 1979.*

Warren, James Francis, *“Weather, history and empire the typhoon Factor and the Manila Galleon trade, 1565–1815,” in Geoff Wade and Li Tana, eds., Anthony Reid and the study of the Southeast Asian past, Institute of Southeast Asian Studies 2012, pp. 183–220.*

y Rodriguez, Francisco Javier Salas, *Documentos inéditos de las islas Filipinas, Vol. 2, Madrid: Sucesores de Rivadeneyra, 1887.*

Yuste, Camen, *El comercio de la Nueva Espana con Filipinas 1570-1785, Mexico City: Instituto Nacional Antropologia e Historia, 1984.*

_ , *“Obras pías en Manila. La Hermandad de la Santa Misericordia y las correspondencias a riesgo de mar en el tráfico transpacífico en el siglo XVIII,” in Maria del Pilar Martinez, Elisa Speckman, and Gisella von Wobeser, eds., La Iglesia y sus bienes: de la amortización a la nacionalización, Mexico City: Universidad Nacional Autonoma de Mexico, 2004, pp. 181–202.*

_ , *Emporios transpacíficos Comerciantes Mexicanos en Manila(1710-1815), Mexico City: Universidad Nacional Autonoma de Mexico, 2007.*

Online Appendices (For Web Publication Only)

1 Historical Appendix

A *Additional Background Information*

The Manila Galleon was the main link connecting the Philippines with the rest of the Spanish Empire. This specific trade route lasted more than 250 years, from the late 16th century up to the early 19th century. It was highly profitable but also dangerous.

Manila and Acapulco were the endpoints of the voyage. Figure 1 depicts the typical route followed by the galleons from Acapulco to Manila, and from Manila back to Acapulco. Manila was, since its conquest by Miguel de Legazpi in 1565, the center of the Spanish presence in Asia. The Philippines became a General Captaincy of the Spanish Empire which officially was subordinated to the larger Viceroyalty of New Spain—whose capital was Mexico City. Its importance was derived from its strategical geographic location, giving access to all Southeast Asia (Bernabeu, 1992; Blair and Robertson, eds, 1904). In America, Acapulco was a minor town of no importance at the southwestern coast of New Spain. Its hot and humid weather along with its poor agricultural prospects made it an unfavorable location for any year-long continuous settlement (e.g. not even pre-hispanic indigenous populations considered it a desirable place to settle). Acapulco's main asset was its large and spacious bay. After considering some alternatives [43], Acapulco was chosen as the default Spanish port in the Pacific.[44]. However, the galleon trade did not radically alter Acapulco urban prospects. For most of the year it remained a fishing village, and it only transformed into a vibrant spot of trade for the few weeks when the Manila Galleon and the rich Mexico City's merchants arrived to trade (Schurz, 1939).

B *The Regulatory System*

The transpacific commercial system of which the Galleon trade was a part of, was governed by the similar legal institutions that regulated the Atlantic trade. These institutions were developed in the early 16th century (Walker, 1979; Fisher, 1992). It had three important characteristics: *(i)* a regime of uniquely privileged ports; *(ii)* a fleet system with periodic scheduled voyages, *(iii)* and an arrangement based on trade privileges upheld by merchant guilds.

C *Building the Ship*

Most of the ships used in the transpacific voyage were built at the Cavite shipyard. Spanish captain Sebastian Pineda wrote letters to the Seville House of Trade detailing the whole process Pineda (1619, 169). Distinct local woods were used for different purposes: Polo Maria was used to build the main framework of the ship as it was light and it "does not hole or chip" when cannons are fired upon it. For the masts and keels, guijo wood was preferred as it was heavy and straight. Wooden planks came from both polo maria, guijo but also from the banaba wood—which was much better at being worm-resistant. Other woods used were maria de monteguas and dangan. Shipbuilding also required ropes and rigging cables that were produced using local hemp. The sails were weaved by Filipinos using pre-hispanic techniques that relied on local cotton. The caulking materials were local too: a combination of fibers

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[43] Notably the port of Puerto Navidad, located in the westerner parts of Mexico, north of Acapulco

[44] Complementing that of Veracruz for the Caribbean and Atlantic

from the coconut husk and oils from local pili nut trees. Iron components were the main input in need of importation, and they came mainly from Mexico, but also from China, Japan and India. Shipbuilding followed the standard Spanish procedures practiced across American and European shipyards.

Manila Galleons were famous for their sturdiness and resistance. Early 18th century English captain Woodes Rogers stated that "these large ships are built with excellent timber that will not splinter; they have very thick sides, much stronger than we build in Europe" (Schurz, 1939, 196). Yet, the ships were constantly rebuilt and repaired across their lifetime. One important problem was the use of unseasoned wood for building them, which led to rapid deterioration of the ship while at sea and made replanking almost a necessary affair after arriving at a port. Shipbuilders realized the situation, but persisted in using unseasoned wood, mostly because seasoning took time and hence it delayed the shipbuilding process (Fish, 2011, 166).

The size of the galleons was initially limited to 300 tonnes, though this limit was routinely ignored as we document in our dataset, and the largest ships reached 2,000 tons. More important than evading proper size regulations, however, was the failure to adhere to structural regulations as this could compromise the stability of the ship. Because of high value of the goods they carried (and the restrictions on the number of ships and voyages that could be made), i.e. as a result of monopoly restrictions, ships began to be built with overly large superstructures above the deck to support the increasing need of storage room for the merchandise. As Perez-Maillana (2005) stresses, this "was detrimental to the defensive capacity of the vessels and even to their fitness to sail since excess weight in superstructure robbed the ships of much of their stability maneuver."

We find further evidence in the travel journals of French astronomer Le Gentil that local merchants lobbied to alter the structure of existing ships to increase their carrying capacity. He describes the case of the Santa Rosa which "had a capacity of about 550 bales of 500 tons at the most. Now each bales is equivalent to about 500 pounds and consequently the Santa Rosa could not carry more than 200 tons of merchandise. The ship although small had splendid between deck space . . . The Manilans, accustomed to evade the king's ordinances, decided that this could not carry enough—that she had too much between the deck spaces. The thought that it would be advisable to increase the dimensions of the hold at the expense of the between deck space . . . the foredeck was raised to a considerable extent so that instead of being able to carry only 550 bales the hold was gauged to carry 762." Le Gentil (1779)

D (Over)Loading the Cargo, Ship Hydraulics, and the Risk of Capsizing

Loading the cargo had to be conducted carefully and supervised by the captain and the ship officials. As discussed in the main test, proper loading of the cargo was crucial in providing stability to the ship. It is generally accepted that "Stowing items in the hold, and rearranging them, could not be done without considering the distribution of ballast and other cargo. Making a large, dense piece of cargo more accessible may unbalance the vessel unless ballast, or another object, is positioned so as to offset the weight . . . when moving or stowing ballast and cargo, each item had to be positioned relative to other items in such a way as to account for the qualities of each item. . . . These characteristics, as well as all the previously outlined factors, make stowage a more complex task than it may seem at first glance. Items cannot simply be loaded wherever they fit or where the weight is needed. Once the process of stowage was completed, weight should be properly distributed throughout the vessel and all items should make it through the voyage without being damaged" (Gifford, 2014, 30-31).

The specific challenge facing the loaders of Manila Galleons was that they had to balance at least three specific challenges: (i) space on the ship was extremely scarce; (ii) the design of Spanish galleons as noted above was top heavy; (iii) additional ballast—typically bilge, rocks and stones—would be needed to be stored at the bottom of the ship in order to offset the weight of additional cargo stored in higher parts of the ship. Heavier items (barrels, bullion, and pottery) were then kept in the main storage rooms—the *bodegas*—that sat just above the ballast. But no space was wasted. Luxury goods such as fine fabrics, varied textiles, household items, ceramics, pottery, furniture, jewelry and other precious stones, foodstuff and spices filled all the decks and were stowed according to their weight, space, and finesse (i.e. fabrics that required to be dry were stored in the uppermost parts).

All of this affected the performance of the ship. As Gifford (2014, 32) "A ship's shape can be influenced by the distribution of weight; if too much weight is placed amidships or at the bow or stern, the hull can flex. The shape of the underwater portion of the vessel is also affected by the rolling, or tilting, of the ship which can be remedied by correctly ballasting the ship and increasing its stability". The resulting drag caused by the uneven force of water will impede the speed and performance of the ship.

As discussed in the main text, the scientific principles of hydrostatic stability explain why the volume and distribution of cargo (as well as it sheer weight) affect the stability of a vessel.

Ship stability is measured by the vertical distance between the center of the mass of a loaded ship and its metacenter. This is called its metacentric height. As outlined by McGrail (1989) the location and volume of a ships cargo affects a ship's metacentric height. Both an excess or an overly small metacentric height affect stability. If the cargo has been loaded such that the ship's mass is centered above the metacenter, this results in a negative metacentric height, which is particularly dangerous. In this case, "the ship will be unstable and, when displaced slightly from the vertical, will continue to roll into a position of permanent heel known as loll". In general, experienced seaman could avoid this "by loading goods of different densities in particular parts of the hold" (McGrail, 1989, 354).

Furthermore, the design of the galleons, as discussed, above, prioritized cargo capacity and led to notably high poop decks. This made the galleons especially vulnerable to capsizing as if the upper stories of the ships were overloaded with cargo this would raise the metacenter of the vessel.

Another factor that could compromise ship stability is an inadequate freeboard where freeboard is the vertical distance between the highest watertight deck and the water-line. "As the ship is loaded its freeboard is decreased. Reduced freeboard means deeper draft which may result in a ship not being able to enter harbour at certain states of the tide or may even lead to a ship running aground" (McGrail, 1989, 354). In Figure A.1, we reproduce from McGrail (1989) a simple illustration of these concepts and how they relate to overall ship stability.

As scientific understanding of hydrostatic stability and other principles of naval architecture was limited until the mid-18 century (Ferreiro, 2007), the precise carrying capacity of ship was unknown.

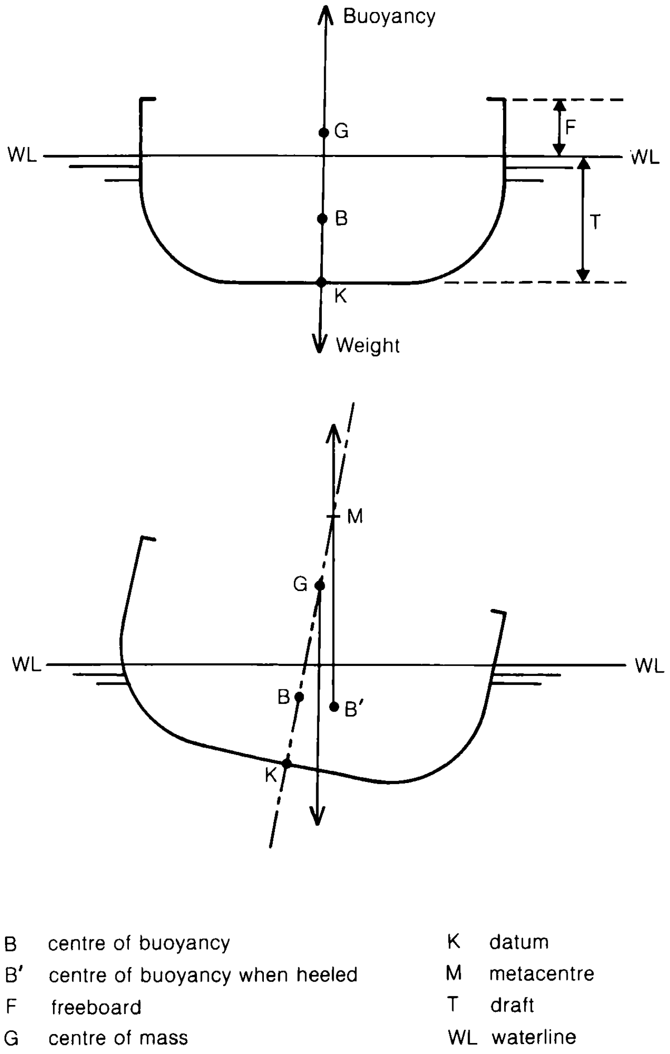

Figure A.1: This diagram depicts the relationship between a ship's center of mass and metacenter and transverse stability. Of particular importance is the relationship between G and M which is affected by how the ship is loaded.Reproduced from McGrail (1989).

How much could be safely loaded had to be guessed at by experienced seamen. The basic relationship between ship stability and the volume, weight, and distribution of cargo had been understood since antiquity (Nowacki and Ferreiro, 2011). Specifically, as documented by McGrail (1989) seamen in the premodern period understood that excess cargo loading could comprise the stability of this ship. But this understanding would have been based on loose rules of thumb rather than exact principles. In the absence of a modern mathematically principles, therefore, it would have been relatively easy to over-estimate how much cargo could have been safely stored.

The bottomline is that the private incentives ship officials had to accept illegal cargo could easily led to galleons carrying both excessive cargo and inappropriately stored cargo. Even if these individuals goods were relatively light (comprised of textiles and porcelains), this could easily affect the stability of the galleon, particularly during rough waters. As the distribution of the cargo had to correspond to the volume of ballast and the overall architecture of the ship, simply offloading excess cargo once at sea would not necessarily be sufficient to stabilize the ship.

E Chronology of the Manila Galleon trade

Table A.1 provides a chronology of the Manila Galleon trade throughout its 250 year history.[45] The Spanish settled the Philippines in 1565. Up until 1593, trade ensued without any formal regulation. The period from 1580 to 1640 was one of high profits and rapid growth. Mexicans and Peruvians were both active participants of trade in which some literature calls the Hispanic American Pacific (Borah, 1954; Bonalian, 2010; **?**). This, however, caused a rift in the political economy of the empire by threatening the interests of the Spaniard merchants, who saw themselves at a disadvantage because they had to compete with Asian merchandises for the share of silver produced in the Americas (Bonalian, 2010, 83-99). Hence, the Spaniards increasingly lobbied for greater restrictions on the transpacific trade routes. Some of them went so far as to push for the abandonment of the Philippines as a colony. In 1593, strict regulations began to be imposed. Specifically, the number of ships that could travel between Manila and Acapulco was restricted to two. The value of the outgoing cargo from Manila was limited to 250,000 pesos. The value of the goods from Mexico was limited to 500,000 pesos. The restrictions were reiterated on several occasions but frequently violated.

After 1640, the Crown became prime arbitrator between the Spanish and American merchants, and set additional limits and regulations to the transpacific trade, giving it its famous characteristics: only one ship was allowed per voyage; the ship had to be limited in its tonnage size; and it had to sail once per year at a definite time. The South Sea trade, that united Peru and New Spain, was legally abolished: Peruvian merchants were forbidden to participate. Bonalian (2010, 55) states that the Pacific "suffered the most abusive . . . restrictive and prohibitionist legislation" of any maritime space in the Spanish Empire. Nonetheless, the local American elites restructured[46] around the new constraints and trade in the pacific boomed during the period (Bonalian, 2010; Yuste, 1984, 2007).

The fleet system continued up with few modifications until the late 18th century. During the Seven Years' War in the 1760s, Manila and Havana—arguably they most important Spanish ports in Asia and America respectively—were captured by the British, entirely disrupting the Spanish commercial endeavors. After the war, Spanish legislators pushed for reforms to reinforce the commercial security of the empire. These policies, known as the "Bourbon Reforms," aimed to decentralize trade, improve the fiscal and state capacity of the Crown (Arteaga, 2020). New mercantile companies were chartered: The Royal Philippine Company formed in 1785 with the aim of linking Philippines directly with Spain(Diaz-Trachuelo, 1989). However, as we discuss in the text, these reforms were initially thwarted

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[45] For conciseness, it only depicts mayor events such as the capture of the galleons by English privateers or the Royal Navy, but not every known shipwreck.

[46] Contraband was rampant. The famous hispanic saying "Obedezco pero no cumplo," captures the ethos of the era quite well: laws were technically obeyed but tacitly not complied.

Table A.1: Timeline of Major Events in the Course of the Manila Galleon Trade

Year	Event
1565	First Spanish settlement in Cebu island
1571	Foundation of the city of Manila by Miguel López de Legazpi
1574	Chinese pirate Limahong attacks Manila but fails to conquer it
1580	Portugal joins the Spanish Empire. Trade between Manila and Macau ensues
1587	English privateer Thomas Cavendish capture the *Santa Ana* close to Baja California
1593	Trade route is legally restricted to two ships per year and Peru is forbidden to engage in it
1596	The *San Felipe* shipwrecks in Shikoku, Japan. Its cargo is seized by the local *Daimyo*
1600	The *San Diego* sinks in Manila bay after a confrontation with the Dutch
1603	Sangley Rebellion in Manila is quelled. Thousands of Chinese-Filipinos are massacred
1604	King Phillip III issues a decree where he instructs ships to not be overloaded
1624	Spanish missionaries and officials are expelled from Japan
1626	Spain establishes a trading post in Keelung, Taiwan
1640	Portugal & its colonies secede from the Spanish Empire
1640	Trade route is restricted to one ship per year
1642	The Dutch settle in Tainan, Taiwan and expel all the Spanish garrisons from the island
1644	The Chinese Ming dynasty falls and Asian trade becomes erratic
1644	Governor of Philippines is indicted of negligence after the shipwreck of *Concepción*
1646	*Battle of La Naval de Manila* occurs where the Dutch failed to conquer the city
1662	Koxinga, Chinese pirate & ruler of Taiwan, raids the Philippines and threats to invade
1694	Shipwreck of the *San José* near Lubang Island
1709	English capture the *Encarnación*
1743	English capture the *Covadonga*
1762	English capture the *Santísima Trinidad*
1762	English capture Manila as part of the Seven Year's War
1769	New Commercial Code introduced
1785	The Royal Company of Philippines is created
1795	Trade in Manila is liberalized
1815	Last galleon sails & its cargo is confiscated by Mexican secessionists in Acapulco

by the domestic interest groups in Manila. The last galleon sailed in 1815 as Latin American wars of independence raged in America.

2 Theoretical Appendix

A *Proofs of the Main Results*

A.1 *Proof of Lemma*

Since $b_{t,1} = \bar{U}_t + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and $b_{t,2} = \bar{U}_t + k_1k_2\mathbb{1}_2 + k_3\mathbb{1}_3$, it suffices to show $\bar{U}_t$ is increasing in t, since k_2 and k_3, once incurred, are incurred until T. In turn, $\bar{U}_t \equiv \mu_{t+1}b_{t+1,1} + (1-\mu_{t+1})b_{t+1,2} = b_{t+1,1} + (1-\mu_{t+1})k_1$ is increasing in t since $b_{t+1,1}$ is increasing in t and, with finite legal boleta holders N_1, $(1-\mu_t)$ is increasing in t.

A.2 *Proof of Proposition 1*

We first show that $\bar{b}_{T,1} = \bar{b}_{T,2} = V$. From equations (2) and (3), the largest bribe that the incumbent can get is V. Thus, by Lemma A.1 and equation (**??**), the incumbent sets sail when $\bar{b}_{T+1} \equiv \bar{U}_T > V$. This implies that $b_{T,1} - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 > V$ and $b_{T,2} - k_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 > V$ or, $b_{T,1} > V + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and $b_{T,2} > V + k_1 + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$. By (2) and (3), this confirms that $\bar{b}_{T,1} = \bar{b}_{T,2} = V$. In turn, $\bar{b}_T \equiv \bar{U}_{T-1} = V$, which implies $b_{T-1,1} = V + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$ and $b_{T-1,2} = V + k_1 + k_2\mathbb{1}_2 + k_3\mathbb{1}_3$. By (2) and (3), $\bar{b}_{T-1,1} = \bar{b}_{T-1,2} = V$. Iteratively applying this, one gets $\bar{b}_{t,1} = \bar{b}_{t,2} = V$ $\forall t = 1, 2, ..., T$.

A.3 *Proof of Proposition 2*

By Proposition 1, the galleon departs when $\bar{b}_{T+1} > V$ or, using (**??**), when $b_{T+1,1} + (1-\mu_{T+1})k_1 > V$. Plugging in the expression for $b_{T+1,1}$, noting that in equilibrium, $b_t = V$, and rearranging, the above inequality can be written as

$$\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)\Big[-\sum_{t=1}^{T}(k_1\mathbb{1}_1+k_2\mathbb{1}_2+k_3\mathbb{1}_3)\Big]+\Big(\frac{1-\rho_{T+1}}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)(1-\mu_{T+1})k_1 > V. \tag{7}$$

Thus, if one can construct values $V_1 < V_2 < V_3$ that the LHS of (7) can take, then we know that when, say, $V < V_1$, then the galleon departs in conditions under which V_1 is constructed. Similarly, if $V_1 \leq V < V_2$, then the galleon departs in conditions under which V_2 is constructed, and so on.

Thus, we first construct values of the LHS of (7) by assuming some levels of cargo, and show that these values are increasing in departure time T or, equivalently, the total amount of cargo loaded by the departure date.

First, note that when the total cargo as of T is $T < \bar{N}, \bar{t}$, then if a cargo were to be loaded at $T+1$, the total cargo at $T+1$ would still not exceed $\bar{N}$ or $\bar{t}$ – at most, $T+1$ could be equal to $\min(\bar{N}, \bar{t})$. This implies that the probability of shipwreck if the galleon were to sail at $T+1$ would be no different that if it were to sail at T. That is, $\rho_{T+1} = \rho_T = \bar{\rho}$. The LHS of (7) thus becomes

$$V_{T<\bar{N},\bar{t}} \equiv (1-\mu_{T+1})k_1.$$

Now if $T \geq \bar{N}, \bar{t}$, then at least one limit ($\bar{N}$, $\bar{t}$, or both) would be surpassed by $T+1$. Hence, in this case, $\rho_{T+1} > \rho_T$. Moreover, the total average cost incurred as of T from loading illegal cargo would be

$k_1\mu_T T$. Meanwhile, the total costs incurred as of T from loading cargo above the limit $\bar{N}$ would be $k_2(T-\bar{N})$ if $T > \bar{N}$, and 0 otherwise. Lastly, the total costs incurred as of T from loading cargo after the deadline $\bar{t}$ would be $k_3(T-\bar{t})$ if $T > \bar{t}$, and 0 otherwise.

Thus, if the galleon were to depart at any time $T \geq \bar{N}, \bar{t}$, the LHS of (7) can be expressed as

$$V_{T\geq\bar{N},\bar{t}} \equiv \Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)[-k_1\mu_T T - k_2(T-\bar{N})\mathbb{1}_{\mathbb{N}} - k_3(T-\bar{t})\mathbb{1}_{\mathbb{t}}] \\ +\Big(\frac{1-\rho_{T+1}}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)(1-\mu_{T+1})k_1,$$

where $\mathbb{1}_{\mathbb{N}}$ is an indicator variable equal to 1 if $T > \bar{N}$, and $\mathbb{1}_{\mathbb{t}}$ an indicator variable equal to 1 if $T > \bar{t}$.

Therefore, to prove Proposition 2, I first show that $V_{T<\bar{N},\bar{t}}$ is less than the minimum value that $V_{T\geq\bar{N},\bar{t}}$ can take, and that $V_{T\geq\bar{N},\bar{t}}$ is increasing in T. That is, I show that:

(a) $V_{T<\bar{N},\bar{t}} < V_{T=\min(\bar{N},\bar{t})}$

(b) $V_{T\geq\bar{N},\bar{t}}$ is increasing in T,

where $V_{T=\min(\bar{N},\bar{t})}$ is the value of the LHS of (7) if $T = \min(\bar{N},\bar{t})$. When these hold, then one can define the following: $V_1 \equiv V_{T<\bar{N},\bar{t}}$, $V_2 \equiv V_{T=\min(\bar{N},\bar{t})}$, and $V_3 \equiv V_{\bar{t}\geq T>\bar{N}}$ if $\min(\bar{N},\bar{t}) = \bar{N}$ or, if $\min(\bar{N},\bar{t}) = \bar{t}$, $V_3 \equiv V_{\bar{N}\geq T>\bar{t}}$, where $V_{\bar{t}\geq T>\bar{N}}$ is the value of the LHS of (7) when $\bar{t} \geq T > \bar{N}$, and $V_{\bar{N}\geq T>\bar{t}}$ the value of the LHS of (7) when $\bar{N} \geq T > \bar{t}$. Since $V_1 < V_2 < V_3$, then if $V < V_1$, then the galleon sails in conditions under which V_1 is constructed, i.e. $T < \bar{N}, \bar{t}$. If $V_1 \leq V < V_2$, then the galleon sails when $T = \min(\bar{N},\bar{t})$. If $V_2 \geq V < V_3$, the galleon sails when $\bar{t} \geq T > \bar{N}$ if $\min(\bar{N},\bar{t}) = \bar{N}$; otherwise, if $\min(\bar{N},\bar{t}) = \bar{t}$, it sails when $\bar{N} \geq T > \bar{t}$. Finally, when $V_3 < V$, it cannot sail when $\bar{N} \geq T > \bar{t}$ or $\bar{t} \geq T > \bar{N}$ for, in this case, $V_3 > V$. Since $V_{T\geq\bar{N},\bar{t}}$ is increasing in T, it must then be that T is larger than $\max(\bar{N},\bar{t})$.

Thus, I first prove (a). In this case, $V_{T=\min(\bar{N},\bar{t})}$ is constructed by letting $T = \bar{N}$ and $T - \bar{t} < 0$ of $\min(\bar{N},\bar{t}) = \bar{N}$, or letting $T = \bar{t}$ and $T - \bar{N} < 0$ of $\min(\bar{N},\bar{t}) = \bar{t}$. In either case, neither cost k_2 nor k_3 is incurred. Thus, $V_{T<\bar{N},\bar{t}} < V_{T=min(\bar{N},\bar{t})}$ can be written as

$$(1-\mu_{T+1})k_1 < \Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)(-k_1\mu_T T) \\ +\Big(\frac{1-\rho_{T+1}}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\Big)(1-\mu_{T+1})k_1$$

or, simplifying, $\frac{\mu_T}{1-\mu_{T+1}} < T$. This is indeed true since $\frac{\mu_T}{1-\mu_{T+1}} < 1$ while T cannot be less than 1. (It is evident that $\mu_{T+1} < 1-\mu_T$ since, with finite number of legal merchants, the probability that a legal merchant arrives at port decreases over time and, hence, $\mu_{T+1} < \mu_T$. Since the latter is true for any value of μ_T, even approximately equal to zero, then it is true for very high values of $(1-\mu_T)$, i.e. close to one.)

We then prove (b). Consider the case when $\bar{t} \geq T > \bar{N}$ ($\min(\bar{N},\bar{t}) = \bar{N}$). Cost $k_2(T-\bar{N})$ is incurred, but k_3 is not. Hence,

$$V_{\bar{t}\geq T>\bar{N}} = a(-k_1\mu_T T - k_2(T-\bar{N})) + a(1-\mu_{T+1})k_1,$$

where $a \equiv \left(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\right)|_{\bar{t}\geq T>\bar{N}} = \omega(1,0)$. Now if T were exactly equal to $\bar{N}$, then $(\rho_{T+1} - \rho_T)\bar{N} = \omega(1,0)\bar{N}$, and $(1-\rho_{T+1}) = 1-\bar{\rho}-\omega(1,0)$. Thus, $1-\rho_{T+1}-(\rho_{T+1}-\rho_{\bar{N}})\bar{N} = 1-\bar{\rho}-\omega(1,0)-\omega(1,0)\bar{N}$, which, by our assumption on $\omega(1,0)$, is less than zero. Thus, if the denominator of a is less than zero at $\bar{N}$, then it is less than zero at all $T \geq \min(\bar{N},\bar{t})$, for both ρ_{T+1} and T would be increasing. Thus, $a < 0$, which in turn requires that $-k_1\mu_T T - k_2(T-\bar{N}) + (1-\mu_{T+1})k_1 < 0$. Now since $(1-\mu_{T+1})k_1$ increases with T, then if $V_{\bar{t}\geq T>\bar{N}}$ increases with T, it must be that $k_1\mu_T T + k_2(T-\bar{N})$ increases with T, which is indeed the case.

An analogous reasoning establishes that when $\bar{N} \geq T > \bar{t}$ (i.e. $\min(\bar{N},\bar{t}) = \bar{t}$), then $V_{\bar{N}\geq T>\bar{t}}$ increases with T.

To complete the analysis, one can also show that T keeps increasing the LHS of (7), that is, when both $\bar{t}$ and $\bar{N}$ are surpassed. In this case,

$$V_{T>\bar{N},\bar{t}} = b(-k_1\mu_T T - k_2(T-\bar{N}) - k_3(T-\bar{t})) + b(1-\mu_{T+1})k_1,$$

where $b \equiv \left(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}-(\rho_{T+1}-\rho_T)T}\right)|_{T>\bar{N},\bar{t}}$. Since $b < 0$, then $-k_1\mu_T T - k_2(T-\bar{N}) - k_3(T-\bar{t}) + (1-\mu_{T+1})k_1 < 0$ and since $(1-\mu_{T+1})k_1$ increases with T, then $k_1\mu_T T + k_2(T-\bar{N}) + k_3(T-\bar{t})$ increases with T, which is indeed the case.

A.4 Proof of Corollary 1

The proof is immediate. From Proposition 2, higher V makes it more likely that there are cargo loaded that are above limits $\bar{N}$ and $\bar{t}$, and from its proof, T increases with V. Hence, the probability of shipwreck at departure, $\rho^T = \bar{\rho} + \omega(T_2^T, T_3^T)$ is larger with higher V since $T_2^T = (T-\bar{N})$ and $T_3^T = (T-\bar{t})$ would be larger.

A.5 Proof of Proposition 3

One only needs to replace equations (5) and (6) with $\bar{b}_{t,1} = \min(b_{t,1}, MWP)$ and $\bar{b}_{t,2} = \min(b_{t,2}, MWP)$. Lemma 1 still holds, and the proof of Proposition 1 is applied, with MWP being the largest bribe that the incumbent can get.

A.6 Proof of Corollary 2

The proof is immediate, by Proposition 2 and Corollary 1.

B Probability μ_t of Drawing a Legal Boleta Holder

With N_1 the total number of merchants with legal boleta, and very large N_2 without boleta, the probability μ_t of drawing a merchant with legal boleta in the first period is $\mu_1 = \frac{N_1}{N_1+N_2}$. At $t = 2$, if a legal merchant was drawn in period 1, the probability of drawing another legal merchant is $\frac{N_1-1}{N_1+N_2-1}$; otherwise, if an illegal merchant was drawn in period 1, then $\frac{N_1}{N_1+N_2-1}$. Thus, the probability of drawing a legal merchant in $t = 2$ is $\mu_2 = \frac{N_1}{N_1+N_2}\left(\frac{N_1-1}{N_1+N_2-1}\right) + \left(1 - \frac{N_1}{N_1+N_2}\right)\left(\frac{N_1}{N_1+N_2-1}\right) =$

$\mu_1\Big(\frac{N_1-1}{N_1+N_2-1}\Big)+(1-\mu_1)\Big(\frac{N_1}{N_1+N_2-1}\Big)$. Similarly, the probability of drawing a legal merchant in $t=3$ is $\mu_3=\mu_1\mu_2\Big(\frac{N_1-2}{N_1+N_2-2}\Big)+\mu_1(1-\mu_2)\Big(\frac{N_1-1}{N_1+N_2-2}\Big)+(1-\mu_1)(1-\mu_2)\Big(\frac{N_1}{N_1+N_2-2}\Big)$.

Thus, for any period t, the probability of drawing a legal merchant can be expressed as:

$$\mu_t=\sum_{x=1}^{t}a_{t-x}\Big(\frac{N_1-t+x}{N_1+N_2-t+1}\Big),$$

where each term is the joint probability of drawing a legal merchant in the $(t-x)$ periods, with $\Big(\frac{N_1-t+x}{N_1+N_2-t+1}\Big)$ the probability that a legal merchant is drawn in the $(t-x)$th period, and a_{t-x} the joint probability that a legal merchant is drawn in the periods prior to the $(t-x)$th period. (For instance, in period 3, the joint probability that legal merchants were drawn in all prior two periods is $a_2=\mu_1\mu_2$; in just the first period, $a_1=\mu_1(1-\mu_2)$; in no period prior to 3, $a_0=(1-\mu_1)(1-\mu_2)$.)

Notice that μ decreases with t, e.g. $\mu_3<\mu_2$. This is intuitive – with small N_1 and very large N_2, the probability of drawing a legal merchant from a decreasing remaining pool of legal merchants decreases over time.

Table A.2: Summary Statistics for Manila to Acapulco

	Mean	Standard Deviation	Min	Max
Lost or Returned	.2	.4004887	0	1
Late	.5631868	.4966741	0	1
Storm	.1902439	.392973	0	1
Pirates or Buccaneers	.0585366	.2350421	0	1
Typhoon	.2200489	.4147867	0	1
Temperature in Western Pacific	-.2602797	.1191281	-.65	.02
Temperature in in Eastern Pacific	.1049201	.4346396	-1.32	1.24
Age of Ship	3.928218	4.281334	0	20
Experienced Captain	.0536585	.2256179	0	1
Total Conflicts	.7073171	.45555	0	1
Navel Conflicts in South East Asia	.1926829	0 .394888	0	1
Conflicts with the Philippines	0.1195122	0.3247866	0	1
Conflicts with England	.4853659	.5003964	0	1
Conflicts with Dutch	.3829268	.4866946	0	1
Interim Governor	.1	.3003665	0	1
Audiencia Governor	.0512195	.2207145	0	1
Tonnage	453.9732	365.6831	40	2000
Silver (pesos)	3178770	1267498	286599	8769993
Silver (kilos)	4279053	5114501	27677	1.93e+07

Table A.3: Summary Statistics for Acapulco to Manila

	Mean	Standard Deviation	Min	Max
Lost or Returned	.0449735	.2075207	0	1
Late	.0870968	.2824327	0	1
Storm	.0899471	.2864851	0	1
Pirates or Buccaneers	.0583554	.2347258	0	1
Typhoon	.0634921	.2441691	0	1
Temperature in Western Pacific	-.2678226	.1220212	-.65	.02
Temperature in in Eastern Pacific	.0872826	.4330218	-1.32	1.24
Age of Ship	4.435262	4.423452	0	21
Experienced Captain	.047619	.2132411	0	1

3 Empirical Appendix

In this appendix we report several further robustness checks that are discussed but not included in the main paper.

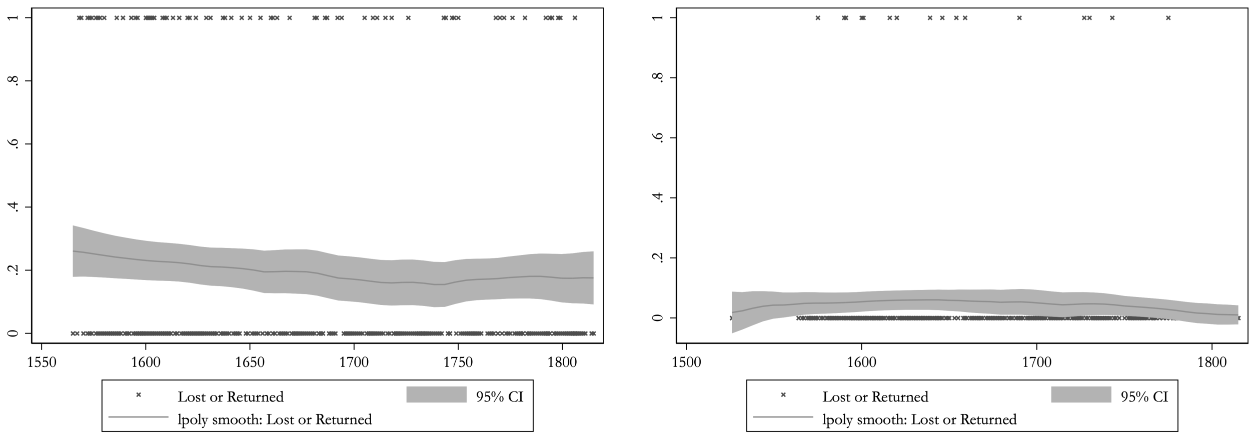
A Summary Statistics

Tables A.2 and A.3 provide summary statistics for the journey between Manila and Acapulco and Acapulco and Manila, respectively.

B Alternative Specifications

In Table A.5 we use ship and year fixed effects instead of ship and voyage fixed effects as in our preferred baseline specification. We obtain comparable results. Indeed the coefficient on late increases to around 0.5. We also report results clustered at both the ship and year level.

Figure A.2: Lost and Returned Ships


(a) Manila to Acapulco

(b) Acapulco to Manila

Table A.4: Manila to Acapulco: The Relationship Between Departure Date and a Failed Voyage

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Departure Date	0.00374***	0.00367***	0.00369***	0.00402***	0.00409***	0.00408***
	(0.00108)	(0.00109)	(0.00110)	(0.00115)	(0.00109)	(0.00109)
Typhoon		0.0285	0.0305	-0.0142	-0.0173	-0.0140
		(0.0740)	(0.0752)	(0.0735)	(0.0744)	(0.0758)
Western Pacific Temperature			-0.0833	0.0404	0.0102	0.0133
			(0.204)	(0.200)	(0.198)	(0.202)
Eastern Pacific Temperature			-0.0914	-0.0662	-0.0427	-0.0413
			(0.0948)	(0.0819)	(0.0775)	(0.0784)
Storm				0.325***	0.335***	0.335***
				(0.102)	(0.100)	(0.100)
Years passed since first voyage					0.0595**	0.0591**
					(0.0274)	(0.0278)
Experienced Captain						-0.0218
						(0.0667)
Constant	-0.550**	-0.531**	-0.538**	-0.625***	-0.657***	-0.652***
	(0.210)	(0.207)	(0.216)	(0.221)	(0.203)	(0.207)
Observations	251	250	250	250	250	250
Adjusted R^2	0.030	0.029	0.028	0.111	0.139	0.136
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes

The relationship between departure date and a failed voyage. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table A.4 we employ departure date as an alternative explanatory variable. We obtain the same results as with late. The advantage of departure date as an explanatory variable is that it provides a continuous measure of how late a ship was to depart.

In the main text we report the results of a linear probability model for ease of interpretation. Table

Table A.5: Manila to Acapulco: The Relationship Between Departure Date and a Failed Voyage Using Year Fixed Effects

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.474**	0.474**	0.503**	0.474**	0.474**	0.503**
	(0.193)	(0.194)	(0.209)	(0.194)	(0.195)	(0.193)
Storm		2.54e-14	2.54e-14		6.53e-15**	6.16e-15
		(.)	(.)		(3.02e-15)	(3.97e-08)
Experienced Captain			0.112			0.112
			(0.121)			(0.119)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Ship	Ship	Ship	Ship & Year	Ship & Year	Ship & Year
Observations	364	364	364	123	123	123
Adjusted R^2	0.687	0.685	0.687	-0.221	-0.272	-0.314

This table reports the relationship between a late departure from Manila and the probability of a shipwreck using ship and year fixed effects. Columns (1)-(3) report clustering on ship id. Columns (4)-(6) report results clustering on ship id and year. Note that the number of observations falls when we cluster on both ship id and year because the `reghdfe` estimator drops observations for which only one ship left Manila in a given year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.7 replicates the structure of Table 1 in the main text, but reports the coefficients and log odds from a logit specification. Table A.8 reports the coefficient and marginal effects evaluated at the mean using a probit specification.

An alternative approach is to relax the ship effects, and employ an inverse-probability weighting estimator. The advantage of this approach is that it allows us to include ship-specific covariates such as tonnage and ship type. As shown in Table A.6 the average treatment effect associated with late is positive and precisely estimated in all specifications.

In Table A.9 we show that our results hold when we do not employ either voyage fixed effects or ship fixed effects.

In Table A.21 we report standard errors clustered at various different levels: ship-level, year of voyage level, voyage fixed effect level, ship and voyage fixed effect level. and ship and year of voyage level. These deliver similar standard errors.

Finally, in Table A.10 we consider the issue of sample attrition. First, in columns (1)-(2) we focus solely on the first voyage of all ships in our sample. This reduces our sample to 73 and we are, of course, unable to include ship or voyage fixed effects. Nonetheless we obtain coefficients that are directly comparable to those obtained in Table 1. Next, in columns (3)-(4) we exclude all ships that are ever recorded as “lost” in our sample. Finally, in columns (5)-(6) we exclude all ships that exist the sample following a failed voyage. Results are comparable to Table 1. If anything the coefficients we are obtain are slightly larger, which is consistent with sample attrition exerting a small downwards bias on our estimates.

C Different Measures of Lateness

In Tables A.11, A.12, and C we report the results of our baseline specification using several different measures of lateness. Specifically, in our main analysis we define vessels as late if they leave Manila

Table A.6: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Treatment Effects

	Shipwrecked or Returned to Port				
	(1)	(2)	(3)	(4)	(5)
ATE Late	0.118^{***}	0.156^{***}	0.138^{***}	0.139^{***}	0.139^{***}
	(0.0301)	(0.0363)	(0.0345)	(0.0345)	(0.0345)
Typhoon		0.697^{***}	0.720^{***}	0.720^{***}	0.733^{***}
		(0.263)	(0.272)	(0.271)	(0.276)
Western Pacific Temperature		-1.458	-1.296	-1.288	-1.340
		(0.900)	(0.943)	(0.947)	(0.967)
Eastern Pacific Temperature		0.181	0.222	0.220	0.230
		(0.259)	(0.263)	(0.263)	(0.266)
Storm			0.299	0.301	0.300
			(0.286)	(0.287)	(0.288)
Years passed since first voyage			-0.0465^{**}	-0.0465^{**}	-0.0472^{**}
			(0.0226)	(0.0226)	(0.0226)
Experienced Captain			-0.151	-0.154	-0.160
			(0.280)	(0.281)	(0.281)
Tonnage Estimate				0.0000222	0.00000929
				(0.000237)	(0.000242)
Galleon Dummy					0.0535
					(0.214)
Observations	674	448	446	446	446

The number of observations shrinks in columns (2)-(5) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: Manila to Acapulco: The Relationship Between Departure Date and a Failed Voyage: Logit

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	1.618^{**}	1.608^{**}	2.767^{**}	3.530^{***}	4.329^{***}	4.337^{***}
	(0.695)	(0.685)	(1.363)	(1.225)	(1.505)	(1.512)
(Odds Ratio)	5.044^{**}	4.992^{**}	15.91^{**}	34.13^{***}	75.85^{***}	76.47^{***}
	(3.505)	(3.420)	(21.69)	(41.80)	(114.2)	(115.6)
Typhoon		0.153	0.285	-0.352	-0.104	-0.0132
		(0.433)	(0.615)	(0.752)	(0.877)	(0.918)
Western Pacific Temperature			-0.265	1.580	-0.524	-0.750
			(2.561)	(3.459)	(3.024)	(3.114)
Eastern Pacific Temperature			-1.058	-0.866	-0.919	-0.960
			(1.168)	(1.101)	(1.346)	(1.330)
Storm				3.882^{***}	4.204^{***}	4.157^{***}
				(1.013)	(1.086)	(1.102)
Years passed since first voyage					0.773^{*}	0.799^{**}
					(0.398)	(0.390)
Experienced Captain						-0.450
						(0.558)
						(0.659)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	180	178	126	126	126	126
Pseudo R^2	0.145	0.144	0.209	0.343	0.394	0.396

The number of observations shrinks in columns (3)-(6) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.8: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage using Probit

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.897**	0.898***	1.464**	1.986***	2.369***	2.374***
	(0.390)	(0.299)	(0.644)	(0.627)	(0.766)	(0.774)
Typhoon		0.0978	0.168	-0.263	-0.127	-0.0700
		(0.281)	(0.337)	(0.394)	(0.401)	(0.430)
Western Pacific Temperature			-0.246	0.685	-0.399	-0.525
			(1.408)	(1.714)	(1.707)	(1.745)
Eastern Pacific Temperature			-0.611	-0.471	-0.417	-0.446
			(0.610)	(0.536)	(0.628)	(0.627)
Storm				2.266***	2.397***	2.370***
				(0.552)	(0.538)	(0.544)
Years passed since first voyage					0.417**	0.434**
					(0.187)	(0.184)
Experienced Captain						-0.287
						(0.322)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	180	178	126	126	126	126
Pseudo R^2	0.141	0.141	0.204	0.338	0.388	0.390

This table establishes a positive relationship between late departures from Manila and failed voyages using probit. The number of observations shrinks in columns (3)-(6) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

after July 15th. In Table A.11 we extend the definition of late forwards to July 19th and obtain very similar results as in the baseline specification.

Table A.12 extends the definition of late backwards to July 10th. Table A.12 compares the coefficient on late when we define late as July 1 or July 30. Consistent with our expectations, we find that the coefficient on late becomes larger as one uses a "later" definition of what counts as a late departure.

D *Period Fixed Effects*

In Table A.16 we implement various period fixed effects. First in columns 1-2, we break the period of study into 50 year periods corresponding to 1550-1600; 1600-1650; 1650-1700; 1700-1750; 1750-1800; and 1800-1850. Next, in columns 3-4, we use century fixed effects. Third, in columns 5-6 we construct fixed effects corresponding to periods described by historians as being periods of expansion or decline. Specifically we use an indicator variable to distinguish: before 1640; 1640-1680; 1680-1760; and after 1760.

E *Governor and Viceroy*

In Table A.17 we introduce several institutional controls. As the Philippines was many thousands of kilometers away from Spain, there were frequent periods in which the governor appointed by the king was not yet resident. During those periods, interim governors were appointed. During other periods the Philippines was governed by its Royal Audiencia. We control for these periods in columns 1-2 and find that they had no effect on our variable of interest. Next we control for the identity of the Viceroy of

Table A.9: Manila to Acapulco and Acapulco to Manila without Fixed Effects

	Manila to Acapulco (1)	 (2)	Acapulco to Manila (3)	 (4)
Late	0.132***	0.197***	0.0941	0.0643
	(0.0462)	(0.0674)	(0.0965)	(0.0924)
Storm	0.292***	0.285***	-0.0233	-0.0497
	(0.0829)	(0.0942)	(0.0403)	(0.0748)
Typhoon	0.0754	0.0203	0.228*	0.179
	(0.0611)	(0.0694)	(0.116)	(0.111)
Western Pacific Temperature	0.223	-0.000459	-0.0205	-0.239*
	(0.189)	(0.192)	(0.127)	(0.122)
Eastern Pacific Temperature	-0.0222	-0.0722	-0.0567**	-0.0276
	(0.0613)	(0.0706)	(0.0261)	(0.0464)
Ship FE	No	Yes.	No	Yes
Voyage FE	No	No	No	No
Observations	250	250	198	198
Adjusted R^2	0.104	0.111	0.080	0.059

This table reports the relationship between late and a failed voyage for both Manila to Acapulco and from Acapulco to Manila without voyage or ship fixed effects. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.10: Manila to Acapluco: Accounting for Attrition

	First Voyage Only (1)	 (2)	Exclud. Lost (3)	 (4)	Excluding Exits (5)	 (6)
Late	0.235***	0.242***	0.219***	0.211***	0.250***	0.258***
	(0.0880)	(0.0871)	(0.0698)	(0.0721)	(0.0721)	(0.0715)
Storm	0.275*	0.287**	0.261***	0.262***	0.229**	0.214**
	(0.140)	(0.140)	(0.0911)	(0.0918)	(0.0948)	(0.0911)
Typhoon	0.0141	-0.0142	-0.0483	-0.0392	-0.0188	-0.0224
	(0.142)	(0.143)	(0.0702)	(0.0721)	(0.0797)	(0.0773)
Western Pacific Temperature	-0.323	-0.307	-0.0196	-0.0424	-0.282	-0.221
	(0.434)	(0.445)	(0.226)	(0.247)	(0.211)	(0.193)
Eastern Pacific Temperature	-0.0145	-0.0312	-0.0213	-0.0174	-0.0687	-0.0695
	(0.116)	(0.117)	(0.0777)	(0.0782)	(0.0879)	(0.0862)
Voyages Made		-0.0419**		-0.00335		0.143***
		(0.0170)		(0.00719)		(0.0415)
Experienced Captain		0.0516		-0.0461		-0.0300
		(0.140)		(0.0596)		(0.0614)
Ship FE	No	No	Yes	Yes	Yes	Yes
Voyage FE	No	No	Yes	Yes	Yes	Yes
Observations	73	73	211	211	217	217
Adjusted R^2	0.113	0.117	0.119	0.114	0.118	0.191

This table demonstrates that relationship between late departures from Manila and failed voyages is robust to controlling for attribution in the sample. In columns (1) and (2) we examine the first voyage of each ship. In columns (3)-(4) we drop all ships that were ever lost at sea. In columns (5)-(6) we drop all ships that ever exit the sample following a failed voyage. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.11: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Different Measures of Late 1

	Shipwrecked or Returned to Port				
	(1) + 1 Day	(2) + 2 Days	(3) + 3 Days	(4) + 4 Days	(5) + 5 Days
Late	0.185^{***}	0.185^{***}	0.173^{***}	0.173^{***}	0.162^{***}
	(0.0540)	(0.0540)	(0.0543)	(0.0547)	(0.0523)
Storm	0.288^{***}	0.288^{***}	0.282^{***}	0.282^{***}	0.281^{***}
	(0.102)	(0.102)	(0.102)	(0.102)	(0.103)
Typhoon	-0.00344	-0.00344	-0.00224	-0.00557	-0.0120
	(0.0683)	(0.0683)	(0.0685)	(0.0689)	(0.0695)
Western Pacific Temperature	0.175	0.175	0.141	0.139	0.122
	(0.164)	(0.164)	(0.176)	(0.174)	(0.177)
Eastern Pacific Temperature	-0.0395	-0.0395	-0.0377	-0.0337	-0.0172
	(0.0706)	(0.0706)	(0.0706)	(0.0692)	(0.0674)
Years passed since first voyage	0.0432^{*}	0.0432^{*}	0.0428^{*}	0.0430^{*}	0.0464^{*}
	(0.0245)	(0.0245)	(0.0246)	(0.0247)	(0.0246)
Experienced Captain	-0.0251	-0.0251	-0.0105	-0.0102	-0.0127
Ship FE	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes
Observations	284	284	284	284	284
Adjusted R^2	0.097	0.097	0.092	0.092	0.090

Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.12: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Different Measures of Late 2

	Shipwrecked or Returned to Port				
	(1) - 1 Day	(2) - 2 Days	(3) - 3 Days	(4) - 4 Days	(5) - 5 Days
Late	0.234^{***}	0.226^{***}	0.182^{**}	0.177^{*}	0.184^{**}
	(0.0780)	(0.0797)	(0.0882)	(0.0905)	(0.0906)
Storm	0.286^{***}	0.287^{***}	0.281^{***}	0.280^{***}	0.281^{***}
	(0.0963)	(0.0968)	(0.0988)	(0.0988)	(0.0987)
Typhoon	-0.00203	0.000349	0.00656	0.00759	0.00247
	(0.0667)	(0.0666)	(0.0691)	(0.0690)	(0.0692)
Western Pacific Temperature	0.106	0.138	0.116	0.0935	0.0899
	(0.171)	(0.169)	(0.174)	(0.175)	(0.174)
Eastern Pacific Temperature	-0.0210	-0.0251	-0.0224	-0.0240	-0.0249
	(0.0677)	(0.0692)	(0.0689)	(0.0693)	(0.0695)
Years passed since first voyage	0.0441^{*}	0.0465^{*}	0.0474^{*}	0.0472^{*}	0.0476^{*}
	(0.0253)	(0.0258)	(0.0256)	(0.0257)	(0.0258)
Experienced Captain	-0.0141	-0.0151	-0.00360	0.00138	0.00375
Ship FE	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes
Observations	284	284	284	284	284
Adjusted R^2	0.112	0.107	0.089	0.087	0.089

Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.13: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Different Measures of Late 3

	Shipwrecked or Returned to Port			
	(1) - 10 Day	(2) - 15 Days	(3) +10 Days	(4) + 15 Days
Late	0.184**	0.152*	0.240***	0.263***
	(0.0968)	(0.0900)	(0.0560)	(0.0568)
Storm	0.277***	0.273***	0.269***	0.278***
	(0.0977)	(0.0992)	(0.102)	(0.101)
Typhoon	0.00576	0.0177	-0.0271	-0.0234
	(0.0686)	(0.0690)	(0.0689)	(0.0673)
Western Pacific Temperature	0.0404	0.0365	0.176	0.155
	(0.171)	(0.176)	(0.181)	(0.183)
Eastern Pacific Temperature	-0.0304	-0.0202	-0.0155	0.0168
	(0.0699)	(0.0704)	(0.0653)	(0.0641)
Years passed since first voyage	0.0442*	0.0456*	0.0509**	0.0516**
	(0.0247)	(0.0248)	(0.0243)	(0.0246)
Experienced Captain	-0.00755	-0.0163	-0.00111	0.00167
	(0.0619)	(0.0629)	(0.0672)	(0.0677)
Ship FE	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes
Observations	284	284	284	284
Adjusted R^2	0.086	0.078	0.125	0.135

Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

New Spain (column 3). Finally, in column (4) we control for the identity of the King of Spain. This does not effect our variable of interest though it seems like in later periods, there were more failed voyages that are otherwise unexplained by our covariates.

Table A.14: Manila to Acapulco: Late Departure and a Failed Voyage, Double Lasso

	(1) Shipwrecked or Returned to Port	(2) Late	(3) Shipwrecked or Returned to Port
Late	✓		0.186***
			(0.0587)
Storm	✓		0.441***
			(0.0811)
Typhoon			
Western Pacific Temperature			
Eastern Pacific Temperature			
Years Passed Since First Voyage			
Pirates			
Captain Experience			
Arrival Date			
Tax Value Total			
Conflicts with England			
Conflicts with Dutch			
Conflicts in the Philippines			
Total Conflicts		✓	0.086
			(0.0717)
Interim Governor			
Audiencia Governor			-0.362
			(0.0717)
ID Audiencia Governor		✓	
ID Viceroy		✓	0.020
			(0.358)
ID King of Spain			
Ship FE	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes
Observations	197	197	360
Lamba	0.0592	0.0182	

This table shows that the relationship between late departure from Manila and a failed voyage using a double lasso for covariate selection. Column 1 reports the variables selected by lasso for explaining a failed voyage. Column 2 reports the variables selected by lasso for a late departure. Column 3 then reports the regression results using the variables selected by the double lasso. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F *Panel Unit Root Tests*

In our main analysis we employ a panel with a long T. It is natural in such a setting to be concerned about non-stationarity. As we note in the main text, we take confidence from Figure A.2 which suggests that our main variables of interest are stationary. Nevertheless in this subsection, we subject this claim to more formal testing.

Specifically, as we have an unbalanced panel with gaps, the most appropriate panel unit root test is the the Fisher-type test proposed by Choi (2001). This test combines the p-values from unit root tests in each cross-section to test for unit roots in the panel. Table A.23 reports the results of these tests. In all specifications we reject the presence of a unit root.

Table A.15: Explanations for Late Departures from Manila

	Late							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Storm	-0.0362	-0.0354	-0.0352	-0.0488	-0.0338	-0.0491	-0.00972	0.00948
	(0.103)	(0.105)	(0.101)	(0.103)	(0.106)	(0.103)	(0.115)	(0.108)
Typhoon	0.139*	0.142*	0.139*	0.119	0.131	0.125	0.107	0.105
	(0.0772)	(0.0779)	(0.0771)	(0.0768)	(0.0830)	(0.0840)	(0.0925)	(0.0933)
Western Pacific Temperature	-0.180	-0.213	-0.203	-0.255	-0.216	-0.251	-0.284	-0.293
	(0.378)	(0.359)	(0.349)	(0.355)	(0.362)	(0.361)	(0.407)	(0.406)
Eastern Pacific Temperature	0.0696	0.0748	0.0695	0.0599	0.0628	0.0628	0.116	0.113
	(0.0793)	(0.0789)	(0.0790)	(0.0783)	(0.0732)	(0.0693)	(0.0980)	(0.0946)
Arrival Date	-0.000150							
	(0.000387)							
Pirates		0.0944						
		(0.0894)						
Conflicts in Southeast Asia			-0.0123					
			(0.0730)					
Conflicts with England				0.154				
				(0.104)				
Conflicts with Dutch					0.107			
					(0.102)			
Total Conflicts						0.158*		
						(0.0911)		
Tax Value Chinese Ships							-0.00000521	
							(0.0000101)	
Tax Value Total								-0.00000498
								(0.00000659)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	250	250	250	250	197	197
Adjusted R^2	0.067	0.069	0.066	0.088	0.071	0.094	0.061	0.062

In this Table we show that there is no relationship between a late departure and our main covairates. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

G Serial Autocorrelation

Our knowledge of the historical setting does not lead us to anticipate serial autocorrelation. In this section, we test for the presence of serial autocorrelation more formally. Specifically, we report the results of Wooldridge's test for autocorrelation in panel data, the Arellano-Bond and the Cumby-Huizinga tests for autocorrelation. The former is implemented with the `xtserial command`, the Arellano-Bond test with the `abar` command; and the latter with the `actest` command.

Table A.16: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Different Fixed Effects

	Shipwrecked or Returned to Port							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Late	0.190***	0.185***	0.181**	0.178**	0.186***	0.177***	0.200***	0.190***
	(0.0700)	(0.0689)	(0.0692)	(0.0679)	(0.0648)	(0.0636)	(0.0709)	(0.0681)
Arrival Date		-0.000697**		-0.000681**		-0.000796***		-0.000787***
		(0.000294)		(0.000277)		(0.000275)		(0.000271)
Storm	0.267***	0.268***	0.258***	0.260***	0.288***	0.282***	0.284***	0.279***
	(0.0963)	(0.0941)	(0.0935)	(0.0915)	(0.0935)	(0.0896)	(0.0937)	(0.0898)
Typhoon	0.0331	0.0299	0.0275	0.0230	0.0310	0.0275	0.0202	0.0158
	(0.0703)	(0.0672)	(0.0686)	(0.0659)	(0.0707)	(0.0659)	(0.0690)	(0.0647)
Western Pacific Temperature	0.0480	0.0967	0.0257	0.0915	0.0404	0.127	0.00801	0.0945
	(0.230)	(0.234)	(0.197)	(0.203)	(0.200)	(0.210)	(0.215)	(0.230)
Eastern Pacific Temperature	-0.0296	-0.0451	-0.0744	-0.0837	-0.0770	-0.0912	-0.0721	-0.0856
	(0.0724)	(0.0736)	(0.0737)	(0.0745)	(0.0742)	(0.0759)	(0.0709)	(0.0726)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	50-year	50-year	100-year	100-year	Period	Period	Oversight	Oversight
Observations	240	240	250	250	249	249	250	250
Adjusted R^2	0.155	0.185	0.133	0.162	0.113	0.157	0.108	0.151

In Table we use different time fixed effects rather than trip fixed effects Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Period fixed effects refer to eras of decline or growth as coded by historians (early, decline, growth, collapse). Oversight fixed effects distinguish the visitador of Pedro de Quiro y Moya and the inspection regime of governor Campo y Coiso and Valdes.

Table A.17: Manila to Acapulco: Late Departure and a Failed Voyage Controlling for Governor, Viceroy, and King

	Shipwrecked or Returned to Port			
	(1)	(2)	(3)	(4)
Late	0.229***	0.232***	0.233***	0.229***
	(0.0763)	(0.0757)	(0.0762)	(0.0740)
Arrival Date	-0.000765***	-0.000748***	-0.000775***	-0.000717***
	(0.000216)	(0.000222)	(0.000209)	(0.000212)
Storm	0.320***	0.332***	0.322***	0.312***
	(0.0952)	(0.0944)	(0.0939)	(0.0961)
Typhoon	-0.0138	-0.00497	-0.00667	-0.00347
	(0.0694)	(0.0718)	(0.0706)	(0.0718)
Western Pacific Temperature	0.0418	-0.0352	0.0355	0.0280
	(0.223)	(0.237)	(0.227)	(0.217)
Eastern Pacific Temperature	-0.0679	-0.0673	-0.0641	-0.101
	(0.0830)	(0.0815)	(0.0808)	(0.0850)
Years passed since first voyage	0.0482	0.0448	0.0395	0.0409
	(0.0310)	(0.0316)	(0.0330)	(0.0277)
Experienced Captain	-0.0200	-0.0157	-0.0237	-0.0257
	(0.0674)	(0.0687)	(0.0666)	(0.0681)
Interim Governor	-0.0573			
	(0.0936)			
Audiencia Governor		0.143		
		(0.166)		
ID Viceroy of New Spain			0.0333	
			(0.0435)	
ID King of Spain				0.217**
				(0.0962)
Ship FE	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes
Observations	250	250	250	250
Adjusted R^2	0.165	0.171	0.166	0.182

Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.18: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage: Controlling for Tonnage

	Shipwrecked or Returned to Port								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Late	0.165***	0.156***	0.156***	0.168***	0.157***	0.156***	0.169***	0.158***	0.157***
	(0.050)	(0.049)	(0.049)	(0.050)	(0.049)	(0.049)	(0.050)	(0.049)	(0.049)
Typhoon	0.0476	0.0491	0.0482	0.0439	0.0487	0.0480	0.0422	0.0473	0.0466
	(0.063)	(0.064)	(0.065)	(0.064)	(0.064)	(0.065)	(0.064)	(0.064)	(0.065)
Western Pacific Temperature	0.241	0.263	0.248	0.259	0.267	0.249	0.264	0.271	0.255
	(0.19)	(0.18)	(0.18)	(0.19)	(0.18)	(0.18)	(0.19)	(0.18)	(0.18)
Eastern Pacific Temperature	-0.0297	-0.0332	-0.0340	-0.0363	-0.0314	-0.0318	-0.0384	-0.0334	-0.0338
	(0.064)	(0.062)	(0.063)	(0.065)	(0.061)	(0.063)	(0.064)	(0.061)	(0.062)
Storm	0.325***	0.331***	0.326***	0.329***	0.329***	0.324***	0.329***	0.330***	0.325***
	(0.089)	(0.087)	(0.088)	(0.089)	(0.087)	(0.088)	(0.089)	(0.087)	(0.088)
Tonnage		0.0000270	0.0000259						
		(0.000052)	(0.000051)						
Tonnage > Mean				0.0200	0.00543	0.00426			
				(0.045)	(0.045)	(0.044)			
Tonnage >Median							0.0342	0.0182	0.0159
							(0.044)	(0.044)	(0.044)
Years passed since first voyage		-0.0200*	-0.0201**		-0.0202*	-0.0203*		-0.0199*	-0.0200*
		(0.010)	(0.010)		(0.011)	(0.010)		(0.011)	(0.010)
Experienced Captain			0.0256			0.0280			0.0274
			(0.064)			(0.065)			(0.065)
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes			
Observations	250	250	250	250	250	250	250	250	250

This table establishes a positive relationship between late departures from Manila and failed voyages controlling for tonnage. Note that we cannot use ship fixed effects and ship tonnage in the same specification. In Columns 1 we report our baseline results without ship fixed effects. In Columns (2)-(3) we control directly for tonnage. In Columns (4)-(6) we include a dummy variable for ships greater than the mean ship size (459 tonnes). In Columns (7)-(9) we include a dummy variable for ships greater than the median ship size (300 tonnes). Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.19: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage When Previous Ship Arrived On Time

	Shipwrecked or Returned to Port						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Late	0.191^{*}	0.184^{*}	0.194^{*}	0.188^{*}	0.179^{*}	0.179^{**}	0.179^{**}
	(0.104)	(0.104)	(0.106)	(0.0945)	(0.0907)	(0.0892)	(0.0780)
Typhoon		0.0607	0.0574	-0.000421	0.00616	0.00476	0.00476
		(0.0834)	(0.0859)	(0.0872)	(0.0895)	(0.0905)	(0.0875)
Western Pacific Temperature			0.0866	0.209	0.143	0.141	0.141
			(0.241)	(0.231)	(0.236)	(0.239)	(0.229)
Eastern Pacific Temperature			-0.0905	-0.0560	-0.0350	-0.0361	-0.0361
			(0.116)	(0.102)	(0.0969)	(0.101)	(0.123)
Storm				0.313^{***}	0.322^{***}	0.322^{***}	0.322^{***}
				(0.104)	(0.0992)	(0.100)	(0.0925)
Years Passed Since First Voyage					0.0541^{*}	0.0542^{*}	0.0542
					(0.0278)	(0.0281)	(0.0328)
Experienced Captain						0.00784	0.00784
						(0.0737)	(0.0553)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Ship	Ship	Ship	Ship	Ship	Ship	Ship & Voyage
Observations	211	211	201	201	201	201	176
Adjusted R^2	0.037	0.036	0.032	0.111	0.133	0.129	0.049

This table establishes a positive relationship between late departures from Manila and failed voyages holds when we exclude voyages that followed on late arrivals. Robust standard errors are clustered at the ship level for columns (1-6) and at the ship and voyage level in column (7). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.20: Manila to Acapluco: Controlling for Silver Flows

	(1)	(2)	(3)	(4)	(5)	(6)
Late	0.224***	0.243***	0.292**	0.168	0.256***	0.232*
	(0.0697)	(0.0751)	(0.143)	(0.103)	(0.0834)	(0.121)
Storm	0.323***	0.311***	0.143	0.395***	0.505**	0.155
	(0.103)	(0.0986)	(0.145)	(0.122)	(0.215)	(0.114)
Typhoon	-0.00439	-0.00345	-0.0147	0.00365	-0.00818	-0.0338
	(0.0689)	(0.0722)	(0.130)	(0.0991)	(0.0867)	(0.140)
Western Pacific Temperature	-0.0429	-0.0339	-0.557	0.212	-0.273	0.350
	(0.211)	(0.205)	(0.474)	(0.306)	(0.332)	(0.250)
Eastern Pacific Temperature	-0.0844	-0.0740	-0.202	-0.137	0.0128	-0.150
	(0.0827)	(0.0846)	(0.185)	(0.115)	(0.167)	(0.117)
Silver Flows (pesos)	-6.17e-08*					
	(3.38e-08)					
Silver Flows (kilos)		8.55e-09				
		(2.58e-08)				
Silver Flows (pesos)			Above Mean	Below Mean		
Silver Flows (kilos)					Above Mean	Below Mean
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	250	97	153	117	133
Adjusted R^2	0.117	0.106	0.138	0.233	0.183	0.152

This table demonstrates that relationship between late departures from Manila and failed voyages is robust to controlling for silver flows from Mexcio. The controls are the same as in Table 1, column (3). In columns (1) and (2) we control for silver flows directly as measured either by value or by weight. In columns (3)-(6) we split the sample by whether they had above mean silver flows. Robust standard errors are clustered at the ship level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.21: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	
Late	0.230***	0.228***	0.236***	0.240***	0.237***	0.238***
S.E clustered at Ship ID	(0.0828)	(0.0829)	(0.0751)	(0.0747)	(0.0731)	(0.0744)
S.E clustered at Year of Voyage	(0.0679)	(0.0687)	(0.0672)	(0.0663)	(0.0644)	(0.0653)
S.E clustered at Voyage FE	(0.0608)	(0.0689)	(0.0590)	(0.0565)	(0.0572)	(0.0590)
S.E clustered at Ship ID and Voyage FE Level	(0.0739)	(0.0788)	(0.0652)	(0.0627)	(0.0628)	(0.0647)
S.E clustered Ship ID and Year of Voyage Level	(0.0811)	(0.0807)	(0.0738)	(0.0726)	(0.0705)	(0.0717)
Typhoon		Yes	Yes	Yes	Yes	Yes
Western Pacific Temperature			Yes	Yes	Yes	Yes
Eastern Pacific Temperature			Yes	Yes	Yes	Yes
Storm			Yes	Yes	Yes	Yes
Years Since First Voyage					Yes	Yes
Experienced Captain						Yes
Constant	0.0421	0.0477	-0.00556	-0.000398	-0.0172	-0.00996
	(0.0674)	(0.0680)	(0.0634)	(0.0697)	(0.0663)	(0.0678)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyage FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	251	250	250	250	250	250
Adjusted R^2	0.030	0.031	0.112	0.110	0.134	0.131

This table establishes a positive relationship between late departures from Manila and failed voyages. We report different levels of clustering for standard errors. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.22: Selection on Observed and Unobserved Variables

Panel A: Sensitivity Analysis following Cinelli and Hazlett (2020)

Outcome: Failed Voyage

Treatment	Estimate	SE	t Value	$R^2_{Y \approx D \mid \mathbf{X}}$	RV	$RV_{\alpha=0.05}$
Late	0.2385	0.0717	3.3246	7%	24 %	11 %

$df = 146$, Bound(Z as strong as Storm): $R^2_{Y \approx D \mid \mathbf{X}} = 10\%$, $R^2_{Y \approx Z \mid \mathbf{X}} = 0.09\%$

Panel B: Sensitivity Analysis following Oster (2019)

	β		δ	R^2		Controls
			$R^2_{max} = 1.3\tilde{R}^2$			
	Uncontrolled	Controlled		Uncontrolled	Controlled	
Late	0.13	0.23	7.57	0.027	0.433	Baseline
	0.13	0.24	8.88	0.027	0.48	+ Storms & Captain Experience
	0.13	0.21	5.8	0.027	0.508	+ Additional Controls

Table Notes: This table reports the estimate of selection on unobservables relative to selection on observables in order to produce a coefficient equal to our baseline estimates (δ). Following Oster (2019) we set $R^2_{max} = \tilde{R}^2$. Baseline controls are Typhoons, Western Pacific Temperature, and Eastern Pacific Temperature. Additional controls adds Years Passed Since First Voyage, Total Conflicts and Pirates. All specifications include ship fixed effects and voyage fixed effects.

Table A.23: Panel Unit Root Tests

Manila to Acapulco

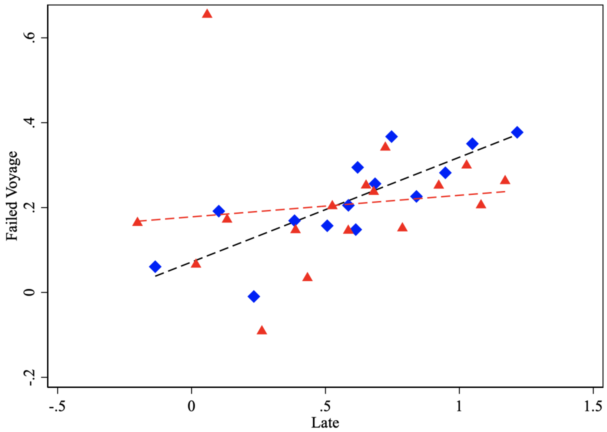
Variable	Test Statistics	P-value	Panels
Lost or Returned	107.8557	0.000	7
Late	47.4213	0.000	6
Storm	01.4696	0.000	7
Pirates or Buccaneers	89.4256	0.000	7
Typhoon	99.6638	0.000	7
Temperature in Western Pacific	43.6458	0.000	7
Temperature in in Eastern Pacific	78.4319	0.000	7

Acapulco to Manila

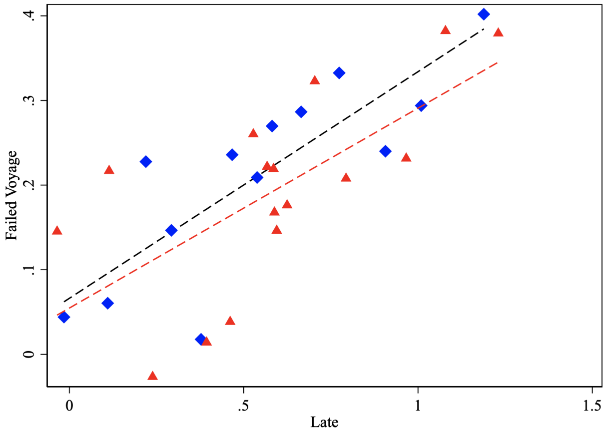
Variable	Test Statistics	P-value	Panel
Lost or Returned	107.8557	0.000	7
Late	47.4213	0.000	6
Storm	01.4696	0.000	7
Pirates or Buccaneers	89.4256	0.000	7
Typhoon	99.6638	0.000	7
Temperature in Western Pacific	43.6458	0.000	7
Temperature in in Eastern Pacific	78.4319	0.000	7

This Table reports the test statistics from a fisher-type panel unit root test for our dependent and explanatory variables and the main control variables. All tests reject the presence of a unit root.

Figure A.3: Testing the model:

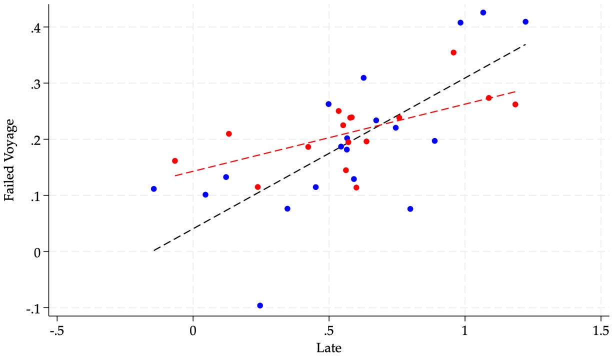


The effect of late by low and high tonnage This figure reports binscatters of the relationship between late departure and a failed voyage by low tonnage (black) and high tonnage (red). Controls include storms, typhoons, and ship fixed effects .

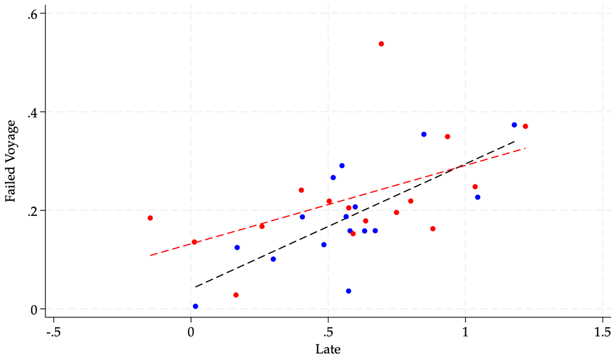


The effect of late by previous failed voyages This figure reports binscatters of the relationship between late departure and a failed voyage if the previous year there was no successful voyage (black) or not (red). Controls include storms, typhoons, and ship fixed effects .

(a) Acapulco to Manila



The effect of late before and after 1640 This figure reports binscatters of the relationship between late departure and a failed voyage after 1640 (black) or before 1640 (red). Controls include storms, typhoons, and ship fixed effects .

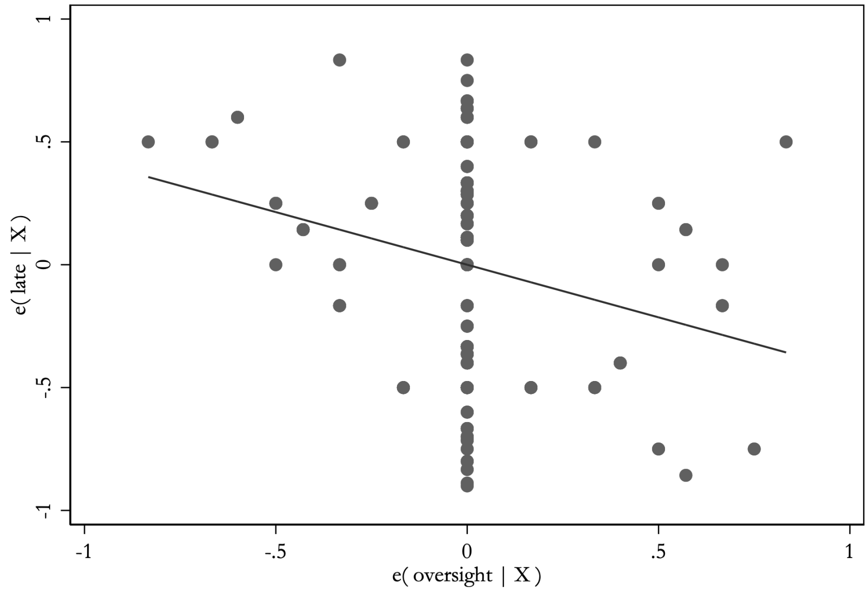


The effect of late by periods of high and low silver output This figure reports binscatters of the relationship between late departure and a failed voyage if silver output (in pesos) was high (black) or low (red). Controls include storms, typhoons, and ship fixed effects .

Table A.24: Manila to Acapulco: No Relationship Between Departure Date and Failed Voyages for On-Time Departures

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Departure Date	-0.00216	-0.00222	-0.00225	-0.00202	-0.00212	-0.00182
	(0.00159)	(0.00179)	(0.00191)	(0.00207)	(0.00222)	(0.00226)
Typhoon		0.00500	-0.0261	0.0170	0.0290	0.0229
		(0.213)	(0.188)	(0.219)	(0.226)	(0.224)
Storm			0.104	0.134	0.137	0.135
			(0.146)	(0.160)	(0.146)	(0.144)
Western Pacific Temperature				-0.380	-0.468	-0.469
				(0.648)	(0.625)	(0.606)
Eastern Pacific Temperature				-0.0785	0.000217	0.00623
				(0.141)	(0.0937)	(0.0980)
Years passed since first voyage					0.0631^{*}	0.0517
					(0.0375)	(0.0414)
Experienced Captain						-0.0764
						(0.0822)
Constant	0.331	0.366	0.349	0.206	0.191	0.157
	(0.260)	(0.300)	(0.311)	(0.451)	(0.459)	(0.475)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyages FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	93	92	92	92	92	92
Adjusted R^2	0.012	-0.023	-0.019	-0.024	0.027	0.028

This table shows that the relationship between departure date from Manila and a failed voyage for ships that sailed before the deadline. The controls are the same as in Table 1. Robust standard errors are clustered at the ship and voyage level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



coef = -.42843757, (robust) se = .17094428, t = -2.51

Figure A.4: The relationship between a late departure and periods of heightened oversight according to Schurz (1939). The avplot depicts the relationship between late departures and heightened oversight conditional on ship fixed effects.

Table A.25: Manila to Acapulco: Relationship Between Departure Date and Failed Voyages for Late Departures

	Shipwrecked or Returned to Port					
	(1)	(2)	(3)	(4)	(5)	(6)
Departure Date	0.00656**	0.00672**	0.00683**	0.00671**	0.00731**	0.00736***
	(0.00284)	(0.00292)	(0.00275)	(0.00286)	(0.00279)	(0.00277)
Typhoon		-0.0650	-0.110	-0.107	-0.102	-0.0859
		(0.0993)	(0.107)	(0.108)	(0.112)	(0.114)
Storm			0.433***	0.429***	0.441***	0.431***
			(0.132)	(0.142)	(0.139)	(0.134)
Western Pacific Temperature				-0.0887	-0.0220	-0.0190
				(0.332)	(0.342)	(0.347)
Eastern Pacific Temperature				-0.00320	0.00459	0.00820
				(0.133)	(0.129)	(0.128)
Years passed since first voyage					0.0541*	0.0511*
					(0.0286)	(0.0291)
Experienced Captain						-0.109
						(0.0822)
Constant	-1.135*	-1.157*	-1.249**	-1.243**	-1.369**	-1.347**
	(0.583)	(0.599)	(0.559)	(0.573)	(0.552)	(0.545)
Ship FE	Yes	Yes	Yes	Yes	Yes	Yes
Voyages FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	158	158	158	158	158	158
Adjusted R^2	0.063	0.061	0.188	0.177	0.191	0.194

This table shows that the relationship between departure date from Manila and a failed voyage for ships that sailed past the deadline. The controls are the same as in Table 1. Robust standard errors are clustered at the ship and voyage level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

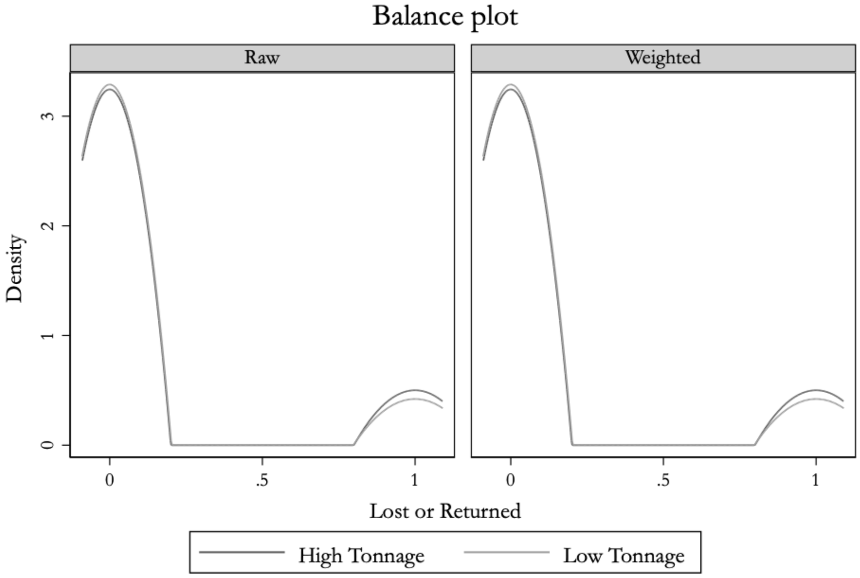


Figure A.5: A density plot show that high tonnage and low tonnage ship were equally likely to be shipwrecked or returned to port.

Figure A.6: Testing the Model: Balance on Discrete Variables II

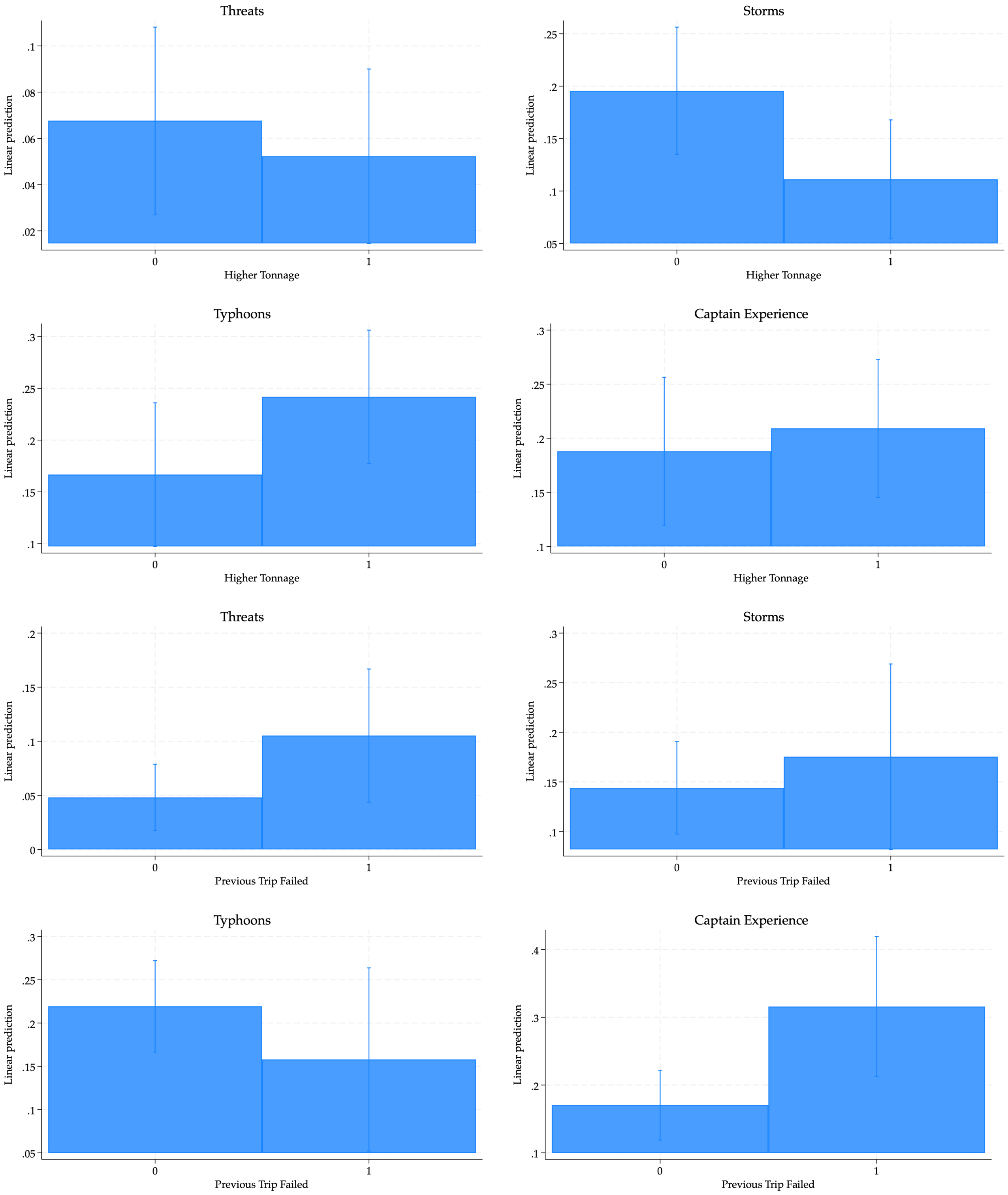


Figure A.7: Testing the Model: Balance on Discrete Variables II

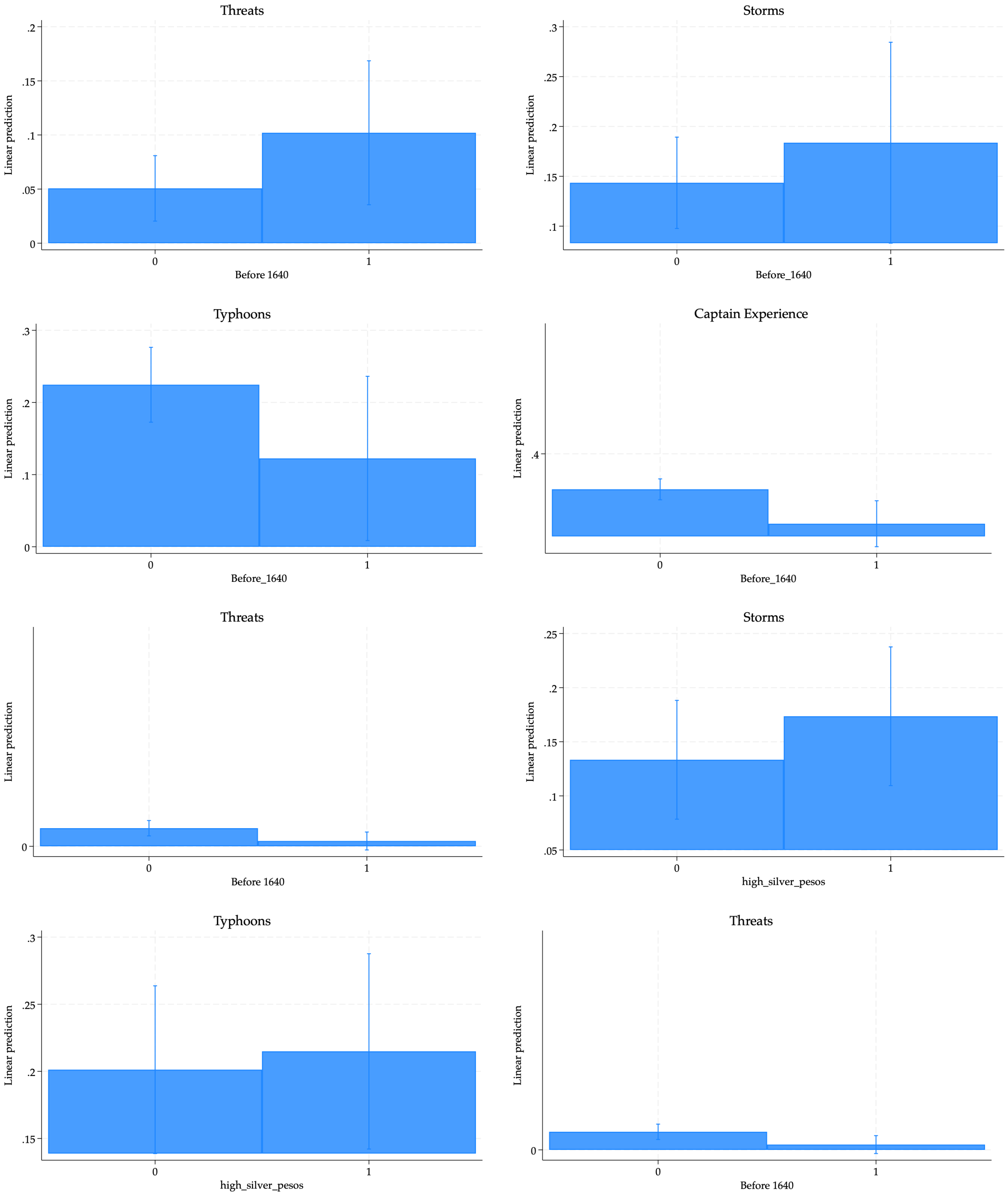


Figure A.8: Testing the Model; Balance on Continuous Variables I

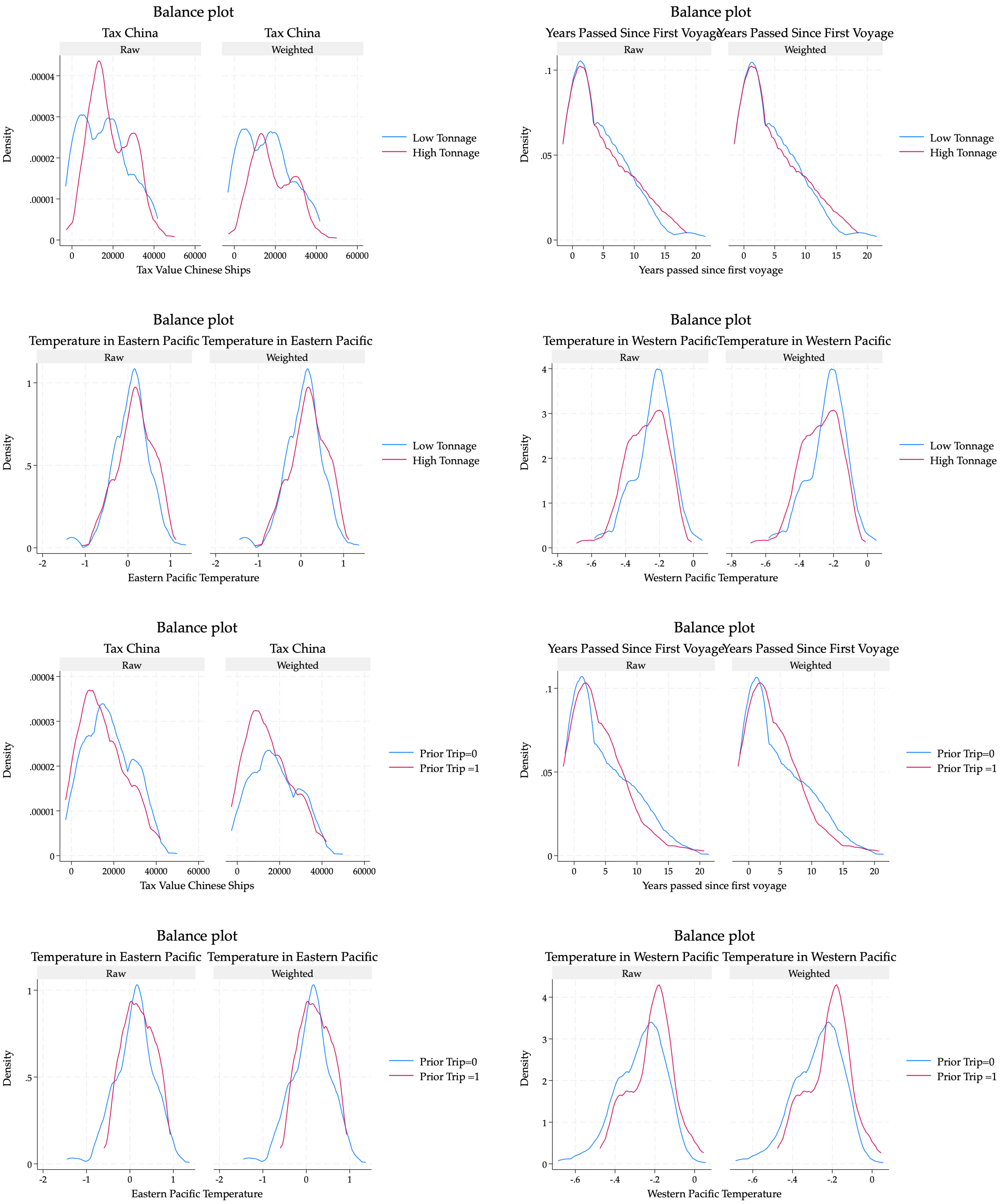
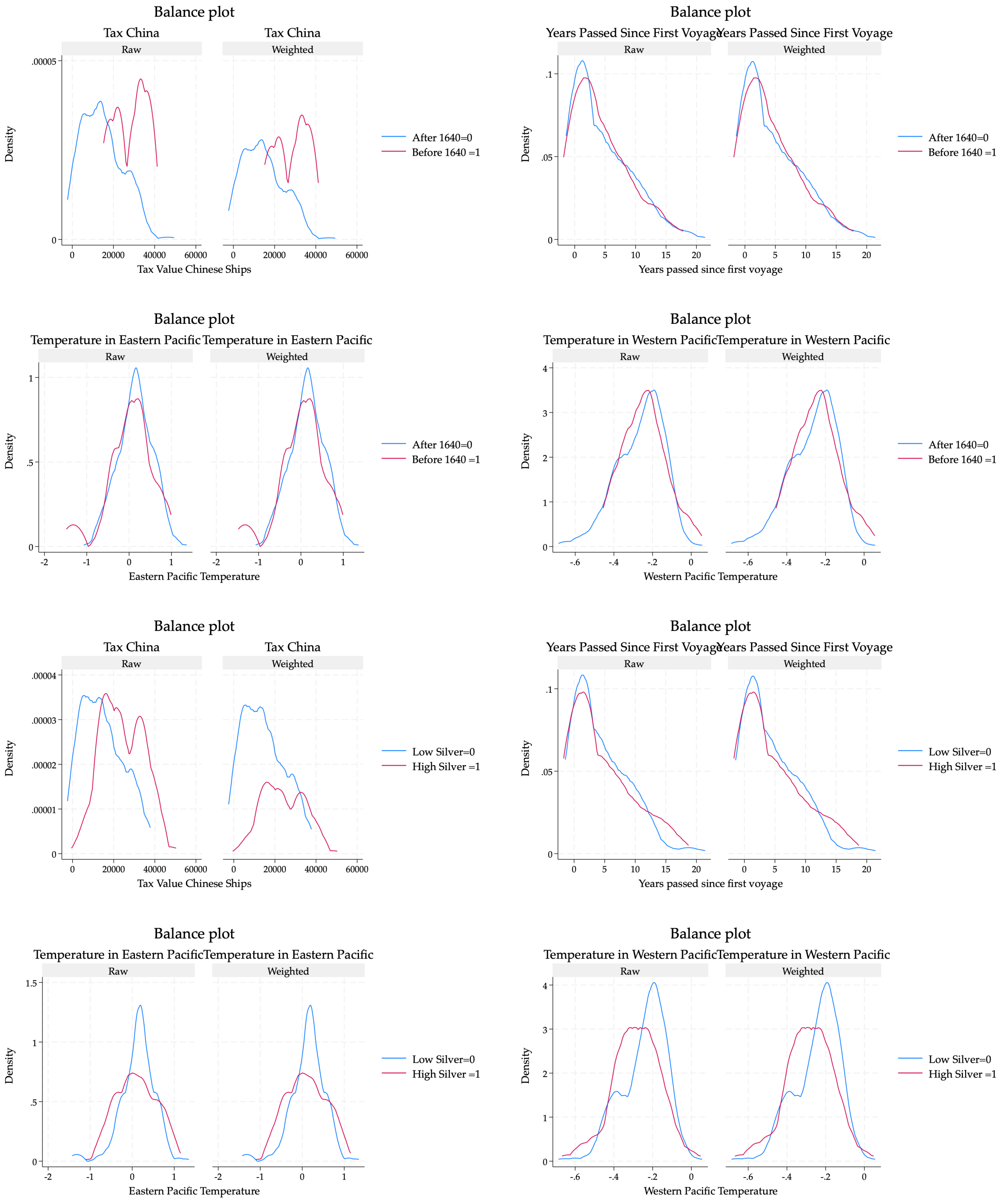


Figure A.9: Testing the Model; Balance on Continuous Variables II



4 Data Appendix

Available upon request.

The main sources used to build the core of the database are Cruikshank (2013):

https://sites.google.com/site/manilagalleonlisting/

a Spanish language website on the history of Spanish America:

https://laamericaespanyola.wordpress.com

and The Three Decks website a prominent web resource for researching naval history during the Age of Sail:

https://threedecks.org/index.php

We compare the information from these databases with a host of other sources to check its accuracy: including Schurz (1939), Fish (2011), Warren (2012), and primary documents from the Archivo General de Indias among others—and provide further details of data construction in this section.

We catalog the information by *(i)* identifying by name the ships sailing each year; *(ii)* by the ship's date of departure and arrival to destination (by year and by the specific day within each year); *(iii)* by route (Philippines to Mexico, or Mexico to Philippines); *(iv)* by the year when the ship made its first transpacific voyage; *(v)* by the age of the ship (the difference between the year of departure and the age of its first transpacific trip); *(vi)* by the number of previous transpacific voyages the ship had made; *(vii)* by the tonnage of the ship; *(viii)* by the final status of the departing ship (noting if it arrived to its destination, if it returned to its port of departure, or if it was reported lost); *(ix)* by the length of the voyage in days (measured as the difference between departure and arrival dates); *(x)* by the difference in days between the departure of the ship and the arrival, to that port, of a previous ship; *(xi)* by lateness of departure (identified when a ship sailed after July 15 for the Manila-Acapulco portion of the trip, and April 15 for the Acapulco-Manila trip); *(xii)* by the presence of storms, typhoons, or contingencies like roaming pirates in the nearby; *(xiii)* by the expected weather in the east and west Pacific (measured as the root mean square error's difference between observed value and forecasted temperatures); *(xiv)* by the identity of the governor of the Philippines at the time, and by his status (if he had been officially appointed, if he was an interim governor, or if the royal audiencia governed instead); *(xv)* by the identity of the captain of the Galleon, and by noting if he was competent enough (competence defined by qualitative descriptions of their expertise and by records showing that he made continuous trips across the Pacific); *(xvi)* by the identity of the Viceroy of New Spain at the time and his status (if he had been officially appointed, or if the royal audiencia governed in interim); *(xvii)* by the identity of the ruling King.

In the next sections we detail the specific process we followed to build the most important variables in the analysis.

A *Identifying the ships*

We build a panel dataset identifying each ship sailing per year, as well as their status and attributes. We use the websites La América española and Three Decks as the foundation of our database, as they had already compiled information from primary sources and constructed databases of their own (identifying most of the ships traveling per voyage from Mexico to Philippines and vice versa, along with specific dates of departure/arrival). We compare those databases with information from other sources including Cruikshank (2013), Warren (2012),Yuste (2007), and the Spanish website Todoavante). In most cases the information complements each other (e.g. an unknown ship in the Todoavante website, may be identified by name in La América española). Whenever inconsistencies between these secondary sources are found, we look into the primary sources (mainly coming from the Archivo General de Indias and Archivo General de la Nación) to settle the discrepancy. Alternatively, we follow a simple heuristic to correctly assess the accuracy of the entries per each of our source's databases: e.g. if we have evidence of ship X successfully arriving at Philippines from Mexico in the year 1700, and we don't find any registry that the ship returned back to Mexico thereafter, it means the same ship could have not sailed from Mexico to Philippines later in 1701. Most of the discrepancies we find are solved by rearranging the registry of ships through a comparison of this kind, between the different sources. Occasionally, however, time inconsistencies are found repeated through the sources. In those cases, we just left the entries as they were.

The status of each ship is categorized in the following form: *(i)* if it arrived at their destination; *(ii)* if it returned to their port of departure; *(iii)* if it was lost at sea. We use the same procedure described before to build our dataset: we compare between our sources trying to find discrepancies, rearranging the entries discretionally to create a timeline that is logical. e.g. if we find that ship Z was described as lost in 1700 in La América española, but we find that ship Z was described as sailing in 1701 in Cruikshank (2013), then it means the ship Z was not lost at all. Alternatively, if ship X sailed from Manila in 1700 and we have no evidence of it ever arriving to Acapulco, and we find a record of it sailing again from Manila in 1702, it implies the ship X returned back to Philippines in the original 1700 trip.

B *Estimating tonnage of ships*

We estimate the tonnage of the ships by looking into official registries that recorded the actual of each ship whenever this information was available. For this exercise, we used https://laamericaespanyola.wordpress.com, https://threedecks.org/index.php. We then proceeded to identify the types of ships that made the trip, and estimated the approximate size of the ship depending on its type according to the legislation of ship-building at the time. We found evidence of the following types of ships: schooners, dispatch-boats, packet boats, caravels, brigs, frigates, and galleons. This assessment was based on consulting the following sources: Sales Colin (2000), Yuste (2007), Maroto (2011), Ruiz (2010), Garcia-Torralba (2016), *Recopilacion de leyes de los reinos de las indias* (1841).

C Identifying the dates of departure and arrival of the ships

For those trips where no evidence of ships being lost or returning to their departing ports is found, we assume they arrived at their destination. Whenever we have any kind of information of departure/arrival dates, we record it. In some cases, our sources describe the exact dates when the ship sailed and/or arrived. Whenever that is the case, we just simply reformat the date (e.g. May 15th of 1700) to a-day-within-the-year format (e.g. day 135 of the year 1700). In other cases, the sources only identify approximate time frames through vague comments (e.g the ship sailed at the end of May). We employ a simple heuristic to transform those statements into a useful format: e.g. when they sources say the ship sailed in "early may" we record it as May 5th (day 125 of a given year); for an "end of May" statement, we transform it to May 25th (day 145); for "middle of May", we record them as May 15th (day 135).

We are interested in identifying dates of departures and arrivals between Manila and Acapulco. Unfortunately, our sources are not always specific in determining the starting/final points of the voyage. In those cases, we assume the dates are linked to Manila/Acapulco. In some cases, the dates we find are explicitly attached to points that are not Manila or Acapulco. Especially for the end points, e.g. Embarcadero in the Phillippines and Cape San Lucas in Mexico were common places the Galleon crossed in their voyage, and recorded dates may also exist when the ships navigated close by (sometimes they are the only dates that we may have record of). In those cases, we still nonetheless assume they were the starting/endpoint of the trip.

D Constructing late and time variables

We build two variables that identify the age of the ship. We first determine when the ship made its first transpacific trip, and then we treat as age *(i)* the previous voyages the ship has made before and; *(ii)* the years passed since the first voyage.

We also construct a variable that assess the time difference in days between the departing of a ship, and the closest arriving ship in a given port. The idea is to assess how the arrival of a previous ship may have impacted the lateness of departure. e.g. a ship's departure from Manila to Mexico—a trip that carried Chinese goods— may have depended on the previous arrival of a ship from Mexico to Manila—a trip that involved the transport of Mexican silver, which may have provided the needed funds to buy the Chinese merchandise that would later be transported to Mexico.

The specific way we build the variable depends on whether the previous arriving ships arrived within the same year as the departing ship, or if they arrived in a different year. For the former case, we take the first ship to arrive as the basis to calculate the difference in days between its arrival and the departure of our ship. For the latter case, when the previous arriving ship arrived in a different year, we base our calculations on the last arriving one. So, for example, if a ship arrived in Manila on July 15th, 1700, and then a second ship arrived in July 30, and our ship left Manila in August 15, 1700, the variable takes a value of 30 (1 month). But if, for example, no ship had arrived on 1700, but one had arrived on July 15, 1699, and other on December 15, 1699, the variable would take a value 240 (8 months).

To assess the lateness of departure we construct a binary variable, where a 1 indicates late voyages and 0 non-late voyages. Fish (2011) guides our considerations to identify when a ship was late. The threshold is April 15th for the Acapulco-Manila trip and July 15th for the Manila-Acapulco return trip. Sailing afterwards was deemed unsafe and not ideal. Hence, ships that departed after the threshold had passed are identified as being late. An imperial edict of 1773 ordered all ships leaving Manila to do so before July 15th, corroborating the importance of the date. To substantiate the robustness of the analysis, we build alternative thresholds by adjusting $+/-$ 10 days from the dates provided by Fish (2011).

E Identifying storms, typhoons, and other contingencies

Cruikshank (2013) and Warren (2012) provide qualitative evidence of the specific contingencies some galleons encountered in their trips. We use both as our main sources to identify potential threats to the safe and successful completion of a voyage. We build dummy variables that identify if a ship faced storms and/or pirates/buccaneers.

Alternatively, we also create a dummy that identifies the occurrence of typhoons in the Northeast Pacific, in the vicinity of the Filipino coast—where the risk of mishaps was the largest. Garcia-Herrera et al. (2007) refine the historical work produced by the Spanish Jesuit Miguel Selga in the early 20th century (Selga, 1935), and compile a yearly time series of typhoons and storms from the 16th to the 20th century. The data they provide is freely available online and we use it as our main source.

https://webs.ucm.es/info/tropical/selga-i.html

To assess climatic conditions we used estimates of historical temperature data from Tierney et al. (2015). Sea temperature is an important determinant of storms. This source codes the deviation in sea surface temperature in the Eastern and Western Pacific regions between the year in which was estimated and its long-term average (1961-1990).

This data is based on coral records. The majority of reconstructed climatic data, such as Guiot and Corona (2010) used by Anderson et al. (2017), is based on terrestrial paleoclimate proxy data. But for estimating oceanic temperatures it is more reliable to use marine proxies. Tierney et al. (2015, 227) note that "Corals represent one of our best high-resolution in situ archives of tropical ocean variability in the recent past". The specific proxy they use is $\sigma^{18}O$—the oxygen isotopic composition of the coral. This is negative proportional to the temperature of calcification. The authors note that "Individual coral records generally show a high level of fidelity in capturing seasonal to interannual climate variability in their geochemical signals" (227).

Tierney et al. (2015) reconstruct this data for four tropical oceans. Our interest to us are their data for the western Pacific (25° N–25° S, 110° E–155° E) and eastern Pacific (10° N°–10S,175° W–85° W). For the Western Pacific they have 23 proxies. For the Eastern Pacific they have 8 proxies. As is standard with reconstructed climatic data, they calibrate this data to the modern era and use this to back-project estimates for the historical past.

F *Identifying governors, viceroys, and captains*

For those trips departing from the Philippines, we identify who were the governors at the time. We use Wikipedia as our main source. We categorize them depending if they where: a) Official Governors, who were appointed by New Spain's Viceroy; b) Interim governors, who were appointed by the Manila Royal Audiencia (the local judicial junta); part of the Royal Audiencia, which sometimes governed as a collective while waiting for an official governor to be appointed.

Whenever possible we identify the name of the commanding navigators in each ship. We use Schurz (1939), Fish (2011), Yuste (2007), and Cruikshank (2013) as our main sources, supplemented by several works: Salas y Rodriguez (1887), Schurman et al. (1900),Blair and Robertson, eds (1904),Blair and Robertson, eds (1915), Bernabeu, ed (1990), *Consulta sobre encomienda a Fernando de Angulo* (1722), *Carta del obispo de Nueva Segovia Miguel de Benavides informando del estado de las islas* (1598), *Bienes de Difuntos: Juan Pardo de Losada Quiroga* (1625), Eldredge and Molera (1909), De Morga (1609), and Aduarte (1693).

We classify the commanding navigators into three groups: commanders; captains; and pilots. The difference between them depends on their particular role in the ship. Commanders were the officers in charge of the whole fleet. Captains were the officers in charge of the ship. Pilots were the officers exclusively in charge of piloting the ship. Whenever we had info for pilots, we recorded it; whenever we did not have info on pilots, we used the ship's captain; in the last instance we used the name of the commander (because commanders were in charge of fleets, one commander could be recorded in different ships that sailed at the same time).

We identify if these captains/pilots/admirals were experienced and competent or not. We primarily looked for qualitative evidence in our primary and secondary sources where we could asses if the given commander/captain/pilot was experienced or renowned. For example, Schurz (1939) states that Commander Diego de Arevalo—who commanded fleets in late 17th century—was on the "honor roll of the line" indicating the he was competent. An opposite example would be Commander Francisco Enriquez de Lozada, defined by Schurz as an "accountant of the royal treasury . . . a person of so different a profession", which implies that he had zero experience as a commander. We also found evidence of negligence where the governor appointed family members or friends. In those cases, we assumed that the persons at hand were not competent either. A second heuristic we followed to record competence is by noting if the same commander/captain/pilot had navigated three or more times across the Pacific. We assumed that doing several trips indicates that, at least, the navigator would have gained experience making him competent enough. Lastly, because the information on the names of navigators, and their competence, is limited, we assumed that whenever we did not find any such mentions, it implied the navigator was either inexperienced or not known for their competence.

G *Identifying conflicts involving the Spanish Empire*

We construct a data set that identifies if Spain was actively involved in a military conflicts for each year across the period study and against a set of identifiable opponents (Dutch, British, Southeast Asian, and local conflicts within the Philippines), We used Wikipedia: List of wars involving Spain as our source. Whenever Wikipedia identifies that a battle occurred against those aforementioned adversaries in a given year, we assume that Spain was in active conflict with them in that year. For the years between 1580 to 1640 we also looked for conflicts that involved the Portuguese Empire, as in that period Portugal was governed by a Spanish King.

H Identifying Asian ships in Manila

To assess the impact of Asian commerce to Manila we use Chaunu (1960). Chaunu gathered yearly data on the arrival of Asian ships to Manila from 1577 to 1780 (from Mainland China, Macau, Taiwan, India, Japan and other Southeast Asian societies). He also provides a proxy for the value of the cargo these ships brought via the amount of taxes they had to pay to Spanish customs in Manila.

Variable Name	Value Type	Details	Sources	Appendix Section
Unique Ship Id	Integer	We identify each individual ship that made the transpacific voyage and assign a unique ID to it. Most of the statistical analyses consider ship fixed effects.	Cruikshank (2013), Warren (2012),Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B1
Lost or Returned	Binary	Main dependant variable. A dummy that takes value of one if the ship was lost (if it did not complete the intended voyage) or if it returned to their port of departure.	Cruikshank (2013), Warren (2012),Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B1
Late	Binary	Main independent variable. A dummy that takes value of one if a ship was late in departing according to the Empire's legal ordinances. The lateness threshold is April 15th for the Acapulco-Manila trip and July 15th for the Manila-Acapulco trip.	Fish (2011), Cruikshank (2013), Warren (2012), Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B4
Years Since First Voyage	Integer	Records the amount of years that had passed since the ship made its first recorded transpacific voyage.	Cruikshank (2013), Warren (2012), Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B4
Storm	Binary	A dummy variable that identifies if a register exists that records the presence of a storm at a close date of a departing ship(within the same year).	Cruikshank (2013), Warren (2012), Garcia-Herrera et al. (2007), Selga (1935)	B5
Typhoon	Binary	A dummy variable that identifies if a register exists that records the presence of a typhoon at a close date of a departing ship(within the same year).	Cruikshank (2013), Warren (2012), Garcia-Herrera et al. (2007), Selga (1935)	B5
Western Pacific Temperature	Float	A variable that identifies the deviation in sea surface temperature in the Western Pacific region between the point in time in which it was estimated and its long-term average	Garcia et al. (2001)	B5

Eastern Pacific Temperature	Float	A variable that identifies the deviation in sea surface temperature in the Eastern Pacific region between the point in time in which it was estimated and its long-term average	Garcia et al. (2001)	B5
Pirates & Buccaneers	Binary	A dummy variable that identifies if a threat of pirates and/or buccaneers was present at the time a ship departed (within the same year). We look for qualitative evidence.	Cruikshank (2013), Warren (2012)	B5
Experienced Captain	Binary	A dummy variable that identifies the captains and/or pitols in charge of the departing fleet. We look for qualitative evidence to asses if they were experienced or not (e.g. they were mentioned as being skilled or having graduated with honors). Alternatively if a captain/pilot had made the voyage more than once we assumed he was experienced.	Schurz (1939), Fish (2011), Yuste (2007), Salas y Rodriguez (1887), Schurman et al. (1900),Blair and Robertson, eds (1904),Blair and Robertson, eds (1915), Bernabeu, ed (1990), *Consulta sobre encomienda a Fernando de Angulo* (1722), *Carta del obispo de Nueva Segovia Miguel de Benavides informando del estado de las islas* (1598), *Bienes de Difuntos: Juan Pardo de Losada Quiroga* (1625), Eldredge and Molera (1909), De Morga (1609), and Aduarte (1693).	B6
Interim Governor	Binary	A dummy variable that identifies the status of the governor of Philippines at the time of departure of a ship. We identify it as interim if the current governor hadn't been apppointed by the Viceroy of New Spain.	Wikipedia: Governor-General of the Philippines	B6
Audiencia Governor	Binary	A dummy variable that identifies the status of the governor of Philippines at the time of departure of a ship. Whenever the Royal Audiencia governed in conjunction, we identify the governor as being the audiencia itself.	Wikipedia: Governor-General of the Philippines	B6
Viceroy New Spain	Integer	We identify the ruling viceroy of New Spain at the time of departure of a ship and assign a unique ID to it	Wikipedia: List of viceroys of New Spain	B6
King Spain	Integer	We identify the ruling King at the time of departure of a ship and assign a unique ID to it	Wikipedia: List of Spanish Monarchs	B6

Regional Conflicts	Binary	A dummy variable that identifies if the Spanish Empire was embroiled in a conflict in South East Asia at the time of departure of a ship (within the same year). We look for evidence of combats in the area that are not related to conflicts with England, Netherlands or local rebellions within the Philippines.	Wikipedia: List of wars involving Spain , Wikipedia: List of wars involving Portugal	B7
Conflicts With England	Binary	A dummy variable that identifies if the Spanish Empire was embroiled in a global conflict with England at the time of departure of a ship (within the same year). We look for evidence of battles against the English.	Wikipedia: List of wars involving Spain	B7
Conflicts with Dutch	Binary	A dummy variable that identifies if the Spanish Empire was embroiled in a global conflict with the Dutch at the time of departure of a ship (within the same year). We look for evidence of battles against the Dutch.	Wikipedia: List of wars involving Spain	B7
Conflicts in the Philippines	Binary	A dummy variable that identifies if the Spanish Empire was embroiled in a local conflict within the Philippines at the time of departure of a ship (within the same year). We look for evidence of battles and raids within the Philippines.	Wikipedia: Philippine revolts against Spain	B7
Total Conflicts	Binary	A dummy variable that identifies if the Spanish Empire was embroiled in whatever conflict at the time of departure of a ship (within the same year)	Wikipedia: List of wars involving Spain , Wikipedia: List of wars involving Portugal , Wikipedia: Philippine revolts against Spain	B7
Departure Date	Integer	Records the day of the year in which the ship departed.	Cruikshank (2013), Warren (2012),Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B3
Arrival Date	Integer	For each departing ship, it records the day of the year in which the first ship arrived to that same port	Cruikshank (2013), Warren (2012),Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B3
Total Number of Ships	Integer	For each departing ship, it records the total number of asian ships arriving into port.	Chaunu (1960)	B8

Chinese Ships	Integer	For each departing ship, it records the total number of chinese ships arriving into port.	Chaunu (1960)	B8
Tax Value Chinese Ships	Integer	For each departing ship, it records the tax value of the merchandises brought by chinese ships arriving into port.	Chaunu (1960)	B8
Tax Value Total	Integer	For each departing ship, it records the tax value of the merchandises brought by asian ships arriving into port.	Chaunu (1960)	B8
Tonnage Estimate	Integer	Identifies the estimate tonnage of the ship. Whenever possible we record the actual tonnage. For the rest we estimated through their types (i.e. a frigate would be larger than a Galleon), and following the Empire's legal ordinances that established legal limits in the size of the ships.	Sales Colin (2000), Yuste (2007), Maroto (2011), Ruiz (2010), Garcia-Torralba (2016), *Recopilacion de leyes de los reinos de las indias* (1841), La América española Blog, Three Decks Website	B2
High Tonnage	Binary	A dummy variable that identifies if the tonnage of the ship was above the mean (439 kilos)	Sales Colin (2000), Yuste (2007), Maroto (2011), Ruiz (2010), Garcia-Torralba (2016), *Recopilacion de leyes de los reinos de las indias* (1841), La América española Blog, Three Decks Website	B2
Low Tonnage	Binary	A dummy variable that identifies if the tonnage of the ship was below the mean (439 kilos)	Sales Colin (2000), Yuste (2007), Maroto (2011), Ruiz (2010), Garcia-Torralba (2016), *Recopilacion de leyes de los reinos de las indias* (1841), La América española Blog, Three Decks Website	B2
Galleon Dummy	Binary	A dummy variable that identifies if the sailing ship is a Galleon or not (other ships that made the transpacific voyage were frigates, caravels, and other smaller boats).	La América española Blog	B2
Previous Voyage Failed	Binary	Identifies if the immediate voyage of the last year failed; that is, if the ship in turn got lost, returned to port, or didn't even sail.	Cruikshank (2013), Warren (2012),Yuste (2007), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website	B1

Table A.27: Details of the Conversions of 17th century Peso to 2020 USD.

Estimate	Peso 17 c.	£ 17 c.	£ 2020 GDP Deflator	$ 2020 Nominal Exch. Rate	$ 2020 PPP Exc. Rate
The Cargo Value in the San Jose Ship (p.1)	7,694,742	1,957,950	295,700,000	399,594,595	442,664,671
Cargo Value Limit, Manila to Mexico (p.9)	250,000	63,613	9,607,000	12,982,432	14,381,737
Legal Cargo Value Limit, Mexico to Manila (p.9)	500,000	127,226	19,210,000	25,959,459	28,757,485
Estimated Boleta Value (p.9)	125	32	4,833	6,531	7,235
Captain Salary, Low Estimate (p.27)	50,000	12,723	1,921,000	2,595,946	2,875,749
Captain Salary, High Estimate (p.27)	100,000	25,445	3,843,000	5,193,243	5,752,994

5 Identifying Silver Flows

A key characteristic of the Manila trade is that it hinged upon silver flowing from America, specifically Mexico, to the Philippines to buy Asian wares. We use silver output both in pesos of 272 Maravedis aand Kilograms of fine silver in Mexico as a proxy of the patterns of silver flow to Manila. Data was taken directly from TePaske (2010).

6 Calculations of 17th Century Prices

Our estimates of the value of the cargo of the Manila Galleons follows the following back-of-the-envelope calculation. We first compare the silver weight between the 17th century Spanish peso and the British pound sterling. The Peso (also called Real de Ocho) was worth an ounce (28.39 grams) of Silver (Marichal, 2006, 32). The British pound was worth 111.4 grams of silver (Shaw, 1896, 44). The peso: pound exchange ratio was 1:0.25. We use it and derive the value of 17th-century British pounds. We then use the MeasuringWorth.com website to estimate the 2020 pounds value. We use 1694 as our baseline year (The year of the sinking of the San Jose), and we deflate using the GDP deflator. Lastly, we estimate the current USD values using current nominal exchange rates (1:0.74 USD to GBP) and current OECD PPP exchange rates (1:0.668 USD to GBP).