# 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 remain undiscovered. We introduce a newly constructed dataset of all of the ships that travelled this route. We show formally how monopoly rents that allowed widespread bribery would have led to overloading and late ship departure, thereby increasing the probability of shipwreck. Empirically, we demonstrate not only that these late and overloaded ships were more likely to experience shipwrecks or to return to port, but that such effect is stronger for galleons carrying more valuable, higher-rent, cargo. This sheds new light on the costs of rent-seeking in European colonial empires.

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Keywords: Corruption, Rent-seeking, Bribery, Shipwrecks, Institutions

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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. 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 more than $500 million in today's money.[1] The *San Jose* was certainly not 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). In contrast, only 3.5% of the ships of the Dutch East India Company sank while traveling between the Netherlands and Asia during the same period (1595-1795).[2]

Why did the *San Jose* and so many other Manila Galleons experience shipwrecks? Two factors are important for understanding its fate and the fate of the other ships that ended in disaster. First, galleons were often overloaded. The *San Jose* had a cargo of more than 12,000 *piezas*, three times the legal limit. Second, the galleons often departed past the official deadline and into the perilous monsoon season. This answer, however, begs a deeper question: Why were the galleons overloaded and late?

In this paper, we establish that overloading and late departures were an equilibrium outcome of the monopoly regulations imposed on the Galleon trade, which provided opportunities for large-scale rent-seeking. The number, size, and weight of the ships were specified by law, and typically only one voyage was permitted per year. These restrictions, put in place because merchants in Spain wanted to restrict the number of Asian goods entering American and European markets, meant that cargo space on each ship was extremely valuable. This enabled ship officials to extract bribes from merchants in Manila in exchange for loading their cargo on to the galleon. Maximizing these rents led to frequent overloading and late departures, thereby increasing the likelihood of shipwreck. We then test our predictions using a unique new dataset of the universe of ships that sailed between the Philippines and Mexico between 1565 and 1815.

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

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[1] See *ORRV Team Discovers Two Shipwrecks in the Philippines* (2011).

[2] See Bruijn et al. (1987).

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 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 almost 2% of the GDP of the entire Spanish empire.[3] That captains risked overloading their ships and sailing into the monsoon season implies that the bribe-rents were so large that they compensated for the expected loss from shipwreck.

There remains disagreement whether bribes impose an additional cost in the form of queues and delays or whether to the contrary, bribery "greases the wheels". For instance, 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, theoretical work by Lui (1985) that explores the relationship between queuing and bribery 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.[4]

This argument applies, however, only when customers pay a bribe in exchange for being provided a service that is inexhaustible. Each bribe is an efficient 'price' that reflects each customer's costs of queuing and there are no external effects since the service is not rationed. In contrast, when customers bid for regulated goods or services, bribes not only reflect the valuation of the customer, but can induce the server to over-provide the service and delay the completion of his task. This can have deleterious effects, such as disasters and shipwrecks, in the particular case of loading valuable ship cargo.[5]

We introduce a novel model to explain why bribe taking led to ships sailing late and overloaded. In our model, traders in Manila, who want to sell merchandise in Acapulco, bribe galleon officials in exchange for cargo space. Such space is legally restricted. There is also a deadline imposed, on or before which the galleon has to depart, in order to avoid dangerous waters during the monsoon season. In equilibrium, galleon officials are able to extract maximum bribes — with many merchants vying for an allocation of the total space in the galleon, officials are able to pit them against each other and bid the bribe up to the cargo's value. Thus, when the cargo value is very high, the bribe payments are also very

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[3] Specifically, the value of the cargo was approximately \$252 million in 1990\$. We calculate our estimates of GDP for the Spanish empire by adding up the separate estimates Arroyo Abad and van Zanden (2016) provide for Spain, Mexico, and Peru and our own back of the envelope estimate of Philippine GDP based on Maddison (2003).

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

[5] There are many disasters that have been linked to corruption. For instance, Ambraseys and Bilham (2011) show 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. See Fisman and Golden (2017) for a survey.

large, inducing officials to load a lot of cargo which delays the departure date and overloads the galleon, and increases the likelihood of shipwreck. Precisely because trade is restricted, and cargo is therefore valuable , bribe rents can compensate for the expected cost of shipwreck.

The model builds on the lobbying framework in Grossman and Helpman (1994, 2001), and the common agency models of Bernheim and Whinston (1986a,b), and Dixit et al. (1997) which have been used to study policy selection and special interest politics. Bribery is efficient for both galleon officials and merchants in that the bribe payments take into account the expected cost from shipwreck. It is, however, socially costly since the payments do not take into account costs to other stakeholders, e.g. lives of crew members and passengers, costs of shipbuilding and repairs, lost revenues to the Crown, nor, more especially, the distortions from the monopoly trade.

Before testing the implications of the model, we first empirically verify what contemporaries already knew at that time — that sailing past the legally mandated deadline (and, thus, into the monsoon season) is likely to end in shipwreck. To do this, we demonstrate that there is a robust relationship between sailing late from Manila 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.

Our model can explain why galleon officials intentionally risked a higher probability of shipwreck by sailing past the deadline. Monopolistic regulation that kept the value of the cargo at a high level allowed the officials to extract bribe payments from merchants in exchange for loading their cargo. In equilibrium, too much cargo was loaded, which meant that either, typically, the ship was overloaded, or it would sail late (since loading took time), or both. Being overloaded or sailing late into the monsoon season increased the probability of shipwreck, even more so if the ship was both overloaded and sailed late. In turn, the higher the value of the cargo, the more likel that the ship was both overloaded and sailed late, since this would have enabled officials to extract larger bribes, in exchange for loading a lot more cargo.

We conduct two sets of empirical tests of the model. First, we provide evidence that a ship that was both overloaded and sailed late was more likely to end in shipwreck 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 also overloaded when sailing late. Our results show that the relationship is indeed much stronger for low–tonnage ships.

As a second test of the model, 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, and even more so for low–tonnage ships. Such periods include those immediately succeeding a failed voyage – to make up for the losses, and the unmet demand for the lost goods, the value succeeding cargo would have been higher. Other periods include those after significant institutional changes and reforms. All our results confirm that in periods of relatively higher value of cargo, a late departure more strongly predicts shipwreck, and even more so when the ship is of low tonnage.

The paper makes several contributions. First, by examining the relationship between bribery, late and overloaded ships, and failed voyages, we shed light on the costs of rent-seeking and corruption.[6] Though a large literature has built on the insights of Tullock (1967), Krueger (1974),Murphy, Shleifer and Vishny (1993), Shleifer and Vishny (1993), and Shleifer and Vishny (1998), measuring the true costs of rent-seeking remain a major challenge. Indeed a survey of the empirical literature on rent-seeking concludes that "its measurement is very problematic" (Del Rosal, 2011, 300). Recent papers on the cost of corruption using microlevel data and causal identification thus focus on 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 vein, our findings are specific to the Manila Galleon trade, but have generalizable insights that are relevant to other settings.

Second, we find that the costs of rent-seeking was exceptionally high. The insight that colonial trading regimes were a rich source of rents to insiders, but imposed high costs on society predates Adam Smith (1776). 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.[7] Ekelund and Tollison (1981, 1997) applied these insights to the mercantilist and colonial regimes of early modern England, France, and Spain. Recent research has studied the long-run consequences of office selling in the Spanish

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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 view them as referring to essentially the same underlying phenomenon.

[7] 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).

empire (Guardado, 2018). More generally, 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.[8]

A third contribution is to the economic history literature on colonial empires (Marichal, 2007; Grafe and Irigoin, 2006; Irigoin and Grafe, 2008; Grafe and Irigoin, 2012). As discussed by Abad and Palma (2021), this empire was largely based around the extraction of precious metals, particularly silver. 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.[9] These stringent regulations produced widespread smuggling in the Americas. The immediate and long-run consequences of both legal and illegal trade are examined by Alvarez-Villa and Guardado (2020).

The paper provides the first empirical study of the Manila Galleon trade, a vital part of Spain's colonial empire. 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). 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). This is the first empirical examination of rent-seeking in the Manila Galleon trade.

The only permissible trade between Mexico and Spain and Philippines was the Acapulco-Manila trade route traversed by the Manila Galleons. The extent of rent-seeking originating out of this trade has been emphasized by historians (Brading, 1971; Walker, 1979; Garner and Stefanou, 1993). Traditionally these institutions were seen as both extremely lucrative, for those involved and costly for society at large. A revisionist literature, however, claims that the returns generated by these restrictions were not abnormally high. Baskes (2005), for instance, contends that "many of the business practices and trade institutions of the early modern Spanish empire that have been identified as the predatory creations of monopoly merchants need to be understood instead as adaptations to risk, attempts to reduce the tremendous uncertainty that characterized long-distance trade" (Baskes, 2005, 27). We are the first to provide an empirical and systematic refutation of this claim. The monopoly rents from the Manila

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[8] 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.

[9] 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).

Galleon trade were in fact too high, since they allowed merchants and officials to take on even *more* risk (of shipwreck) by overloading the galleons and sailing into the monsoon season.

The remainder of the paper is as follows. Section 2 provides an overview of the historical background to the galleon trade. Section 3 introduces our data and establishes a robust positive relationship between a late departure and a failed voyage. To examine why ship captains routinely left Manila late despite the additional risks this imposed, we introduce in Section 4 a model that shows how rent-seeking could have led to overloading and late departures, which increased the probability of failed voyages. In Section 5 we present several tests of this model. Section 6 concludes.

## 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 is a unique source as it 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).[10] For this reason, subsequent scholarship on the Manila Galleon trade remain reliant on Schurz (1939).

### *2.1 Historical Background*

A major motivation for Spanish colonial exploration and conquest 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 Spanish to establish 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, an excellent natural harbor of no other economic or political significance (Schurz, 1917, 18).

The trade proceeded as follows. In May, merchants from China, but also from other parts of Asia,

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[10] The search for the lost log books is described by Burt (1990) 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".

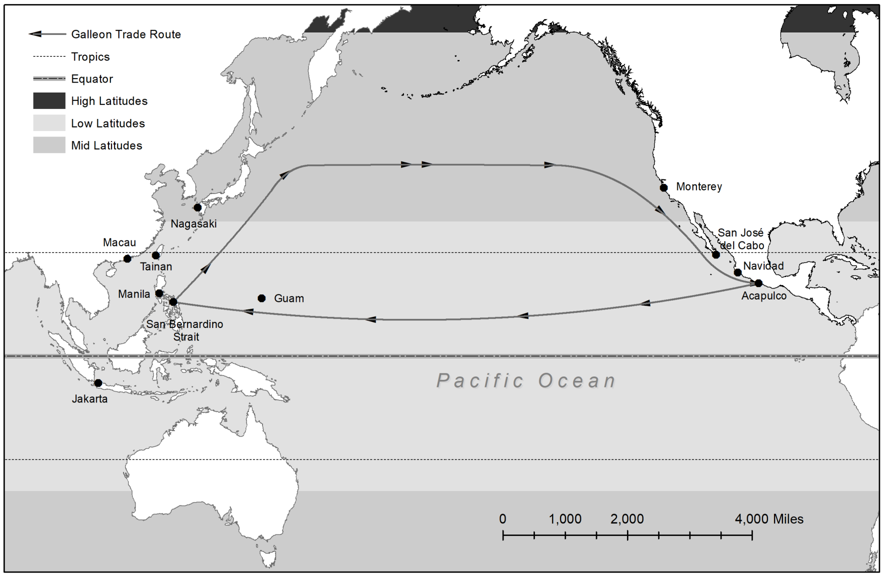

Figure 1: The Route of the Manila Galleons

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 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 as 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 degree latitude and 20 degree 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 East 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 (Meijia, 2019).

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 (Yuste, 2007b). Consequently, both the number of voyages and the size of the cargo per voyage were 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).

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*).[11] Second, to

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[11] This board included the Governor, the senior judge of the *Audiencia*, the fiscal (attorney-general), two members of

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 in their assessment that this highly regulated and monopolistic system generated opportunities for percolation, rent-seeking and corruption. For instance, Mccarthy notes that "'[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 Overloading*

The official number of *piezas* was chosen not because it corresponded to the carrying capacity of the ships involved, but because lobbying interests in Spanish wished to limit the importation of Asian goods. Therefore, the limit on the number of legal cargo, i.e. *pieza* with *boleta*, was typically 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. However, if the ship was carrying far in excess of the official limit, the safety of his ship was put at risk.

In particular, what put these galleons are high risk was the distribution of cargo. 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 of the galleons were filled with ballast. Stability required a certain ratio between cargo and ballast. Additional cargo threatened stability because it easily 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".

The principles of hydrostatic stability explain why the volume and distribution of cargo (as well

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the City Council, and the Archbishop. In 1768 this was changed to a *consulado* composed of merchants.

as it sheer weight) can compromise ship stability. The concept of a metacenter from fluid mechanics is helpful in understanding this. 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).

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 until the mid-18 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. But this would have been based on loose rules of thumb Absent a modern understanding of hydrostatic stability, it was have been easy to over-estimate how much cargo could be stowed without endangering the ship. We provide a more detailed discussion in Appendix D.

The problem of overloading was well-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 and we mandate that ship tonnage limits be observed . . . we extremely caution against the overloading of ships, as it increases the risk of being lost due to mishaps. We recommend for ships to be in conditions to withstand sea torments and enemies." (*Recopilacion de leyes de los reinos de las indias*, 1841, 125-126)

Yet, more than a century later after such law was decreed, 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 were often late. The optimal departure from the port of Cavite was in June. The date of departure 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.[12] 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 a dangerous one. 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, the 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.

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[12] 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).

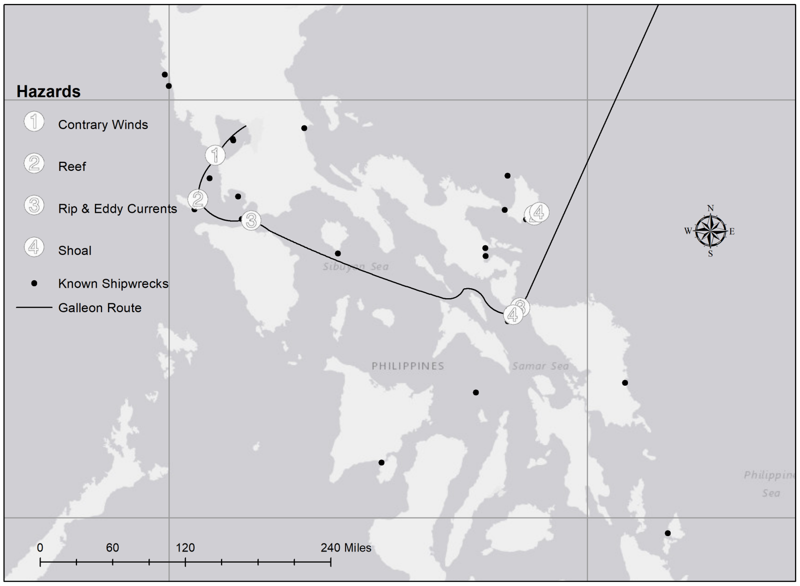

Figure 2: The main hazards on departing Manila via the Embocadero route & locations of known shipwrecks (Bennett, 2010). Ships severely damaged on en route from Manila often returned to port. In contrast, a ship wrecked out in the Pacific was more likely to be declared lost.

However, this alternative was rejected by merchants in Manila. The reason given was that it would have necessitated a significantly earlier departure.[13]

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*

Our measure of a failed voyage is either a lost ship or a ship 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 almost as disastrous as a shipwreck itself:

> “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

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

> 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).[14]

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 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) 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"

Thus far, no quantitative evidence has ever been marshaled to investigate this. In the next section, we introduce a new dataset of voyages, ships, storms, and underlying weather conditions for the eastern and western Pacific. We first establish that there is indeed a robust empirical relationship between late departures and failed voyages. Then in Section 4 we formalize the hypothesized relationship between rent-seeking, overloading, and late departures, and test its implications in Section 5.

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[14] 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".

## 3 The Relationship Between Late Departures and Failed Voyages

### *3.1 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 of data 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.[15]

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.[16]

We know whether the ship safely arrived at its destination, or whether 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.

To explain failed voyages, we first need a variable indicating 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. However, 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

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

[16] 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.

which the ship sets sail.[17]

We want to show that a late departure increases the probability that the voyage results in a failed voyage and that the reason is that galleon officials extract bribes from merchants in exchange for loading cargo, which induces the officials to load too much cargo, to the point of overloading the galleon and departing past the deadline. Note, then, that we do not merely want to identify a reduced-form relationship between late departure and failed voyages, but we aim to uncover a specific mechanism that generates this relationship. That we do not instrument for late departure is thus deliberate, as we are precisely interested in showing *why* officials deliberately sailed late.

One could, of course, estimate a structural model that specifies, in the first stage, the relationship between bribe-taking and overloading and late departures, and in the second stage, the relationship between late departures and failed voyages. However, the main challenge to identification is that while it was widely known that ships were typically overloaded and that bribery was ubiquitous, no data exists on the amount of cargo loaded in each voyage, nor on any bribes that were paid. How, then, could one systematically link sailing late and overloading to bribe-taking in a way that results in a failed voyage? Our strategy is as follows.

First, we establish a clear relationship between late departure and a failed voyage that is robust to the inclusion of other variables (as well as ship and voyage fixed effects) that are related to late departure and affect the safe arrival of a ship at its destination port. That the effect of late departure remains strong suggests some other related factor which, from our reading of the historical literature, we hypothesize to be the propensity of galleon officials to load too much cargo in order to maximize the total amount of bribes extracted from merchants. To demonstrate why this is logically plausible, we propose a model in section 4 that formally shows the mechanism linking bribe-taking with overloading, late departures, and failed voyages. To show that the mechanism is not at odds with empirical evidence, we derive some auxiliary predictions from the model that we can test with our data. Section 5 presents these final set of empirical results.

One obvious factor associated with both late departures and failed voyages is the weather. Sailing late into the monsoon season increases the chances of encountering rough waters and storms, and hence the probability of a failed voyage. To capture the threat of storms or bad weather we use several sources: (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). Another

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[17] 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 Shurz. (More later).

important determinant of the length and success of any voyage was the climate of the Pacific. Sea temperature is an important determinant of the risk of a tropical storm. When sea water is warm enough to evaporate at a fast enough rate, the chances of a storm become higher. We make use of reconstructed temperature data in Western and Eastern Pacific from Garcia et al. (2001). 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 reasons other than the rent-seeking mechanism proposed here. 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.[18] Ship captains or commanders were appointed by governors and this was known to be a lucrative appointment and a source of corruption. Schurz (1939, 206) notes that "The richest gift within the power of the governor was command of the galleon. Padre Zuñiga said the governor named as general 'whomever he wished to make happy."' This was a rich gift, not because of the salary associated with the position, but because of the opportunities to obtain bribes from the Manila merchants and from his own private cargo on the ship. A successful voyage could make a captain so rich that it "removed the stimulus of further service" (Schurz, 1939, 205).[19] It was only in 1800 that governors ceased to have the power to appoint the captain and as Schurz (1939, 202) notes this "reform had come too late to affect the history of the line".

Although the incompetency of the ship captain and crew had little to do with the decision to set sail, it is nevertheless mentioned by historians as a potential explanation for shipwrecks.[20] Compared to service in the Atlantic, the voyage between Manila and Acapulco was more dangerous and arduous.

To proxy for the competency of captains, we construct a novel dataset of ship captains. We code a

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[18] 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".

[19] In contract, the other sailers could be motivated to repeat the voyage several times because of the pecuniary rewards. Costa (1965) recollects the memory of a local who states "Notwithstanding the dreadful sufferings in this prodigious voyage, yet the desire of gain prevails with many to venture through it four, six, some ten times. The very sailors, though they forswear the voyage when out at sea, yet when they come to Acapulco, for the lucre of two hundred and seventy five pieces of eight the king allows them for their return, never remember past sufferings"

[20] 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".

captain as experienced if he satisfies either of the following criterion: (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, and could therefore confound the relationship between late departures and failed voyages. These are the identity of the governor who appointed the galleon captain, the date of arrival of the Acapulco–Manila galleon that carried silver payment for the previous batch of cargo, the presence of pirates and periods of war and conflict, and the trade with China and Asia. (See section 3.3 for details.)

Lastly, we replicate all our regression exercises 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 rent-seeking opportunities and incentives to overload and depart late. Of course, the Acapulco–Manila route was also 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.[21] However, what is important is whether there is a relationship between late departures and failed voyages and we find no evidence of this when the placebo sample is used.

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.

### *3.2 Late Departures and Failed Voyages*

We run regressions based on the following specification:

$$\text{Failed Voyage}_{i,v} = \alpha + \beta_1 \text{Late}_{i,v} + \mathbf{X}_{i,v}\gamma + \Lambda_i + \Gamma_v + \epsilon_{i,v} \qquad (1)$$

where Failed Voyage$_i$ refers to a ship $i$ wrecked or returned to port (*arribada*) during voyage $v$. $\Lambda_i$ are ship fixed effects and $\Gamma_v$ are voyage fixed effects. The coefficient of interest is $\beta_1$. Standard errors are clustered at the ship level in most specifications; elsewhere we cluster at the ship-voyage level. All

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[21] 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.

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) | (7) |
| Late | 0.176$^{**}$ | 0.178$^{**}$ | 0.232$^{***}$ | 0.240$^{***}$ | 0.237$^{***}$ | 0.238$^{***}$ | 0.238$^{***}$ |
| | (0.0704) | (0.0702) | (0.0828) | (0.0747) | (0.0731) | (0.0744) | (0.0693) |
| Typhoon | | 0.0212 | 0.0383 | -0.00260 | -0.00439 | 0.000463 | 0.000463 |
| | | (0.0623) | (0.0741) | (0.0714) | (0.0713) | (0.0729) | (0.0668) |
| Western Pacific Temperature | | | -0.148 | -0.0358 | -0.0666 | -0.0615 | -0.0615 |
| | | | (0.214) | (0.206) | (0.203) | (0.205) | (0.210) |
| Eastern Pacific Temperature | | | -0.101 | -0.0766 | -0.0543 | -0.0522 | -0.0522 |
| | | | (0.0953) | (0.0829) | (0.0802) | (0.0808) | (0.0846) |
| Storm | | | | 0.313$^{***}$ | 0.322$^{***}$ | 0.322$^{***}$ | 0.322$^{***}$ |
| | | | | (0.101) | (0.0991) | (0.0988) | (0.0988) |
| Years passed since first voyage | | | | | 0.0557$^{*}$ | 0.0551$^{*}$ | 0.0551 |
| | | | | | (0.0298) | (0.0301) | (0.0318) |
| Experienced Captain | | | | | | -0.0331 | -0.0331 |
| | | | | | | (0.0639) | (0.0652) |
| 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 | 360 | 359 | 250 | 250 | 250 | 250 | 217 |
| Adjusted $R^2$ | 0.013 | 0.010 | 0.032 | 0.110 | 0.134 | 0.131 | 0.059 |

This table establishes a positive relationship between late departures from Manila and failed voyages. The number of observations shrinks in columns (3)-(7) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level for columns (1-6) and at the ship and voyage level in column (7). $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

specifications include ship fixed effects and voyage fixed effects.[22] 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.

Table 1 reports results from estimating (1) by OLS — a linear probability model.[23] 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 climate (column 3). Column 3 is our benchmark specification. The coefficient of interest remains comparable across specifications and remains similarly robust when we sequentially include controls for storms (as recorded by the logs of the ships) (column 4), the age of the ship, and the experience of the

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[22] 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.15, we include 50–year and century fixed effects. For completeness, we also report results without ship and voyage fixed effects in Table A.9.

[23] 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.

captain (column 5).[24] 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.[25] An alternative 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. 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. We report alternative specifications in the Empirical Appendix including those using departure date as our explanatory variable (Appendix Table A.4) and using an inverse probability weighting model (Appendix Table A.6 and Appendix Figure A.3). Finally, we show that our results are not affected by attrition bias (Table A.10).

In contrast, when we examine the voyages from Acapulco to Manila we find no such relationship between a late departure and a failed voyage even with the least restrictive bivariate specification (Table 2, column (1)). This is an important finding as it suggests that there was something specific to the situation in Manila that was responsible for the relationship between late departures and failed voyages. We explore this in detail in sections 4 and 5, but first we consider other variables that historians have proposed to have affected the departure date of the galleons.

### *3.3 Other Correlates of Late Departure*

**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. One of 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

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[24] As the presence of a storm is recorded from the logs of ships, this variable needs to be interpreted cautiously.

[25] When omitting ship fixed effects, we can test whether ship size was responsible for shipwrecks at least on the 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.17 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.

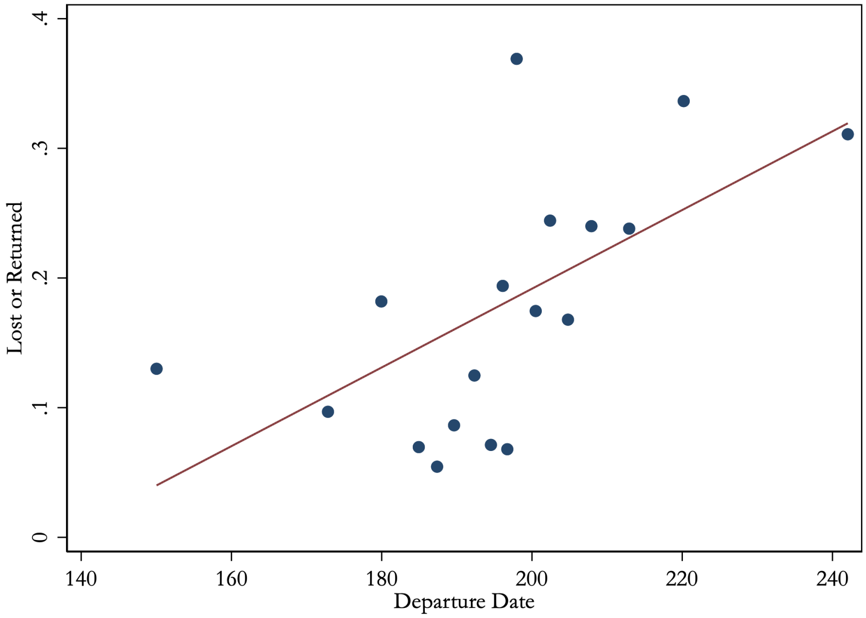

Figure 3: A binscatter plot of the relationship between departure date and a failed voyage. Controls include the presence of a storm, pirate threats, typhoons, temperature in the Eastern and Western Pacific and captain experience, and ship and voyage fixed effects.

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. In Appendix Table A.16 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 (net of other factors), as we actually want the estimated coefficient of late departure to capture corruption. That is, it is the relationship between late departure and failed voyage that is explained by bribe-taking that we want to capture and not throw out. 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.[26]

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[26] 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".

**Determinants according to Schurz** The relationship between a late departure and a failed voyage thus far remains very robust, but this could have still been due to innocuous reasons that had nothing to do with rent-seeking. In fact, 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).[27]

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.14, we show that with one exception, none of these proxies are significantly correlated with our measure of late departure.[28] 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* (Table 1).

**(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*).[29]

We report results using a linear probability model (Table 3). 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. 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 failed voyage, it does not reduce the explanatory power of a late departure.

**(ii). 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;

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[27] 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)".

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

[29] 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. Recall discussion in 3.1.

Table 2: Acapulco to Manila: No Relationship Between Late Departure and a Failed Voyage

| | Shipwrecked or Returned to Port | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Late | 0.0992 | 0.0935 | 0.0762 | 0.0794 | 0.0787 | 0.0787 | 0.0787 |
| | (0.0708) | (0.0715) | (0.0963) | (0.0986) | (0.0977) | (0.101) | (0.0869) |
| Typhoon | | 0.148 | 0.188 | 0.204$^{*}$ | 0.207$^{*}$ | 0.209$^{*}$ | 0.209 |
| | | (0.0964) | (0.120) | (0.122) | (0.124) | (0.125) | (0.125) |
| Western Pacific Temperature | | | -0.247 | -0.267 | -0.278 | -0.286 | -0.286 |
| | | | (0.166) | (0.167) | (0.175) | (0.177) | (0.253) |
| Eastern Pacific Temperature | | | -0.0494 | -0.0542 | -0.0543 | -0.0545 | -0.0545 |
| | | | (0.0534) | (0.0506) | (0.0505) | (0.0508) | (0.0435) |
| Storm | | | | -0.0846 | -0.0874 | -0.0857 | -0.0857 |
| | | | | (0.0874) | (0.0878) | (0.0843) | (0.0655) |
| Years Passed Since First Voyage | | | | | -0.00530 | -0.00561 | -0.00561 |
| | | | | | (0.0134) | (0.0133) | (0.0135) |
| Experienced Captain | | | | | | 0.0335 | 0.0335 |
| | | | | | | (0.0713) | (0.0746) |
| 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 | 303 | 303 | 196 | 196 | 196 | 196 | 161 |
| Adjusted $R^2$ | 0.015 | 0.040 | 0.059 | 0.071 | 0.067 | 0.066 | 0.011 |

This table demonstrates that there is no relationship between late departures from Acapulco and failed voyages once we control for typhoons and weather variables. The controls are the same as in Table 1. The number of observations shrinks in columns (3)-(7) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Lane, 2016). In fact, on several occasions, Manila galleons were captured by English raiders. 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.

In Table 4 we first 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 (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 the all conflicts (column 6). Only the latter is positively related with failed voyages. More importantly, the point estimates for *Late* remain largely unchanged.

Table 3: 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 | 0.208$^{**}$ | 0.207$^{**}$ | 0.224$^{**}$ | 0.233$^{***}$ | 0.231$^{***}$ | 0.231$^{***}$ |
| | (0.0833) | (0.0831) | (0.0870) | (0.0767) | (0.0747) | (0.0757) |
| Arrival Date | -0.000745$^{***}$ | -0.000680$^{***}$ | -0.000821$^{***}$ | -0.000826$^{***}$ | -0.000754$^{***}$ | -0.000749$^{***}$ |
| | (0.000213) | (0.000204) | (0.000241) | (0.000222) | (0.000214) | (0.000216) |
| Typhoon | | 0.0391 | 0.0301 | -0.0110 | -0.0118 | -0.00879 |
| | | (0.0694) | (0.0723) | (0.0686) | (0.0689) | (0.0705) |
| Western Pacific Temperature | | | -0.0490 | 0.0638 | 0.0296 | 0.0320 |
| | | | (0.232) | (0.224) | (0.216) | (0.219) |
| Eastern Pacific Temperature | | | -0.111 | -0.0870 | -0.0676 | -0.0663 |
| | | | (0.0949) | (0.0836) | (0.0805) | (0.0815) |
| Storm | | | | 0.315$^{***}$ | 0.322$^{***}$ | 0.322$^{***}$ |
| | | | | (0.0959) | (0.0942) | (0.0941) |
| Years passed since first voyage | | | | | 0.0461 | 0.0458 |
| | | | | | (0.0304) | (0.0308) |
| Experienced Captain | | | | | | -0.0200 |
| | | | | | | (0.0674) |
| Ship FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Voyages FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations. | 273 | 272 | 250 | 250 | 250 | 250 |
| Adjusted $R^2$ ) | 0.075 | 0.070 | 0.077 | 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. The number of observations shrinks in columns (3)-(5) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**(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. While we do not have the arrival date of these merchants, we can use proxies for the volume of goods that they brought. 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 5 we use data collected 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 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.

Table 4: 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) |
| 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 | -0.0125 | | | | | |
| | (0.0984) | | | | | |
| Conflicts Southeast Asia | | 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) |
| 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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## 3.4 *Identifying the role of rent-seeking*

Our empirical analysis thus far shows that a late departure of the Manila–Acapulco galleon strongly predicts a failed voyage, even when controlling for storms and weather conditions, other threats, captain competency, and ship and voyage fixed effects. This is unsurprising as the Embocadero route (depicted in Figure 2) which the galleon took to sail to Acapulco was particularly perilous during the monsoon season, i.e. irrespective of any typhoons or storms that could have also occurred.

The puzzle is *why* captains sailed late.

If ship officials knowingly risked shipwrecks by sailing late, it must have been profitable to do so. Anecdotal evidence from Schurz suggests that the rents were indeed very large. The captain alone earned commissions and bribes amounting to 50–100,000 pesos per voyage, or even as high as 200,000 — roughly equivalent to 13 million US dollars, which is over ten times the official captain salary of 4,325 pesos.

Table 5: 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 l | | -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) |
| 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. The number of observations shrinks in columns (3)-(5) because temperature data is only available from 1617 onwards. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Our hypothesis, from our reading of the historical literature, is that the captain, likely in connivance with other officials, took bribe payments from merchants in exchange for loading their cargo on to the galleon. Such rent-seeking opportunity would have induced officials to load too much cargo in order to maximize total bribe rents. This meant that it was likely that either the galleon was overloaded, or it departed past the deadline (as it took time to load cargo), or both. In turn, sailing on the dangerous Embocadero route — while overloaded, or after the monsoon season has begun, increased the likelihood of aa failed voyage. One could also expect that being both overloaded and sailing late increased this likelihood even more.

The qualitative literature provide examples which give credence to our hypothesis. For example, Fish (2011, 502) reports that when the *Nuestra Senora de la Concepcion* sank in 1638 "[D]ocuments indicate that a portion of the ships cargo was illegal and the property of the Governor of the Philippines, Sebastian Hurtado de Corcuera" who "was in the habit of shipping unregistered cargo in the galleons which included gifts he had received as bribes". De Corcuera was later prosecuted for corruption and specifically for transporting illegal goods on the galleons.

If our hypothesis is correct, then the variation in the probability of a failed voyage that is explained by *Late* in our regressions (net of the influence of all the other control variables) captures the effect of bribe rents on the likelihood of a failed voyage. We cannot determine whether a particular galleon that sailed late was also overloaded — as there is no data on the amount of cargo. However, being overloaded and sailing late are positively correlated precisely when our proposed bribe-taking mechanism holds. Thus, the coefficient on *Late* includes the entire effect of bribe rents — whether through just sailing late, or being overloaded, or both.

To further establish the plausibility of this hypothesis, we examine periods during which there was greater oversight and, hence, opportunities for bribe-taking were limited. Schurz (1939) describes these periods. 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).[30] Another period where there was comparatively more oversight 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. Table 6 provides evidence that during these years of heightened oversight, the relationship between late departures and failed voyages is much weaker. Specifically, we find that in periods when oversight was more common the coefficient on late is about 60% of the size that it is in other periods.[31]

To provide more evidence that rent-seeking was largely responsible for failed voyages, we test auxiliary predictions with available data. Such predictions can be logically derived from a model. We construct this in the next section, where we formally depict galleon officials extracting bribes from merchants in exchange for loading cargo on to the galleon, and establish the link between rent-seeking, late departures, overloading, and a failed voyage.

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[30] 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".

[31] We confirm that these two coefficients are statistically different using a version of the Hausman test as implemented by the Stata `suest` command. In all specifications, the null that the two coefficients are statistically indistinguishable is rejected with a p-value of 0.000.

Table 6: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage by Periods of Heightened Oversight

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Late | $0.341^{***}$ | 0.263 | $0.347^{***}$ | $0.212^{**}$ |
| | (0.0834) | (0.170) | (0.0847) | (0.0876) |
| Storm | $0.387^{***}$ | -0.0171 | $0.382^{***}$ | 0.141 |
| | (0.111) | (0.111) | (0.110) | (0.113) |
| Typhoon | -0.0623 | 0.302 | -0.0510 | $0.448^{**}$ |
| | (0.0772) | (0.256) | (0.0794) | (0.174) |
| Western Pacific Temperature | 0.0185 | 0.503 | 0.0608 | 0.212 |
| | (0.231) | (0.286) | (0.236) | (0.290) |
| Eastern Pacific Temperature | -0.0803 | 0.0566 | -0.0757 | 0.150 |
| | (0.0893) | (0.184) | (0.0904) | (0.0996) |
| Experienced Captain | | | -0.0884 | $-0.244^{**}$ |
| | | | (0.0583) | (0.105) |
| Ship FE | Yes | Yes | Yes | Yes |
| Voyage FE | Yes | Yes | Yes | Yes |

This table reports the relationship between late and a failed voyage by periods of heightened oversight. Specifically we contrast the periods that are recorded as experiencing much greater oversight in order to reduce corruption In all columns, the control variables are the same as in Table 1. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## 4 A Model of Ship Cargo Loading and Departures

Our model is a variant of the lobbying framework in Grossman and Helpman (1994, 2001) and has 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 bid 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 captain is able to bid up the bribes up to the value of the cargo.

We construct this model to closely resemble the actual institutional details of the Manila Galleon trade. Specifically, there are two types of players: (i) the ship 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 captain faces three restrictions: (1) to load only legal cargo; (2) not to load beyond the ship's capacity; (3) and to sail by the deadline so as to avoid the monsoon season. Going against these restrictions entails costs. Let $\bar{N}$ denote the ship's cargo limit, and $\bar{t}$ the sailing deadline, where $\bar{N}$ could be greater or less than $\bar{t}$. The server incurs cost $k_1$ for each illegal cargo, $k_2$ for each cargo beyond the ship's capacity $\bar{N}$, and $k_3$ for each cargo loaded beyond the deadline $\bar{t}$.[32] In addition, since restrictions (2) and (3) are put in place in order to ensure the safe arrival of the ship in Acapulco, the probability $\rho$ that the galleon sinks increases with $k_2$ and $k_3$. In particular, letting $\bar{\rho}$ denote some exogenous probability of shipwreck, we assume that the probability of shipwreck increases (at a decreasing rate) beyond $\bar{\rho}$ for every cargo that exceeds the ship's limit $\bar{N}$, and 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 given by $\rho^S = \bar{\rho} + \omega(T_2^S, T_3^S)$, where $\omega(0,0) = 0$ and $\omega$ 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 $\omega(0,2) - \omega(0,1) < \omega(0,1) - \omega(0,0)$.[33] Note that if $\bar{N} < \bar{t}$, then $\omega(1,0)$ is the smallest (non-zero) value that $\omega$ 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 $\omega$ can take. We put the following lower bounds on these values: $\omega(1,0) > \frac{1-\bar{\rho}}{1+\bar{N}}$ and $\omega(0,1) > \frac{1-\bar{\rho}}{1+\bar{t}}$.[34]

Let the players be the incumbent official $I$ (i.e. the ship captain, possibly in connivance with other officials) who decides which cargoes to load and the departure date of the galleon, and the set $N = N_1 + N_2$ of merchants.

Game $G$ is played, in which the following occurs at each time period $t = 1, 2, \ldots, N$:

1. A merchant, randomly drawn from $N$, arrives at port, and offers incumbent $I$ bribe $b$ in exchange for loading her cargo, which $I$ accepts or rejects.
2. Incumbent $I$ 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. Incumbents can reject one bribe and waits for another merchant who can pay a higher bribe. Thus, a merchant at $t$ pays a bribe that at

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[32] Since $t$ also indexes the number of cargoes that could have been loaded as of $t$, deadline $\bar{t}$ can be cast as a type of cargo limit, distinct from the physical limit $\bar{N}$. With the same departure deadline imposed for all galleons leaving Manila, a higher (lower) tonnage ship would be more likely to face $\bar{N} > \bar{t}$ ($\bar{N} < \bar{t}$).

[33] 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.

[34] 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 incumbent's reservation utility at $t$, which reflects the incumbent's expected bribe offer from another merchant at $t+1$. We elaborate on this mechanism by constructing an equilibrium in which the incumbent 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.

## *4.1 The Decision to Set Sail*

We proceed by backward induction. For the incumbent $I$ 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 $I$ gets to keep should the voyage successfully reach its destination — the sum of all the bribe payments $I$ has accepted as of $T$.[35] The expected payoff from sailing at $T$ is, thus, $a \equiv (1-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3})$, where $\mathbb{1}_{1}$ is an indicator variable equal to 1 whenever an illegal cargo is loaded, $\mathbb{1}_{2}$ and $\mathbb{1}_{3}$ are as previously defined, and $\rho_T = \bar{T} + \omega(T_2^T, T_3^T)$ is the probability of shipwreck as of $T$.[36] On the other hand, if the incumbent 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 $b \equiv (1-\rho_{T+1})(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3}) + (\bar{b}_{T+1} - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3})$.

The incumbent sets sail at $T$ if $a \geq b$ which, re-arranging and letting bind with equality, gives the incumbent's expected payoff (at $T+1$) upon sailing at $T$: $\bar{b}_{T+1} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3})}{1-\rho_{T+1}} + k_1\mathbb{1}_{1} + k_2\mathbb{1}_{2} + k_3\mathbb{1}_{3}$.

Notice then that at $T$, the incumbent 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 $b_{T+1,1} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3})}{1-\rho_{T+1}} + k_2\mathbb{1}_{2} + k_3\mathbb{1}_{3}$ the bribe payment if the $(T+1)$th merchant is a legal one (i.e. from set $N_1$), and $b_{T+1,2} = \frac{(\rho_{T+1}-\rho_T)(\sum_{t=1}^{T}(b_t - k_1\mathbb{1}_{1} - k_2\mathbb{1}_{2} - k_3\mathbb{1}_{3})}{1-\rho_{T+1}} + k_1 + k_2\mathbb{1}_{2} + k_3\mathbb{1}_{3}$ if illegal (i.e. from set $N_2$). Denoting the probability that a legal merchant arrives in period $T+1$ as $\mu_{T+1}$, 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[37]

$$\bar{b}_{T+1} = b_{T+1,1} + (1-\mu_{T+1})k_1. \tag{2}$$

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

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

[37] The probability $\mu_{T+1}$ 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.

This is the minimum amount of bribe that the incumbent would want from the $(T+1)$th merchant — below this, the incumbent would not be willing to wait and would thus prefer to sail. In turn, if the incumbent expects to earn this from the $(T+1)$th merchant, the $T$th 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 incumbent's reservation utility that a merchant who comes at period $T$ has to match in order to induce the incumbent to load her cargo, rather than wait for the $(T+1)$th merchant's cargo.

### *4.2 Bribe Payments*

Moving backward in the game, i.e. given $b_{T+1,1}$, $\mu_{T+1}$, one can then solve for the bribe payment that the incumbent would demand at $T$. If the $T$th merchant is a boleta-holder, then for the incumbent to accept her bribe, she 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 incumbent demands to be satisfied by a merchant arriving at $T$. If the $T$th merchant is illegal however, then the incumbent 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:

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

and:

$$F_{T,2} = b_{T,2} - \Big[(1-\mu_{T+1})\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,2} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big)$$
$$+\mu_{T+1}\Big(\sum_{t=1}^{T-1}(b_t - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3) + (b_{T,2} - k_1\mathbb{1}_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3)\Big)\Big(\frac{\rho_{T+1}-\rho_T}{1-\rho_{T+1}}\Big)\Big] - k_1 - k_2\mathbb{1}_2 - k_3\mathbb{1}_3 = 0 \tag{4}$$

Equations (3) and (4) 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 (3) and (4) to solve for $b_{t,1}$ and $b_{t,2}$ for each $t$.[38] Note that because illegal merchants have to compensate the incumbent for incurring cost $k_1$, $b_{t,2} > b_{t,1}$.

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[38] Given $b_{T,1}, b_{T,2}$, the incumbent'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 (3) and (4), with subscript $T$ replaced by $T-1$ and subscript $T+1$ replaced by $T$.

However, while the incumbent 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 merchant arriving at $t$ pay are, respectively:

$$\bar{b}_{t,1} = \min(b_{t,1}, V) \tag{5}$$

$$\bar{b}_{t,2} = \min(b_{t,2}, V) \tag{6}$$

### *4.3 Equilibrium*

Before providing the equilibrium of game $G$, 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 incumbent 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 incumbent at each time period $t$ is given by $(\bar{b}_1 = V, \bar{b}_2 = V, \ldots, \bar{b}_T = V)$, the incumbent'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 $\bar{b}_{T+1} > V$.*

In other words, each merchant that arrives before the galleon departs, whether legal or illegal, pays the maximum bribe $V$.[39] With a large number of merchants vying for limited space in the galleon, the captain is able to pit them against each other, thereby extracting all the surplus and earning $V$ from each merchant. The captain 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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[39] The captain does not discriminate between legal and illegal merchants because the captain bears the cost $k_1$ of loading illegal cargo. Since all merchants can then pay the full price $V$, the captain 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 captain 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 captain 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 captain 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.*

## 5 Testing the Model

The model not only predicts that late-sailing and overloaded ships have a higher probability of shipwreck, but reveals that the ship captain (incumbent) intentionally sails late and overloads the ship in order to keep capturing bribes. It is precisely because each cargo beyond the deadline and the cargo limit of the ship increases the chance of shipwreck that the ship captain can keep extracting bribes. The only constraint to such rent-seeking is the price of the cargo, as merchants cannot pay bribes beyond this maximum amount. Thus, when each cargo can be sold at a high price in Acapulco, the ship captain can keep accepting cargo in Manila in exchange for bribes, thereby overloading the ship and delaying departure, and risking shipwreck.

The likelihood of being overloaded and of sailing late are positively correlated: they both increase with the amount of bribes which, in equilibrium, is equal to the total value of the cargo. Thus, as noted in Section 3.4, while our empirical results thus far do not separately identify the effect of just being overloaded or just being late on the probability of a failed voyage, the coefficient on *Late* captures the total effect of bribe rents. Table 6 established that this was plausible since the relationship between a late departure and a failed voyage is weaker during periods of greater oversight, when opportunities for bribe-taking are limited.

As further evidence for our proposed rent-seeking mechanism, we now test two auxiliary predictions that emanate from the model (Proposition 2.3 and 2.4, and Corollary 1). First, we show that ships that are both 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 overloading by comparing low and high-tonnage ships. Given the same departure time, the former are more likely to be overloaded than the latter. Thus, we expect the positive relationship between a late departure and a failed voyage to be stronger for ships with low tonnage.

A second prediction is that the higher the value of the cargo, the stronger the relationship between a late departure and a failed voyage. Moreover, this should be even stronger for ships that sailed late that were also 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. Finally, this effect should be even stronger for low-tonnage ships that sailed late, as these ships are more likely to have been overloaded as well.

**By tonnage** To test the first auxiliary 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: importantly, low–tonnage ships were no more likely than high–tonnage ones to experience shipwrecks or returned voyages (see Appendix Figure A.4). Next, in Table 7 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 sample (columns 1-2). This difference remains robust when we control for storms, typhoons, and temperature and for arrival date (columns 3-4). This difference shrinks a little in size when we include more covariates, but remains large and statistically significant overall.[40]

**By value** To test the second auxiliary 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 8 confirm this. Columns (1)-(2) report the contrast using only ship fixed effects. In columns (3-4) we introduce more controls. The difference in the magnitude of the respective coefficients declines somewhat, but it remains economically meaningful and statistically significant. Moreover, our theory suggests that the effect of a previous failed voyage should be greatest for smaller ships. This is indeed what we find in columns (5)-(6).

Second, there are longer periods during which the value of the cargo was likely higher. For instance, in columns (1)-(2) of Table 9, 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 confirms this prediction.[41]

We also consider the late 18th century, a period when Spanish colonial institutions began to be reformed. Specifically, in 1769, a new commercial code was established, which created the *consulado*, a corporation of merchants with control over the galleon trade. There is nothing in these reforms, however, to suggest that they would have reduced the value of the cargo — on the contrary, the cargo would have been more valuable, as the *consulado* might have consolidated the power of existing mercantile elites in Manila. This would then have strengthened the relationship between late departures and failed voyages, which indeed is what we find in column 3 Table 9. The same is true for another much lauded reform, the creation of the Royal Philippine Company in 1785. The purpose of the Royal Philippine Company was to develop direct trade between the Philippines and Spain. However, Schurz (1939, 57) notes that in practice little was done: "the passive opposition of the Manila merchants to this radical innovation in their field of business was largely to defeat the purpose of the change and to delay the full fruition of

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[40] We confirm this formally using a version of the Hausman test as implemented by the Stata `suest` command. In all specifications, the null that the two coefficients are statistically indistinguishable is rejected with a p-value of 0.000.

[41] Note that when comparing different time periods we do not include voyage fixed effects. This is because the inclusion of voyage fixed effects when examining subsamples of the data absorb a lot of relevant variation and because we lose a lot of power when examining shorter time spans as in columns (4) and (5) of Table 9.

its possibilities to a later time". The same applies to initial attempts to open up Manila to the ships of other countries. Even when foreign ships were allowed into Manila bay, they were prohibited from trading outside Asia. It was actually only in 1795 that trade was fully liberalized (Schurz, 1939, 58-59). This liberalization would have reduced the value of the cargo and therefore weakened the relationship between late departures and failed voyages. In fact, what we find is that the relationship becomes statistically insignificant (Table 9, column (5)).

Finally, the value of the cargo might have been higher in periods when the economy of Mexico was more buoyant. We consider this possibility in Appendix Table A.18 where we employ two proxies for the business cycle in Mexico based on aggregate silver production: (i) the monetary value in pesos of silver produced in Mexico; and (ii) the weight in kilos of silver produce. We find evidence that the coefficient on *Late* is larger in periods when silver production was greater (Columns (3)-(6)).

Together these results provide evidence that is consistent with the model. Manila galleons that were overloaded, or departed late, or both, were shipwrecked by rents.

Table 7: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage by Tonnage

| | Shipwrecked or Returned to Port | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Late | $0.266^{***}$ | 0.0961 | $0.290^{*}$ | $0.177^{*}$ |
| | (0.0905) | (0.108) | (0.146) | (0.0941) |
| Storm | | | 0.209 | $0.405^{**}$ |
| | | | (0.134) | (0.163) |
| Western Pacific Temperature | | | 0.251 | -0.331 |
| | | | (0.276) | (0.321) |
| Typhoon | | | -0.0413 | 0.00910 |
| | | | (0.0882) | (0.0816) |
| Eastern Pacific Temperature | | | -0.117 | -0.111 |
| | | | (0.114) | (0.154) |
| Arrival Date | | | -0.000408 | $-0.00134^{***}$ |
| | | | (0.000332) | (0.000334) |
| Tonnage | Low | High | Low | High |
| Ship FE | Yes | Yes | Yes | Yes |
| Voyage FE | Yes | Yes | Yes | Yes |
| Observations | 210 | 150 | 121 | 129 |
| Adjusted $R^2$ | 0.123 | 0.009 | 0.215 | 0.244 |

This paper establishes that the relationship between late departure and a failed voyage is strongest for ships with low tonnage. The control variables are the same as in Table 1 The number of observations shrinks in columns (3)-(4) 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 8: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage by Previous Failed Voyage

| | Shipwrecked or Returned to Port | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Late | 0.351$^{***}$ | 0.163$^{*}$ | 0.276$^{***}$ | 0.105 | 0.412$^{***}$ | 0.352 |
| | (0.0936) | (0.0961) | (0.0981) | (0.126) | (0.112) | (0.203) |
| Typhoon | | | -0.0788 | -0.659$^{*}$ | | |
| | | | (0.0688) | (0.385) | | |
| Western Pacific Temperature | | | 0.298 | 2.848$^{***}$ | | |
| | | | (0.277) | (0.911) | | |
| Eastern Pacific Temperature | | | -0.149$^{*}$ | 1.392$^{*}$ | | |
| | | | (0.0891) | (0.803) | | |
| Storm | | | 0.334$^{***}$ | -0.265 | | |
| | | | (0.118) | (0.263) | | |
| Arrival Date | | | -0.00118$^{***}$ | -0.0166$^{***}$ | | |
| | | | (0.000320) | (0.00537) | | |
| Previous Voyage Failed | Yes | No | Yes | No | Yes | Yes |
| Tonnage | | | | | Low | High |
| Ship FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Voyage FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 115 | 245 | 196 | 54 | 87 | 28 |
| Adjusted $R^2$ | 0.189 | 0.019 | 0.235 | 0.878 | 0.146 | 0.735 |

This table establishes that the relationship between late departure and a failed voyage is strongest for ships that followed after the failure of a previous voyage. Columns (1)-(2) contrast ships that followed a previous failed voyage with those that did not. The coefficient on late is significantly larger for the former. Columns (3)-(4) include our main covariates. Columns (5) - (6) show that the effect of late when the previous voyage failed is stronger for smaller ships than for larger ships. The controls are the same as in Table 1. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## 6 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. 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. It establishes a link between rent-seeking and failed voyages—either shipwrecks or ships forced to return to port—in the Manila Galleon trade. 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,

Table 9: Manila to Acapulco: The Relationship Between Late Departure and a Failed Voyage by Time Period

| | Before 1640 | After 1640 | After Consulado | After Royal Philippine Company | After Liberalization |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Late | 0.122 | $0.213^{***}$ | $0.329^{***}$ | $0.268^{*}$ | -0.159 |
| | (0.0977) | (0.0704) | (0.0745) | (0.127) | (0.417) |
| Typhoon | 0.0142 | -0.0118 | -0.0443 | -0.0590 | -0.222 |
| | (0.119) | (0.0649) | (0.114) | (0.173) | (0.176) |
| Storm | $0.547^{***}$ | $0.355^{***}$ | 0.362 | 0.407 | $0.693^{***}$ |
| | (0.0981) | (0.114) | (0.241) | (0.324) | (0.185) |
| Experienced Captain | -0.132 | -0.00478 | -0.172 | -0.426 | 0 |
| | (0.129) | (0.0575) | (0.193) | (0.245) | (.) |
| Years passed since first voyage | 0.0149 | 0.00516 | -0.00544 | 0.00111 | -0.0415 |
| | (0.0126) | (0.00789) | (0.0114) | (0.0131) | (0.0238) |
| Ship FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 154 | 205 | 59 | 37 | 22 |
| Adjusted $R^2$ | 0.002 | 0.035 | 0.040 | 0.034 | 0.209 |

This table reports the relationship between late and a failed voyage by subperiod. Specifically, in columns (1)-(2) we contrast the period after the number of ships was restricted with that before. We find that the coefficient increases in size considerably after that date (1640). In columns (3) we examine the period of reforms in the late 18th century. We find that the introduction of the Consulado was associated with a stronger relationship late departures and failed voyages. Similarly the introduction of the Royal Philippine company did not weaken this relationship (column (4)). In contrast, we do find that after trade in Manila was liberalized (allowing any ship to trade there) the relationship between late departures and failed voyages weakens (column 5). In all columns, the control variables are the same as in Table 1. Note that we do not employ trip fixed effects in these regressions. Robust standard errors are clustered at the ship level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

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 both why ships were late departing Manila and why late departures were associated with failed voyages we build a formal model of bribe-taking. When galleon officials can extract bribes from merchants in exchange for loading their cargo on to the galleon, the captain can end up loading too much cargo. This implies that either the galleon is overloaded, or it sails beyond the deadline (since cargo loading takes time), or both. The higher the value of the cargo, the larger the bribes that can be extracted, and the more likely that the galleon is both overloaded and departs late.

To test the model, we derive two additional predictions. First, we expect smaller ships to be more likely to be overloaded when they sailed late. For these ships, the relationship between a late departure and a failed voyage would be larger, since they likely would have been overloaded as well. Second, we expect the incentive to overload and to sail late to be greater when the value of the cargo is higher. In these cases, merchants can afford to pay higher bribes, inducing ship officials to load more cargo, and therefore increasing the likelihood that the ship is both overloaded and departs late.

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 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 rent-seeking and corruption were important factors in explaining the high 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. Our evidence undercuts the recent revisionist historiography that downplays these costs. It suggests that similar costs might have been relevant in other colonial trading regimes including the British, Dutch and French.

Specifically, we show how monopoly regulations increased the transaction costs of trade and how these increased transaction costs had unanticipated negative consequences in the form of shipwrecks. 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. For example, overloaded planes are a frequent cause of airline crashes.[42]. Consulting the *Airline Data Project*, we found at least 180 airline accidents in the last 70 years that have been directly caused by overloading.[43] In some cases these crashes were associated with rent-seeking behavior by baggage loaders. Our study thus suggests several avenues for future research into the unseen costs of corruption.

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[42] See for instance, Associated Press (2003).

[43] This data is available from http://web.mit.edu/airlinedata/www/default.html.

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# Online Appendices (For Web Publication Only)

## Table of Contents

# 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 [44], Acapulco was chosen as the default Spanish port in the Pacific.[45]. 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). 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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[44] Notably the port of Puerto Navidad, located in the westerner parts of Mexico, north of Acapulco

[45] 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.

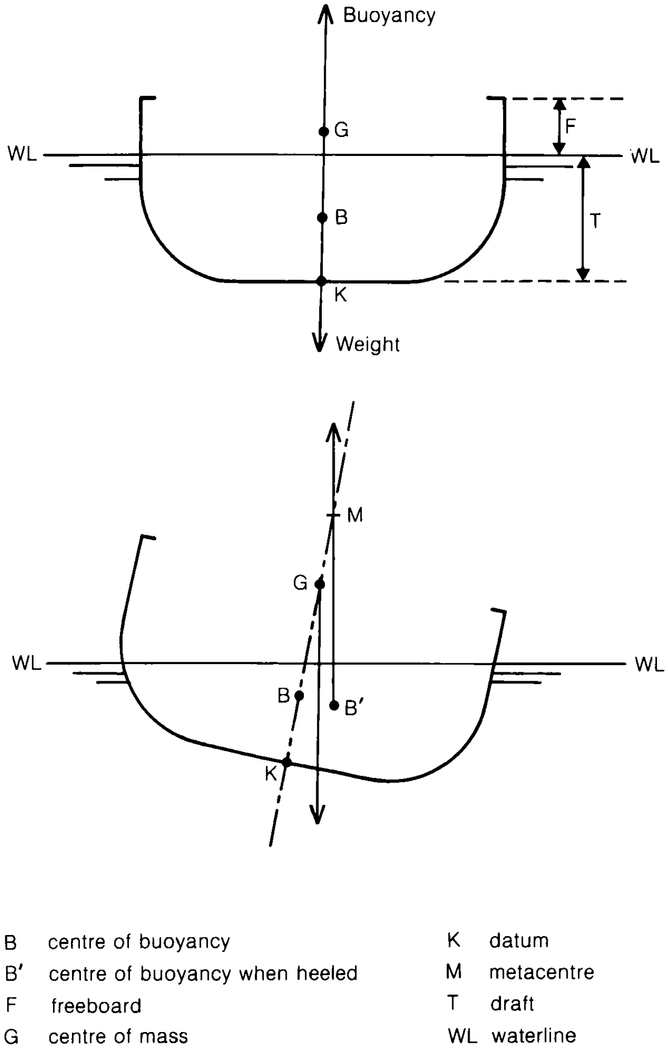

Figure A.1: This diagram depicts the relationship between a ship's center of mass and metacenter and transverse stability. Of particular importance is the relationship between $G$ and $M$ which is affected by how the ship is loaded.Reproduced from McGrail (1989).

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.[46] The Spanish settlement in the Philippines began in 1565. During the initial period (until 1593), trade occurred without any formal regulation. The period from the 1580s to the 1640s was one of high profits and rapid growth. And it was not only Mexicans that participated, but Peruvians too—Trade between Acapulco in New Spain and El Callao in Peru expanded in these decades (Borah, 1954; Bonalian, 2010). This growth of trade, 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 (Yuste, 2007b). 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 came to act as arbitrator of the disputes 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[47] around the new constraints and trade in the pacific boomed during the period (Bonalian, 2010; Yuste, 1984, 2007a).

The fleet system continued unmodified up 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 ended, Spanish legislators pushed for reforms with he aim of reinforcing the commercial security of the Empire. These policies are known as the "Bourbon Reforms" and were aimed at decentralizing trade and empowering the Crown *vis a vis* local actors (Arteaga, 2020) Complementary to these reforms, mercantile companies were created in the model of those the British and Dutch have had for centuries

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[46] 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.

[47] Contraband became rampant, and as a famous Spaniard saying goes "Obedezco pero no cumplo," 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 then. One of those companies was the Royal Philippine Company, formed in 1785. But as we discuss in the text, these reforms were largely thwarted by domestic interest groups in Manila. Official direct commerce between the Islands and Spain began to occur for the very first time (Diaz-Trachuelo, 1989). 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 $b_{t,2} = \bar{U}_t + k_1 k_2\mathbb{1}_2 + k_3\mathbb{1}_3$, 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 (3) and (4), the largest bribe that the incumbent can get is $V$. Thus, by Lemma A.1 and equation (2), 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 (3) and (4), 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 (3) and (4), $\bar{b}_{T-1,1} = \bar{b}_{T-1,2} = V$. 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 (2), 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

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

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 $\mu_T$, 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 $\rho_{T+1}$ 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.

## *B Probability $\mu_t$ 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 $\mu_t$ 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 $\mu_2 = \frac{N_1}{N_1+N_2}\left(\frac{N_1-1}{N_1+N_2-1}\right) + \left(1-\frac{N_1}{N_1+N_2}\right)\left(\frac{N_1}{N_1+N_2-1}\right) = \mu_1\left(\frac{N_1-1}{N_1+N_2-1}\right) + (1-\mu_1)\left(\frac{N_1}{N_1+N_2-1}\right)$. Similarly, the probability of drawing a legal merchant in $t=3$ is $\mu_3 = \mu_1\mu_2\left(\frac{N_1-2}{N_1+N_2-2}\right) + \mu_1(1-\mu_2)\left(\frac{N_1-1}{N_1+N_2-2}\right) + (1-\mu_1)(1-\mu_2)\left(\frac{N_1}{N_1+N_2-2}\right)$.

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

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

where each term is the joint probability of drawing a legal merchant in the $(t-x)$ periods, with $\left(\frac{N_1-t+x}{N_1+N_2-t+1}\right)$ 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 $\mu$ 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.

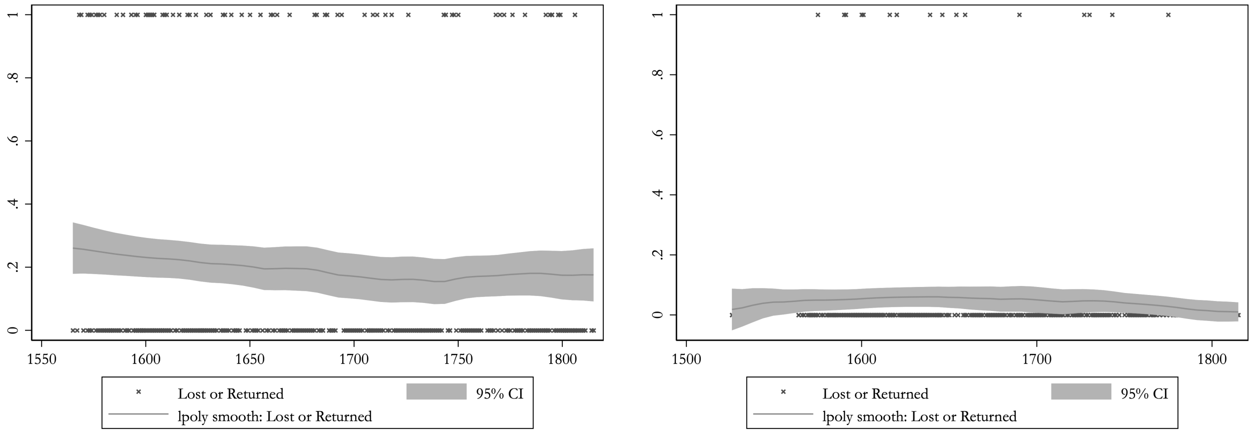
### *A Summary Statistics*

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 | $0.00347^{***}$ | $0.00346^{***}$ | $0.00369^{***}$ | $0.00402^{***}$ | $0.00409^{***}$ | $0.00408^{***}$ |
| | (0.00106) | (0.00106) | (0.00110) | (0.00115) | (0.00109) | (0.00109) |
| Typhoon | | 0.00366 | 0.0305 | -0.0142 | -0.0173 | -0.0140 |
| | | (0.0632) | (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) |
| Ship FE | Yes | Yes | Yes | Yes | Yes | |
| Voyage FE | Yes | Yes | Yes | Yes | Yes | |
| Observations | 360 | 359 | 250 | 250 | 250 | 250 |
| Adjusted $R^2$ | 0.019 | 0.015 | 0.028 | 0.111 | 0.139 | 0.136 |

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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

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 A.7 replicates the structure of Table 1 in the main text, but reports the coefficients and log odds from a

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 | | $6.53\text{e-}15^{**}$ | 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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

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.

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 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

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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

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.15 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.16 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 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.9: Manila to Acapulco and Acapulco to Manila without Fixed Effects

| | Manila to Acapulco | | Acapulco to Manila | |
|---|---|---|---|---|
| | (1) | (2) | (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 | | Exclud. Lost | | Excluding Exits | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (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)<br>+ 1 Day | (2)<br>+ 2 Days | (3)<br>+ 3 Days | (4)<br>+ 4 Days | (5)<br>+ 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)<br>- 1 Day | (2)<br>- 2 Days | (3)<br>- 3 Days | (4)<br>- 4 Days | (5)<br>- 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)<br>- 10 Day | (2)<br>- 15 Days | (3)<br>+10 Days | (4)<br>+ 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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## 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.19 reports the results of these tests. In all specifications we reject the presence of a unit root.

## 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.14: 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. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A.15: 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.16: 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.17: 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.18: 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.19: 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.

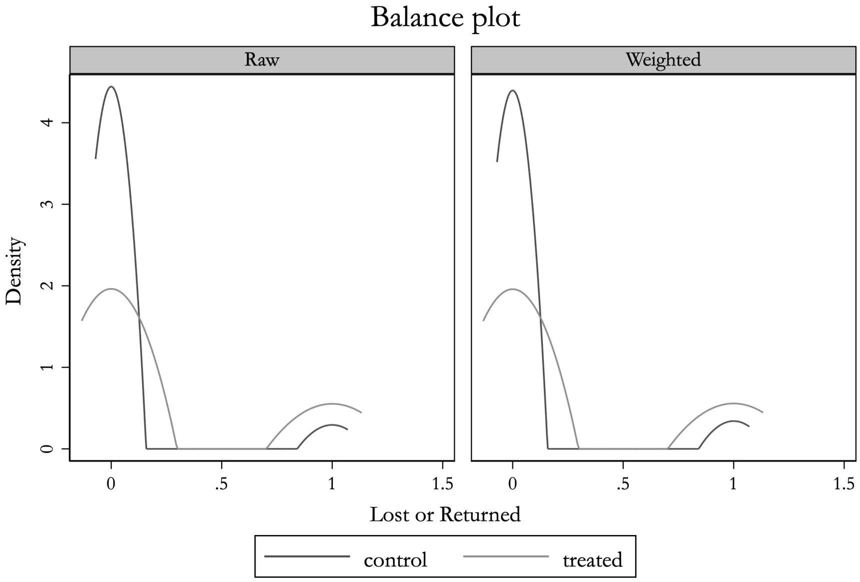


Figure A.3: A deny plot depicting the inverse probability weighted estimates of being late compared to on time for Manila to Mexico.

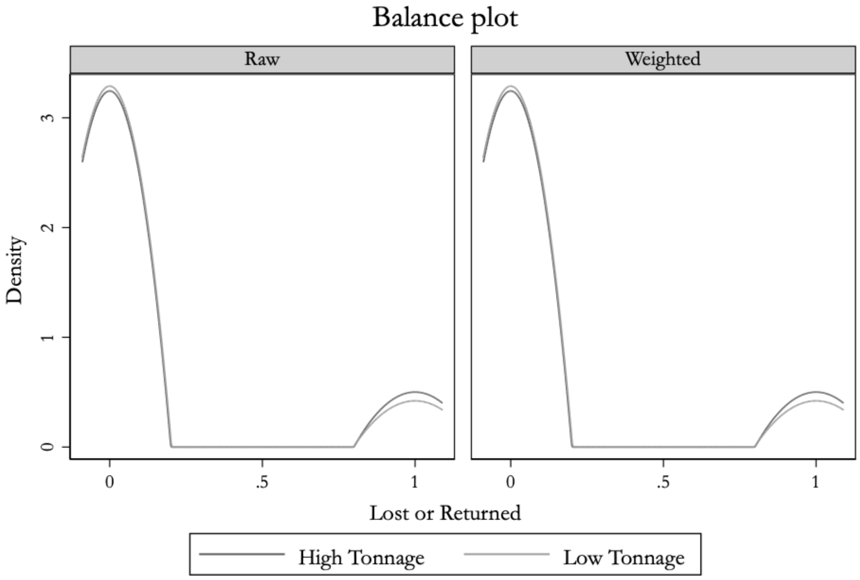


Figure A.4: A density plot show that high tonnage and low tonnage ship were equally likely to be shipwrecked or returned to port.

## 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 (2007a), 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 (2007a), 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 Garcia et al. (2001). 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.

## *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 (2007a), 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 inexperienced or incompetent.

## *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 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 (2007a), 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 (2007a), 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 (2007a), 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 (2007a), 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 bucaneers 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 (2007a), 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 (2007a), 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 (2007a), 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 (2007a), 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 (2007a), 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 (2007a), 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 (2007a), Archivo General de Indias, Archivo General de la Nación, La América española Blog, Three Decks Website | B1 |