Patronage for Productivity: Selection and Performance in the Age of Sail*

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Abstract

Patronage is a byword for poor performance but it remains pervasive around the world. We study the selection effects of patronage in the most successful navy in world history – the Royal Navy between 1690 and 1849. Using newly collected data on the battle performance of over 5,800 naval officers promoted with and without family ties to the top of the navy hierarchy, we find that connected promotees outperformed unconnected ones. There was substantial heterogeneity by the admiral in charge of promotions. Discretion over appointments thus created scope for "good" and "bad" patronage. Because the majority of admirals promoted based on merit and did not favor their kin, the overall selection effect of patronage was positive.

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1 Introduction

A growing literature views the recruitment and allocation of public employees as a key determinant of state capacity and economic performance (Rauch and Evans, 2000; Dal Bó et al., 2013; Finan et al., 2017). Discretion in public appointments, or patronage,[1] is often regarded as an important source of inefficiency – it can lead to corrupt appointments, distort incentives, and undermine state effectiveness.

How patronage affects performance, however, is in principle ambiguous. Discretion over appointments has been shown to bias the allocation of public sector positions (Akthari et al., 2018; Xu, 2018; Colonnelli et al., 2018). At the same time, it could also allow principals to use private information to improve selection – particularly in environments where performance is difficult to evaluate (Prendergast and Topel, 1996; Allen, 2011). The ubiquity of patronage – not only throughout history but even in developed countries today – raises an intriguing question: Are there any environments in which discretion in the allocation of public sector positions is actually beneficial?

In this paper, we examine the costs and benefits of patronage, and demonstrate that it *can* lead to better selection. Specifically, we focus on the promotion of officers of the British Royal Navy during its eighteenth-century heyday. Our paper is the first to show empirically in a public sector setting that patronage can have a *benign* effect overall, improving selection. Importantly, we provide evidence that patronage effects depend on management style and the extent of external competitive pressures. During wartime, promotions in the Royal Navy were, in general, more merit-based and resulted in a better selection of naval officers. This is in line with models that see warfare as a key driver of state capacity (Besley and Persson, 2010; Tilly, 1990; Gennaioli and Voth, 2015).[2]

The Royal Navy provides a particularly suitable setting to study the selection effects of patronage. First, it was a highly successful organization where patronage was widespread. Between 1690-1849, the Royal Navy fought its way into the history books as the most successful navy on earth, playing a crucial role in Britain's rise as a global power (Kennedy, 2010). Officers of the Royal Navy were

[1] "Patronage" refers to the discretionary appointment of individuals to governmental or political positions (Webster's II New College Dictionary 1995).

[2] As Fukuyama (2011) argued: "...at war, meritocracy is not a cultural norm but a condition for survival..."

highly trained specialists commanding ships with hundreds of men, often taking them to the far-flung corners of the world. They were also skilled military leaders, commanding battle ships with up to 120 guns. Their career progression heavily relied on connections.

Second, the military provides a setting where objectives are clear and the outcomes are readily measurable: In contrast to civil administrators who may pursue multiple objectives, defeating the enemy at sea is *the* raison d'être of naval officers; a ship either sinks another or is sunk itself. Third, the navy was rife with principal-agent problems because communications were slow, and effort itself could not be observed (Allen, 2002, 2011). Finally, the sheer size of the Navy and its intense fighting history during the 18th century allow us to observe outcomes as well as promotion and allocation decisions for a large number of officers, made by a large number of decision makers – the admirals of the Royal Navy.

Our study is based on the construction of a new, granular dataset. We assemble a yearly officer-ship-level panel for the time period 1690-1849, covering almost the entire universe of all naval officers and warships. The resulting "matched-captain-ship" dataset provides information on 5,848 officers assigned to 3,904 ships. We also observe 4,193 promotion decisions made by 49 different Admiralty-boards, allowing us to compare the promotion and performance patterns of those selected under different naval administrations.

To measure patronage, we collect information on family ties between naval officers and the two most senior naval leaders – the Lord Admiral and the Admiral of the Fleet – drawn from a large genealogical database. Regular turnover at the top of the navy hierarchy (the "Admiralty") generates shocks to connections to serving officers – allowing us to observe *the same* officer both connected and unconnected to the apex of the organization.[3] We measure performance using battle outcomes – the number of captures, successful actions and enemy units destroyed. We estimate selection effects of patronage in a difference-in-differences setting, comparing the performance of connected and unconnected officers before and after their promotion to post-captain – a key step that granted officers independent command over much larger ships, substantially increasing their span of control.[4]

[3]Connections to the very top were undoubtedly crucial because all promotions to post-rank had to be confirmed by the Admiralty in London. Nonetheless, promoted officers likely received patronage from their commanding captain and admiral as well.

[4]Prior to being made "post", naval officers were typically employed in junior roles, as

To guide our empirical analysis, we adapt a canonical model of statistical discrimination to highlight the key trade-off between information and bias (Phelps, 1972). In our model, the principal (Admiralty) chooses to promote a connected or unconnected agent (naval officer). The principal observes the performance of officers with an error, but can extract more useful information about underlying ability in the case of connected subordinates (due to better information). The admiral may also be biased as he or she derives a private benefit from promoting his or her kin (favoritism). The net effect of patronage will thus depend on two key primitives: How well principals observe performance, and the extent of bias.

Our results are threefold: First, we establish empirical patterns that map directly into our model. We confirm that promotions are indeed merit-based, but more so for officers connected to the Admiralty. Seen through the lens of the model, this is consistent with better information and the absence of major biases (on average).

Second, when we compare across promoted officers in an event study, we find that officers who were promoted while connected to the Admiralty outperform unconnected promotees subsequently. This positive performance difference is persistent over time, not driven by the assignment to better ships, and holds even for officers whose promoting patron has rotated out of the Admiralty. To ensure that the results are not driven by the preferential allocation of ships and assignments to connected officers, we also perform a battle-level analysis. To that end, we hand-coded 94 fleet, 263 flotilla actions and 172 single ship actions. We show that in fleet and flotilla actions, even conditional on being assigned to a particular position in the line of ships, connected promotees outperform, i.e. they are more likely to sink, burn or capture enemy ships (and correspondingly less likely to lose their own). In single ship actions – chance encounters that provide exogenous variation in the matching of officers to enemy ships – connected promotees win markedly more often. Interestingly, this is driven by a lower number of indecisive engagements.[5]

lieutenants serving under a captain in overall command. Only when assigned to particularly small ("unrated") ships did they have command of a vessel. After being made "post", naval officers had much higher prospects of being assigned a ship, and were promoted automatically based on seniority. Lieutenants on the other hand had little employment security, no automatic promotions, and at best commanded much smaller vessels.

[5]This suggests that "fighting spirit", an unwillingness to break off an engagement until a decisive advantage has been gained, was one of the key factors that admirals selected

Third, we test for heterogeneity as predicted by the model, examining promotion decisions made under multiple Admiralties. We examine whether top "management teams" that made more merit-based promotions to post-rank were also more likely to pick connected officers that performed well afterwards. These different "Admiralty styles" provide empirical variation in the model parameters that govern whether patronage effects are positive or negative. In line with theoretical predictions, we find that connected promotees particularly outperform when the promoting Admiralty is more merit-oriented. In contrast, connected promotees perform worse the more biased the promoting Admiralty is. Merit increases and bias decreases during periods of major wars – times during which the objectives of the Admiral are more closely aligned with the organizational objective.

Discretion over appointments thus created scope for good and bad patronage in the Royal Navy. Without discretion, admirals could not have exploited private information to pick the men best-suited to the job. The price of discretion was that poor admirals could make poor choices, favoring low ability family relations or the offspring of the political elite. On average, however, patronage contributed positively to the Royal Navy's fighting record.[6]

Our results contribute to the emerging literature on the selection and incentives in the public sector (Khan et al., 2015, 2019; Ager et al., 2016; Ashraf et al., 2016; Bertrand et al., 2019; Weaver, 2018). Rational and complex military organizations such as the Royal Navy foreshadowed the emergence of professionalized bureaucracies. Indeed, concepts such as meritocracy (often associated with "Weberian" bureaucracies) first emerged in the military. While a range of papers show that homophily matters for the allocation of positions,[7] there is little systematic evidence on how this affects performance. Exceptions include Xu (2018), who shows that patronage disincentivizes favored colonial bureaucrats, who then raised less revenue; Colonnelli et al. (2018), who show that winning municipal mayors in Brazil employ less qualified personnel from their pool of supporters;[8]

on in the case of connected promotees.

[6]Connected promotees in the Royal Navy fought better – but since we do not have data on patronage in other navies, we do not know if it contributed differentially to its overall performance.

[7]See Finan and Schechter (2012); Do et al. (2017); Azulai (2017).

[8]Brollo et al. (2017) show that in closely-run municipal elections in Brazil, the winning party hires more of its own members, who on average are equally (or better) qualified as

Lott (2013), who shows that political influence reduces the quality of judges appointed to the bench in the US; and Fisman et al. (2018), who demonstrate that scholars of the Chinese Academy of Science have worse CVs when they share hometown ties with admissions committee members. In contrast, evidence on the positive effects of discretion, including in family firms, are much more frequent in the private sector (Fisman et al., 2017; Bertrand and Schoar, 2006).[9] Our theoretical framework – highlighting the trade-off between information and bias – makes precise under which conditions patronage can have positive or negative effects on performance. While other studies have focused on the characteristics of selected candidates, we examine the effect of selection on outcomes.

More broadly, our results complement the larger literature on the role of social connections and discrimination (Bertrand and Duflo, 2016; Ashraf and Bandiera, 2017) by providing evidence from the public sector, highlighting the importance of "administrative styles" in predicting bias in promotions. We provide evidence that the style of leaders is not only important for performance in the private sector but can also increase state effectiveness (Bertrand and Schoar, 2003; Bloom and Van Reenen, 2007; Rasul and Rogger, 2017). With captains commanding capital ships – complex hierarchical organizations with hundreds of personnel – our results directly resonate with the large literature on the selection effects of CEOs (Bertrand, 2009).[10]

We also relate to the historical literature on the Royal Navy. Historians have long attributed its superior performance to Britain's financial prowess – building, manning and maintaining large fleets, and supplying them effectively on the high seas for years (Dull, 2009; Rodger, 2005). While most of the literature is descriptive, economic analyses of navy performance have emphasized the role of high-powered incentives, both for officers and for seamen – the Royal Navy created incentives and enforced rules that compelled captains to fight (Allen, 2002), paid all men on board of successful ships substantial prize money (Benjamin, 2005), promoted men on the lower deck by performance (Benjamin and Thornberg, 2007) and successfully solved

those of the opposition.

[9]The exception is Hoffman et al. (2017), who find that managers ignoring test recommendations hire workers with subsequently shorter tenures.

[10]Finally, our finding that less constrained selection of leaders can lead to greater variance in performance echoes the results in (Jones and Olken, 2005), who show that more autocratic regimes experience more uneven growth.

incentive problems in the victualling of its large fleets (Allen, 2018). It also improved more rapidly over time than its rivals, gathering more experience in naval warfare and arguably learning more from it (Benjamin and Tifrea, 2007).[11] We agree that the Royal Navy's carefully balanced system of incentives was an important contributor to its success. For it to work, however, the right men had to be in command – real time monitoring was de facto impossible (Allen, 2002). We are examining the complementary process that put the captains in place on whom the Navy's success was built, and in particular, the role of patronage in selecting them.

Finally, we relate to the literature on the origins of state capacity. A growing literature has emphasized the importance of military competition for state building (Tilly, 1990; Besley and Persson, 2010), noting that many underdeveloped countries of the world today are located in areas with few inter-state conflicts (Herbst, 2014). Contributions to the state building literature have typically focused on the growth of taxation as the key channel for greater state capacity (Gennaioli and Voth, 2015). Our finding that meritocratic selection increased during wartime suggests that there is another, potentially important channel leading from interstate conflict to state capacity – improvements in the selection of key state personnel.

2 Historical background

In this section, we summarize the Navy's organization, promotion system, and officers' incentives. We also describe the key determinants of success in the "Age of Sail", and the nature of the patronage system.

2.1 Size and organization

The Royal Navy has its origins in the armed merchant ships that fought at the behest of English kings and queens. The Spanish Armada's attempted invasion of England was largely defeated by converted merchant ships (Rodger, 1999). Britain's Parliament in 1649 authorized the first major building program of capital ships, the so-called "Speaker" class (Dull, 2009). By the time of the Restoration in 1660, Charles II

[11] Benjamin and Tifrea (2007) also argues that patronage in the Royal Navy mainly accelerated promotion, but did not create additional ones.

controlled a permanent fleet of purpose-built warships, commanded by career officers. As the pace of warfare increased after 1700, the Navy expanded. By the eighteenth century, Britain found itself at war in one year out of three, and the majority of government spending went on war (Gennaioli and Voth, 2015).

The Royal Navy absorbed a large share of overall military expenditure. Between 1690 and 1810, the Royal Navy grew from a 147 to 752 larger ships. Ship armaments increased slightly more slowly, from 10,000 to 43,000 guns. During peacetime, the navy typically shrank to a quarter or a fifth of its wartime strength (Figure 1). Of the over 3,900 unique ships in our database, 957 were ships-of-the-line (24.5%). Another 1,024 were frigates; the rest were smaller, unrated ships typically sailed by lieutenants serving as commanders.

Each individual ship required an enormous expenditure: "Even smaller ships in the English navy of the 18th century cost more than the largest industrial companies had in capital." (Brewer, 1990).[12] Pay for seamen, costs for sails, cordage, food, powder, shot and the spars all added to the expense of running a fighting navy. Royal dockyards built and repaired warships, and a separate Victualling Board ensured that provisions reached the ships (Baugh, 2015; Allen, 2018).

The Royal Navy was run from the Board of Admiralty, consisting of a number of Lord Commissioners of the Admiralty. These were a mix of naval officers ("Sea Lords") and politicians. The President of the Board of Admiralty was known as the First Lord of the Admiralty. The Admiralty devolved many powers and decisions to station commanders and admirals commanding fleets, but was responsible for setting overall naval strategy. Crucially, it also controlled appointments and assignments of officers – directly for those serving in home waters, and indirectly on foreign stations, where appointments made by station chiefs had to be confirmed by the Admiralty (Pope, 2013).[13]

[12]Naval warfare overall was highly capital-intensive – there were approximately 400 canons used by both sides during the Battle of Waterloo, but 5,700 at the Battle of Trafalgar.

[13]There are numerous examples of the Admiralty overturning local station commanders' recommendations and provisional appointments; there are also many documented cases of the Admiralty forcing appointments on local commanders, picking men who had not been recommended by the station chief (Malcomson, 2007).

2.2 Career progression

Aspiring officers typically went to sea at an early age – 10 or 12 was common. Connections typically mattered from day 1 – most young gentlemen were entered in a ship's books through the patronage of a friendly captain. Depending on their age, they would either join as midshipmen or be promoted to be one from able seaman or captain's servant to midshipman. Training was overwhelmingly informal; the ship captain was in charge of organizing lessons in seamanship, gunnery, and navigation. Midshipmen who had absorbed all the material necessary to sail and fight a ship could apply for the rank of lieutenant, and were examined by a tribunal of active captains chosen by the Admiralty (Pope, 2013).

On receiving their commission, new lieutenants had to wait for an appointment (and would often end up "on the beach" i.e. on half-pay). Larger ships would often have many lieutenants, and their role varied by rank determined through seniority. Lieutenants attended to the day-to-day running of the ship, from readying stores for long voyages to daily sailing and the commanding of gun crews. They also kept the ship's log, which was crucial in monitoring the captain (Allen, 2002).

Lieutenants could also be appointed as "Master and Commander". As such, they would be in charge of a small vessel (typically "brigs" of 20 guns or less). Such ships typically sailed with messages or were used to intercept coastal traffic. Independent command constituted an important opportunity to distinguish oneself.[14]

The key step in a naval officer's career was promotion to "post-captain" – i.e. the officer in charge of a larger vessel. Many lieutenants were never promoted. Once appointed as a post-captain, further career progression was by strict seniority. If a lieutenant was made "post" at a young age and continued to receive ship assignments, eventual promotion to admiral was all but guaranteed as long as an officer survived. Initial appointment of post-captains was typically to a "sixth-rate" or "fifth-rate" ship, frigates with 20-32 guns and 150-300 men. Step by step, captains would then progress to larger and larger ship until they were put in command of a first-rate ship of the line, carrying 80-120 guns and 850 men. Despite the seniority prin-

[14]While a lieutenant appointed as commander was in effect acting as the captain of a ship, he would not yet have the rank of "captain" - but out of courtesy would normally be referred to as a captain.

ciple, connections mattered after being made "post" – some captains found themselves on half-pay without a vessel for extended periods, while others were swiftly moved from one ship to the next (Baugh, 2015).

Once they had reached the top of the captain's list, naval officers qualified for promotion to admiral – rear admiral first, then vice admiral, finally admiral. Each of these was assigned a specific fleet (i.e. the Admiral of the Red commanded the British Home Fleet).

2.3 Success in the Age of Sail

No European navy had a major technological advantage compared to its peers. Shipbuilders competed vigorously with each other, and frequent captures of enemy ships disseminated innovations. British-built ships were not the best; historians debate whether French-built vessels were better (Allen, 2002; Rodger, 1987) , and the Spanish *Santissima Trinidad* was the largest warship of the age. Naval engagements were overwhelmingly decided by the relative size of fleets, the armament of individual ships in ship-to-ship duels, and the seamanship, fighting skill and motivation of captains and their crew.

Despite the similarity of ships, battle outcomes for most of the 18th century were decidedly one-sided. During the Napoleonic Wars, for example, the Royal Navy only lost 166 ships (of which 5 were ships of the line), while it inflicted the loss of 1,201 ships (159 ships of the line) on its enemies. The "exchange ratio" was a staggering 7:1 on average, and 30:1 for battleships.[15] As C.S. Forester (1960, p. 29) observed:

> "...the British Navy could look back with complacence over a record of victories frequently gained and easily won. Time and time again it had faced numerical odds and had emerged triumphant... There had been single-ship actions too numerous to count, and in the great majority of these actions British ships had been victorious, and often over ships of greater tonnage, with more guns and larger crews."

Why did the Royal Navy outfight its enemies? Skill was one important factor. Britain could draw on the manpower of a large mer-

[15]The majority of 18th century conflicts produced similar ratios; during the Seven Years War, for example, the Royal Navy was arguably even more successful than in 1793-1815 (Allen, 2002).

chant navy - but so could the Dutch and French navies (Allen, 2002). In wartime, recruitment by force ("the press") was common, and ensured that the Royal Navy had first pick of prime seaman. Since Britain often blockaded enemy fleets, its own seaman had more practice than their enemies. A highly professional officer corps also enhanced the fighting power of the Royal Navy; in contrast to the British army, for example, commissions could not be purchased but had to be earned through exams and appointments.[16] There were also no major organizational upheavals, such as the drastic egalitarian reforms that undermined the fighting power of the French Navy after 1793.

The principal challenge for a naval commander during the Age of Sail was to find the enemy fleet. Without modern means of communication, visual contact was necessary to bring fleets into action. Frigates serving as "eyes of the fleet" were in high demand. Nonetheless, much of the naval history of the 18th century consists of chance encounters and month-long cat-and-mouse chases, such as the long-delayed meeting of the British and combined French-Spanish fleets at Trafalgar (which followed a chase to the West Indies).

While the Royal Navy had a number of structural advantages, it also gave itself rules that contributed to its success (Allen, 2002). Chief among them was a strong bias in favor of taking action against an enemy. Principal-agent problems are rife in every military organization (van Creveld, 2004), and nowhere more so than on the high seas in the Age of Sail, when messages from the Admiralty could take months to reach a commander (Allen, 2002). From the mid-eighteenth century onwards, Navy regulations did not allow British captains to avoid confrontation with an enemy of broadly similar size. Instead, they were required to do their utmost to attack and defeat him.[17] Where efforts were insufficient, the punishment could be severe. Loss of a ship brought an automatic court martial, and convicted navy officers could suffer the ultimate punishment – as in the case of Admiraly Byng, executed for failing to do his best to capture Menorca from the French in 1759, as he had been ordered to do. Contrast this with the behavior of the Royal Navy's main competitor:

[16] See Allen (2011) for a general theory of when purchasing commissions works better than patronage.

[17] "British commanders were expected to defeat enemy forces much stronger than their own. . . . In single ship actions, it was reckoned that a British ship had a good chance against an enemy of 50 per cent greater gun power and crew." (Lavery, 1998, p. 317).

> "French fleets never attacked, as indeed they had never attempted to do since 1704. Their tactics when opposed by fleets of equal strength were mainly defensive." (Tunstall and Tracy, 1990, p. 7).

2.4 Patronage in the Royal Navy

Patronage was an important factor in personnel decisions of the Royal Navy. Boys joining a ship for the first time often did so through family connections; promotion to midshipman, lieutenant, and post-captain were all affected by how much "influence" an officer had at higher levels of the naval hierarchy, in Parliament, and at court. How could such a system produce competent captains in large numbers?

A simple example can illustrate the extent to which nepotism pervaded Navy careers. A young man, the sixth of eleven children of an Anglican reverend, joins the Navy at age 13. He begins as a seaman serving in HMS *Raisonnable*, commanded by his maternal uncle, Captain Maurice Suckling. Soon he is promoted to midshipman and begins officer training. After serving in a variety of ships, he is first appointed acting lieutenant. He passes the examination as lieutenant, aged 19, in front of an examining board presided over by his uncle, who has in the meantime risen to the position of Comptroller of the Navy – the member of the Admiralty Board supervising all spending.

Immediately after his promotion, the young naval officer is appointed as lieutenant in a 32-gun frigate, HMS *Lowestoffe*. After capturing various enemy ships and taking prizes, the lieutenant is appointed Commander of the tender *Little Lucy*. Since his captain is impressed with him, he posts him to the flagship of Sir Peter Parker, Admiral on the Jamaica station. After a successful attack on a Spanish fort, Parker puts his protegé in charge of HMS *Hinchinbrook*, a 28 gun frigate. He is thus made a post-captain at age 21, an appointment decided by the local station commander and then confirmed by the Admiralty. Within two years, he has transitioned from midshipman to captain of a major warship (Coleman, 2001).

The young man was, of course, Horatio Nelson – arguably one of history's most outstanding naval office. He would later command the fleets that vanquished England's enemies at the Battle of Abukir and Trafalgar. There is no question as to his various talents and abilities, as a captain, naval commander, and strategist. And yet, without his uncle's influence, Nelson – who had a weak constitution that left him

ill for months on end, was no great navigator, and who suffered from sea-sickness all his life – would probably never have risen to the very top of the Navy hierarchy. Instead, patronage from several highly ranked officers ensured that he became one of the fastest-promoted captains in the Royal Navy. Naval historians have indeed argued that patronage was a key determinant of success:

> "... successful patronage was the key to a successful career, the principal means by which a reliable ship's company was cemented, and one of the strongest social forces within the Navy." (Rodger, 1987, p. 124).

> "... power of patronage was the key to the eighteenth-century Admiralty's authority, the one element which counterbalanced weakness to command and near inability to punish." (Rodger, 1984, p. 245).

> "... patronage, properly used, did much to save the country in wartime by giving outstanding men rapid promotion... the effect ... because of patronage, luck, or endeavour, was that ... the right men ended up in the right jobs." (Pope, 2013, p. 24+p. 29)

Cases such as Nelson's suggest that patronage and performance were not necessarily mutually exclusive. Next, we introduce a conceptual framework that clarifies how patronage can enhance performance in our setting.

3 Conceptual framework

We use a signal extraction framework to motivate our empirical analysis. To clarify matters, we focus on a simple framework that abstracts from incentive effects and focuses solely on the selection margin that Admirals face when making promotion decisions.

3.1 Setup

Agents belong to two groups, $j \in \{1, 0\}$; some are connected to the principal ($j = 1$), while others are unconnected ($j = 0$). The perfor-

mance of agents g is given by $g = a + \varepsilon$, which depends on ability a and noise ε. The principal observes performance g and group membership j, but cannot directly observe ability and noise. The ability of agents is distributed as $a \sim N(\mu_j, \sigma_j^2)$ and the noise in the measurement of performance is distributed $\varepsilon \sim N(0, \sigma_{\varepsilon j}^2)$.

Assumption 1: *The mean ability of connected vs. unconnected agents is weakly lower:* $\mu_1 \leq \mu_0$.
This assumption reflects the fact that the pool of connected candidates from which the principal can choose is more constrained. The assumption also works "against" an ability advantage for connected agents, thus making the screening problem interesting.

Assumption 2: *Principals observe the performance of connected agents with less noise:* $\sigma_{\epsilon 1}^2 < \sigma_{\epsilon 0}^2$. *Without loss of generality, we set* $\sigma_{\epsilon 1}^2 = 0$.
When assessing performance, principals are better able to distinguish luck from ability for connected subordinates. This assumption reflects the informational advantage of connections. The principal's objective function is $U = a + b_j$. The principal seeks to promote the higher ability agents. In addition, the principal may derive an added benefit b_j of selecting an agent from the group j. Principals, for example, might exercise favoritism and derive a private benefit from selecting connected agents, in which case $b_1 > b_0 \geq 0$. For simplicity, we normalize $b_0 = 0$. We refer to this preference for connected agents as "bias".

3.2 Promotion choices and performance

The principal will promote the connected agent if the expected utility conditional on observing a given level of performance is higher: $E[U|g, j = 1] > E[U|g, j = 0]$. The expected utility from promoting an agent of group j with the observed performance of g is:

$$E[U|g, j] = \left(\frac{\sigma^2}{\sigma^2 + \sigma_{\varepsilon j}^2} g + \left(1 - \frac{\sigma^2}{\sigma^2 + \sigma_{\varepsilon j}^2} \right) \mu_j \right) + b_j \tag{1}$$

The conditional distribution of ability given performance is normal with mean equal to a weighted average of the performance and the unconditional group mean (DeGroot, 2004).

Expression (1) captures the basic trade-off the principal faces when making promotion decisions. The principal would like to promote the agent that yields the highest (private) utility. On the one hand, the principal is better able to identify higher ability candidates among connected subordinates due to better information, as modelled using the smaller measurement error $\sigma^2_{\epsilon j}$. On the other hand, favoritism (b_1) might distort the selection. Even if an agent is known to be of low ability, a biased principal might nonetheless promote the connected agent if the private benefit from doing so is sufficiently large. The model yields two propositions on how family ties interact with promotion and performance. The proof can be found in the Appendix.

Proposition 1: Complementarity in performance and connections. *The link between promotion and performance will be stronger for agents connected to the principal:* $\frac{\partial E[U|g,j=1]}{\partial g} > \frac{\partial E[U|g,j=0]}{\partial g}$. Intuitively, since the performance of connected agents is observed with less noise, the principal can more reliably attribute the observed performance to ability. With our extreme assumption of $\sigma^2_{\varepsilon 1} = 0$, performance is a perfect measure of the agent's ability. The principal will thus be more responsive to performance when assessing connected agents. This is the value of better information (Jia et al., 2015).

Proposition 2: Performance and promotions. *In the absence of bias, connected promotees always outperform unconnected promotees. The positive performance gap between connected and unconnected promotees is declining with bias. While connected promotees outperform unconnected promotees if bias is sufficiently small, there will be a threshold* $b > \bar{b}$ *above which connected promotees underperform relative to unconnected promotees.* In the absence of bias ($b_1 = 0$), the principal will promote the connected agent *only if* the observed performance is above average, and promote unconnected agents if performance is below average. In other words, since distinguishing ability from luck is difficult for the Admiralty in the case of the unconnected, they will make more "mistakes". The ability to pick the highest ability agent from the pool of connected agents reflects the value of better information. In the presence of bias, the performance implications depend on the trade-off between superior information and bias. On the one hand, better information enables principals to better identify talent among connected agents. On the other hand, bias leads the principal to lower the promotion threshold for connected agents. Figure 2 illustrates these results graphically.

We first consider the case of the unbiased principal. The dashed line shows the expected payoff from promoting a connected agent with observed performance g. The solid, flatter line shows the expected payoff from promoting an unconnected agent with the same performance g. Due to better information, the relationship between performance and promotion is steeper for connected agents (Proposition 1). The unbiased principal will promote the connected agent if the performance is greater than the average performance of the unconnected principal μ. If the connected agent underperforms below μ, the principal is able to tell that it is not due to bad luck. In this case, the unbiased principal is better off promoting an unconnected agent.

In the case of bias, however, the principal will lower the performance "bar" for connected agents (Proposition 2). This is seen in Figure 2 as a shift away from the dashed line. There is now a wedge between the unbiased promotion rule that selects purely on performance and the promotion rule that accounts for the private benefit. The area in the figure marked "Promote only when biased" is the range in which connected promotions will be of lower quality.[18]

4 Data and descriptive evidence

In this section, we describe the data used in our empirical analysis, their limitations, and the sources from which the data are derived.

4.1 Personnel and ship data

Our core dataset is based on data from Threedecks.[19] This is a web resource that features detailed information on vessels, crews and naval actions. The dataset contains information about 25,229 ships, 33,959 seamen and 1,022 actions and battles among European seapowers (the major ones being British, French, Spanish, Dutch and Portuguese).[20] The dataset is maintained by naval enthusiasts; it is a trusted source referenced by the National Maritime Museum in Greenwich, United

[18]There is no question that such promotions occurred: "... no obviously stupid captain was appointed. But occasionally an officer who was a competent seaman but had defects in his character which should have barred him did in fact obtain command because of influence: he or a relative... knew an admiral or minister." (Pope, 2013, p. 54).

[19]See http://www.threedecks.org.

[20]We downloaded the data in September 2018. Numbers are correct as of this date.

Kingdom. Threedecks constitutes the most comprehensive data source on the personnel and ships of the Royal Navy, as well as of fighting events during the "Age of Sail."

We extract Threedecks' complete records to construct our main dataset. We restrict the sample to the time period 1690-1849, covering the classic "Age of Sail." We drop lower tier seamen and petty officers, confining the sample to cover only British lieutenants, commanders, post-captains and admirals ("naval officers"). We then combine the individual level panel of officers and positions with the ship-level panel to construct a matched "ship-officer" dataset. The resulting ship-level panel contains rich data on outcomes such as the number of enemy ships captured or destroyed, the number of actions taken part and whether the ship itself was captured, sunk or wrecked.

We conduct a series of validation exercises to assess the coverage and quality of the data. To assess the coverage, we compared the number of rated ships included in our sample to the complete record of all rated ships (College and Warlow, 2010).[21] The comparison yields a coverage rate of 95%. To assess the data quality, we randomly sampled 1% of the officers and checked the careers against standard references like Syrett and Dinardo (1994) and Clowes (1897).

The resulting dataset contains information on the careers of 5,848 officers, 3,904 ships over 160 years – with a total 82,958 officer-ship-year observations. Figure A1 gives an overview of variation over time. Unsurprisingly, fighting events cluster during wartime, and the number of officers in our dataset also spikes at the same time. At the peak, we can draw on 500 fighting events per year, and relate them to 1,500 officers. Table 1 shows the summary statistics for the main sample on the officer-level. The average officer remains in the Royal Navy for an average of 14 years, commanding a ship for about 7.5 years. On average, an officer serves across 3.6 different ships with an average of 30 guns. Naval officers in our dataset only spend 18% of their entire service span on large battle ships, the ships of the line. On average, each officer can claim one enemy capture, while only 14% of the officers ever lose a ship to the enemy. The likelihood of other performance-related events such as the number of actions seen or ships destroyed is lower. Finally, half of all officers make it to post-captain and above. Only a small share (3%) eventually become admirals.

[21] College and Warlow (2010): *Ships of the Royal Navy: The Complete Record of all Fighting Ships of the Royal Navy from the 15th Century to the Present.*

4.2 Measuring family ties

Our analysis focuses on connections to the two top admirals – the First Lord of the Admiralty, and the Admiral of the Fleet ("Admiral of the Red"). These two officers were crucial in all personnel decisions – who got to command which vessel and who was put on half-pay, whether an officer would serve in a disease-ridden station or near home, and whether a captain's junior officers would receive promotions.

We use genealogical data from the Peerage dataset[22] to measure whether officers were connected to the Admiralty. The dataset contains family tree data for the peerage of Britain as well as the royal families of Europe, including the genealogical data of the British elite and military. We link officers in our dataset to the Peerage data by matching based on full name, title and year of birth and death. For 11% of officers, the geneological data can be used to measure family distance to the Admiralty. In light of the antiquity of the data (1690-1849), and the fact that many officers rose from lower classes (and thus are not included in the elite dataset), we consider this a reasonable match rate.[23] As the family trees of nearly all Admirals are mapped out, we can safely assume that the remaining officers are unconnected to their superior. Since our empirical strategy exploits within-officer variation in connectedness, this assumption does not introduce selectivity issues – if anything, it is likely to bias our estimates towards zero, yielding more conservative results. For the subset of matched officers, we compute the shortest distance in pre-determined family ties. We then define an admiral and officer to have shared ancestry (family ties) if the degree of separation is sufficiently close.[24]

There is a trade-off in choosing a cut-off that defines "closeness." A low degree of separation increases the likelihood of an actual social tie. At the same time, a close cut-off will reduce the number of admirals and officers who are classified as kin. As the empirical strategy exploits observing the same officer under changing connectedness to the Admiralty, a lower degree will reduce the number of switchers. We thus count a naval officer as connected when he is no more than 16 degrees separated from the two leading admirals. This follows the definition of Xu (2018) and captures the extent to which two individ-

[22] See http://www.thepeerage.com.

[23] In comparison, Xu (2018) obtains a match rate of 34% for governors of the British Empire 1854-1966, who are recruited from a much more elite population.

[24] The results are robust to cut-offs between 14 and 20.

uals have a shared ancestry. While this is a generous cut-off, it is in line with the enormous weight put by contemporaries on "pedigree" and social connections – as exemplified in the numerous publications listing the family tree of noblemen and -women.

Figure A2 shows variation in the share of naval officers connected according to this measure between 1690 and 1849. While there were very few officers linked to the top of the naval administration in the first decades of the 18th century, their share increased over time. During the Revolutionary Wars against France, their share peaked at over 20% of the total. Afterwards, it fell sharply after a highly successful career admiral from a middling background, John Jervis (Earl of St. Vincent), became First Lord of the Admiralty – and decided to curtail the role of "influence" in naval appointments.

Out of the 5,848 in our dataset, 562 were at some point of their career connected through family ties to the Lord Admiral or the Admiral of the Fleet. Since both the Lord Admiral and the Admiral of the Fleet come and go, we observe variation over time in connectedness to the very top of the Navy hierarchy. Among the 562 ever connected officers, 196 are connected throughout their career (always connected). For the 366 who experience a switch in their ties to the Admiralty during the career, the average "switcher" enjoyed ties to the Admiralty for 60% of his time on active service.

4.3 Battle-level outcomes

Finally, we make use of the rich documentation of naval engagements to construct battle-level outcomes. These range from famous single ship actions such as HMS Java vs. USS Constitution in 1812 to full-scale fleet actions like the Battle of Trafalgar. The latter involved a total of 74 battle ships. These naval engagements have been carefully documented by the Royal Navy and subsequent historians.

We focus on two types of engagements: the first type of battle comprises fleet and flotilla actions. These actions involve multiple ships on either side. Using Threedecks for our study period 1690-1849, we identify 94 fleet actions and 263 flotilla actions, with a total of 972 British ships involved. The second type of engagement are single-ship actions. These are "chance" engagements between two opposing ships, often of relatively equal size. We were able to identify 172 single ship actions.

For each of these actions, we conducted careful qualitative research

by drawing on historical accounts such as Clowes (1894-1903) and descriptions from the *London Gazette*. This allows us to hand-collect officer-ship-action level information on whether a given officer captured an enemy ship, saw his own ship captured or retreated. We link the officers and ships involved to our main dataset to obtain performance-related outcome characteristics such as experience, or the gun count of the ships.

5 Promotion, performance and family ties

5.1 Promotions and performance

We now test Proposition 1. Figure 3 provides the empirical counterpart to the theoretical prediction shown in Figure 2. It plots the share of commanders who are promoted to post-captain at different levels of cumulative performance, broken down by connectedness to the Admiralty. Consistent with merit-based promotions to post-captain, the share promoted rises with performance. Those who capture more enemy ships, see more action and destroy more enemy structures are more likely to be "made post". There is evidence of favoritism: Admiralty-connected commanders have a higher chance of promotion at every level of performance. At the same time, and crucially, the positive relationship between promotion and performance is stronger for officers who are connected to the Admiralty: Admirals are promoting *even more* by merit when their subordinate is a kin.

In order to move beyond the bivariate correlation, we estimate the following regression model as the empirical counterpart to (1). For officer i in year t, we estimate,

$$y_{it} = \alpha q_{it} + \beta c_{it} + \gamma q_{it} \times c_{it} + \theta_i + \nu_{X(i,t)} + \tau_t + \varepsilon_{it} \qquad (2)$$

where $y_{it} = 1$ if the officer i was promoted to post-captain in year t, and 0 otherwise. The variable q_{it} is the performance measure. In this context, we measure performance as the cumulative number of captures, actions seen and ships destroyed. To ensure that the measure of performance is pre-determined and not driven by the contemporaneous allocation choices of Admirals, we measure the cumulative performance up to the previous year. The variable $c_{it} = 1$ if the officer i has family ties to the Admiralty in year t. θ_i are officer fixed effects; $\nu_{X(i,t)}$ are tenure fixed effects that restrict our empirical comparison

to officers with the same years of tenure; τ_t are year fixed effects and ε_{it} is the error term, which we cluster at the officer and officer-admiral level, the level at which the measure of connections varies.

The interaction between performance and connectedness is the key identifying variation we exploit. Throughout their careers, officers experienced changes in the extent to which they were connected to the Admiralty. As Admirals turned over at the top due to retirement and seniority-based progression, some officers gained connections while others lost them. This allows us to compare the promotion chances of the same officers with not just varying performance in different years but also varying connectedness to the Admiralty. In the presence of a complementarity between performance and connections, we expect the key interaction $\gamma > 0$. Since promotion to post-captain is an absorbing state, we restrict the sample to officers who can still be promoted.

The results are shown in Table 2 and confirm the complementarity between performance and connections in determining promotion decisions. In Column 1, we first report the level effects before moving to the key interaction. All regressions include year fixed effects, tenure fixed effects and entry cohort fixed effects. Promotions to post-captain are performance-based but connections are also important. One additional fighting event is associated with an 5.6% point increase in the probability of promotion. Officers with family ties to the Admiralty are 8.4% point more likely to make post than officers who are unconnected. Compared to the unconditional promotion probability of 9.6%, these magnitudes are economically meaningful.

In Column 2, we include the interaction between performance and connections. Consistent with the visual evidence in Figure 3, we find that performance and connections are complements for promotions to post-captain. While there is an overall positive relationship between promotion and performance, the association is stronger for those who are connected to the Admiralty. This is consistent with the interpretation that Admirals hold better information (Section 3). Finally, Column 3 reports the preferred specification using officer fixed effects. With officer fixed effects absorbing any time-invariant cross-officer differences in promotion, performance and connectedness, we are now holding constant the selection margin. The identifying variation in performance is thus stemming from the fact that the very same officer exhibits differential performance over time; similarly, variation in connectedness is now driven by turnover at the highest echelon of the

Admiralty. Once holding constant selection, the main effect of connectedness is now substantially smaller and statistically insignificant. This suggests the presence of officer-specific unobserved correlates of connectedness that also drive promotion decisions, e.g. that connected individuals may be of differential quality. Conversely, since the magnitude of the coefficient on performance grows as we add controls, we can be confident that unobservables are unlikely to be driving the relationship. Importantly for our empirical test, we find that the interaction between performance and connections remains positive and statistically significant.

Finally, we address concerns that the results are driven by connected officers being allocated better ships. We do so in two ways: first, we exploit the fact that the same ship is observed under different officers. This allows us to introduce ship fixed effects to absorb ship-specific time-invariant unobservables. As Column 4 shows, the inclusion of ship fixed effects leaves the estimates of interest nearly unchanged. Performance and connections thus served as complements in determining whom to promote.

5.2 Post-promotion performance

Are connected promotees actually more effective after the crucial promotion to post-captain? It is unclear whether these officers will outperform as post-captains (Proposition 2): If Admirals are biased in favor of their kin, connections will substitute for ability and thus lead to lower quality officers being promoted. Conversely, if Admirals screen on unobservable characteristics that predict greater performance, we expect connected promotees to outperform even high-achieving peers. To examine this question empirically, we conduct an event study looking at the performance difference between connected and unconnected promotees around the promotion to post-captain. We create a balanced panel of promoted officers for whom we have data in the five year window around the year of making post. This ensures that the results are not driven by composition changes in the pool of officers over time. Our analysis is based on a balanced panel of 638 officers, of whom 16% are connected promotees.

Figure 4 provides visual evidence for the performance of post-captains around their promotion window. The figure contrasts connected promotees with those who were unconnected to the Admiralty in the year of their promotion. While there are no large differences be-

tween connected and unconnected officers prior to the promotion, the performance gap after making post is large and persistent.

To move beyond the raw plot, we estimate for officer i in year t,

$$\log q_{it} = \beta C_i \times post_t + \theta_i + \tau_t + \varepsilon_{it} \quad (3)$$

where q_{it} measures the cumulative performance of officer i in year t. C_i is a dummy equal to one if the officer was connected to the Admiralty in the year of making post, and 0 otherwise. $post_t$ is a dummy that is 1 after the officer was promoted to a "post ship". In this difference-in-differences setting, the key coefficient of interest is the difference in performance between connected and unconnected promotees after both were promoted to post-captain. This is captured in the interaction $C_i \times post_t$ and the coefficient β. τ_t are dummies for each year around the promotion window. θ_i are officer fixed effects. As before, the standard errors are clustered at the officer-level and officer-admiral level, the level at which connections vary.

The results are shown in Table 3, Panel A. There is no statistically significant difference between connected and unconnected promotees in the years prior to the promotion to post-captain. After promotion to post-captain, however, those promoted while connected to the Admiralty consistently outperform (Column 1). In Column 2, we add officer fixed effects. These officer fixed effects partial out time-invariant individual-specific differences that may be correlated with connectedness – for example, that connected officers are from more elite families. The identifying variation thus stems from officers who experience a switch in their connectedness to the Admiralty around the promotion window. Despite this substantially more restrictive specification, the pattern remains robust.

Since those connected to their superior often remain connected for a while, an important question concerns whether the observed effects are driven by the selection made *at the time of promotion*, or whether they are driven by contemporaneous connections to the Admiralty. This has important implications for the interpretation of the results: If the results are driven by contemporaneous connections, it will be much harder to rule out that Admirals are providing connected promotees with better inputs throughout – for example allocating them more skilled crews, or assigning them to more promising theatres of war. In Column 3, we therefore control for contemporaneous connectedness to the Admiralty. Interestingly, the impact of connected promotions remains, suggesting that it is indeed the past promotion

decision of the previously connected Admiral that drives the effect. To corroborate this, Column 4 restricts the sample to officers who see their promoting Admiral rotate out post-promotion. Consistent with better screening, connected promotees continue to outperform even if their patron is no longer in office. Finally, the results hold up using different control groups. In Column 5, we confine the comparison to only the subset of officers that experience switches in family ties to the top of the Navy during their career. While officers who are connected to the Admiralty throughout may differ substantially from those who were never connected to the Admiralty, the sample that experiences changes in connections during the career is likely to be more comparable. The results are largely unaffected.

The role of assignment. The greater performance of connected promotees post-promotion could be driven by three channels: First, connected promotees may have been given command more often (reducing time on the "beach"). Second, they receive better ships and crews, offering them more opportunities to distinguish themselves. Third, conditional on any given command, officers could perform at a higher rate. To investigate these three channels, Table 3, Panel B, Column 1 repeats the event study of Panel A using a dummy that is 1 if the officer is given command over a ship in a given year. As Column 1 shows, connected promotees enjoy a 12.6% point higher probability of actually commanding a ship after promotion to post-captain. At the same time, connected promotees also appear to outperform whenever they command a ship. In Panel B, Columns 2-5, we repeat the performance event study by restricting the analysis to only those officers who were given a ship (and thus had a chance to perform). Conditional on commanding a ship, connected promotees still outperform unconnected promotees post-promotion.

To test whether the performance gap is driven by the preferential allocation of better ships to connected officers, we include ship fixed effects. As Column 3 shows, partialling out cross-ship differences in performance does not explain away the performance gap. In Column 4, we also include controls for the ship's age, as well as a dummy equal to one if a ship was refitted in a given year. Once again, the point estimates remain comparable. Finally, we assess whether the performance gap can be explained by better crews. The naval records contain information about the time crews were paid off. This allows us to reconstruct crew turnover for each ship. Once again, the in-

clusion of ship-specific crew fixed effects leaves the point estimates nearly unchanged (Column 5).

We conduct a range of additional robustness exercises. We check if the performance results differ when we confine the sample to only those who ever commanded a ship. Reassuringly the results remain comparable (Appendix Table A1). We also conduct a bounding exercise to assess the extent to which selective half-pay can explain away our results. Specifically, we impute varying counterfactual performances for those who are on half-pay. As Appendix Table A2 shows, our results remain robust and – if anything – become stronger.

Incentives and loyalty. A remaining concern might be that the results do not solely reflect selection through better promotion decisions. Connected promotees could be more motivated to exert effort in order to progress towards flag positions. Similarly, if connected promotees are more likely to hail from naval families, reputational concerns may induce greater effort. In both cases, the results may capture a combination of selection and incentive effects.

Since promotions among post-captains are rigid and primarily determined by seniority, there is little room to increase one's chances through greater effort, thus alleviating concerns over strong incentive responses. To demonstrate this empirically, we repeated the promotion regressions (Table 2) for the sample of post-captains to predict progression towards Admiral positions (Appendix Table A3). As expected given the seniority-based progression, neither battle performance nor connections predict promotions to Admiral. To assess the role of reputational concerns (e.g. family honor), we test if the effect is driven by members of naval families, i.e. those who are sons and nephews of naval officers (who may also be more likely to be connected to the top of the naval hierarchy). While officers with close relatives in the navy do better on average, connected officers with a father in the navy do not outperform differentially. Importantly, results remain comparable even after controlling for this factor (Appendix Table A4). Taken together, these results consistently show that connected promotees – on average – outperform unconnected promotees, and that selection is likely to be a key factor.

6 Mechanisms

What is driving the remarkable performance gap? To examine the determinants of fighting performance, we first distinguish two types of naval actions – fleet actions, and single-ship encounters. In fleet actions, favored officers may be included in a squadron about to bring the enemy to action, or given more prominent position in the line of battle, and score more easily, for example – a factor for which we can control. In single-ship actions, on the other hand, chance encounters on the high seas determine who fights whom – and once we control for the quality of ships, we can readily measure the combined effect of seamanship, gunnery, and leadership. Results show that the ships commanded by connected appointees outfight those of their peers in both types of engagements.

Next, we examine where the performance gap comes from. Are Admirals who in general promote more on merit also those who only favor talented relatives, who then go on to earn more laurels? And are Admirals favoring their kin in general also poor at picking good officers when it comes to promotions? We estimate indicators of admirals' "style" and show that they have predictive power for the performance of connected appointees.

6.1 Fleet actions

We have information on 1,959 British officers who fought in fleet and flotilla actions. On average, they were outgunned – they fought with less than 60% of the enemies' ships and 63% of the enemies' guns. In almost 14% of actions, they captured an enemy ship; in 2%, they lost their own. Connected promotees make up 21% of our sample (Table A5).

In Table 4, we examine the determinants of performance. Panel A looks at captures of the enemy. Column 1 shows that connected promotees are 8% points more likely to capture an enemy ship than the unconnected – a sizeable difference compared to a base rate of 13.9%. This effect is unchanged if we control for promotion year fixed effects and post-captain experience (Column 2). In Column 3, we introduce fixed effects for the position of ships, controlling for whether a ship is at the vanguard, center or rear of the battle formation. In Column 4, we control for the relative size and strength of fleets. While a more numerous British fleet made it harder for each individual officer to

"score", having more guns in the British fleet helped. Column 5 repeats the exercise for British losses. The main result here is the opposite of that for British captures – connected promotees are markedly less likely to lose their ship to the enemy. The effect is sizeable, cutting the average rate of losses by more than half.

6.2 Single-ship actions

The British Navy dominated in single ship actions. Out of 128 single ship encounters, British officers captured or sank 85 enemy ships, lost only 11 ships and had 32 inconclusive encounters. Among the 32 inconclusive encounters, the enemy withdrew 22 times (69%). The British public considered defeat in a single-ship action as particularly shameful (Lambert, 2013). Importantly, single ship encounters are often chance encounters on the high seas. While connected promotees typically commanded larger ships due to their greater performance, the size of the enemy ship – as measured by the guns or men – is remarkably comparable (Appendix Table A6).

Table 4, Panel B reports the results for single ship actions. Column 1 provides the simple comparison of the winning rate between connected and unconnected promotees. A single ship action is deemed won if the enemy ship was either captured or sunk. Connected promotees are significantly more likely to win: On average, connected promotees are 20% points more likely to win a single ship engagement (Column 1). Compared to the mean of the dependent variable, this represents a sizeable 31% increase. To ensure that the higher capture rate is not driven by more favorable terms of engagement, Column 2 controls for the gun ratio (the ratio of own guns over enemy guns). While ships with a more powerful broadside were more likely to win, controlling for gun ratios leaves the gap in winning rate nearly unaffected. Finally, Column 3 also controls for the year of promotion to post-captain and experience (which, according to Benjamin and Tifrea (2007) was a key source of competitive advantage for the Royal Navy). As before, the point estimate remains almost constant. Officers promoted while connected to the Admiralty thus saw a significantly higher success rate in single ship encounters. While connected promotees were as likely to lose an engagement as the unconnected, the higher success rate overall is driven by a smaller number of inconclusive engagements – connected officers basically only lost or won, but never experienced a draw, whereas one quarter of unconnected

officers fought indecisive engagements. In single ship encounters, a key determinant of differential performance for the connected promotees was therefore "fighting spirit" – the willingness to fight until victory was won, and the determination to pursue an enemy that was trying to break off the engagement.

6.3 Role of Admiralty styles

While connected promotees outperform unconnected promotees as post-captains, this average result may mask substantial heterogeneity. A large literature on management styles (Bertrand and Schoar 2003; Bloom and Van Reenen 2007) suggests that the selection effect may vary with the governance "style" of the Admiralty.

Seen through the lens of our model, differences in governance "styles" will reflect Admiralty-specific variation in two parameters: Admirals, for example, will vary in their propensity to promote based on merit due to differences in their ability to observe performance ($\sigma^2_{\epsilon j}$). Similarly, admirals may vary in the extent they exercise favoritism to bias the allocation of positions towards their kin (b_1).

We bring these predictions to the data by exploiting the fact that we observe post-captain promotions under different Admiralties over time. We use each combination of Head of the Admiralty and the Admiral of the Fleet as a separate observation, giving us 49 combinations of top naval administrators overall.

To assess how meritocratic a "management team" was, we estimate α and β from Equation 2 for each Admiralty. As Figure 5, Panel A shows, for certain Admiralty "teams", performance influenced chances of promotion only a little – and for three management teams, it is even associated negatively with promotion prospects. For 42 admiral combinations, however, the effect of merit was strictly positive.

Second, guided by our theoretical framework, we estimate the extent of family-bias for each Admiralty. Figure 5, Panel B reports the estimated connection premia for the different Admiralty periods. The figure shows that no-one discriminated against relatives, and that some mild favoritism was the norm: Coefficients are overwhelmingly positive, but mostly small and mostly insignificant. Only 10 teams of top naval administrators discriminated significantly in favor of related officers.

Figure 6 plots both of these measures over time. Positive bias in promotions was mostly a phenomenon of the late 17th and early 18th

centuries. Merit-based promotions were particularly strong in the 1720s and 1740s. The two measures are inversely correlated – admiralty teams that showed favoritism gave lower weight to merit in promotions, providing indirect support for the notion that we are measuring "style".[25]

Table 5 uses the estimated coefficients for merit and bias to explain the performance of post-captains. Column 1 repeats our baseline estimate of the differential performance of connected officers around the promotion to post-captain. In Column 2, we show that officers promoted by admiralty teams that valued merit at the time of deciding on "post" picked better, more successful men. In addition, connected officers chosen for promotion outperformed more the more meritocratic an Admiralty team's management style, but results are not significant. In Column 3, we show that the opposite also holds – more bias spelled worse performance. While the unconnected do not lag in battle performance, connected promotees who owed their appointment to Admiralties that favored relatives independent of merit underperformed particularly strongly. Finally, we corroborate these findings using an alternative shifter of "management styles" – war. War years are periods when the Admiralty's incentive to select the highest performing officers is arguably greater.[26]

These results suggest that the greater performance of relatives in the Royal Navy varied with the management style of top naval bureaucrats. When the leading admirals were meritocratic in promotions, they particularly boosted the careers of talented relatives, who went on to outfight other, comparable officers. When the leading naval staff was practicing nepotism, rewarding relatives with plum assignments, performance on the whole suffered because connected appointees underperformed. The overall effect of patronage therefore hinged on the probity and judgement of the decision makers at the top of the naval hierarchy.

7 Conclusion

Winston Churchill famously argued that the Royal Navy ran on "rum, sodomy, and the lash". It was also a nepotistic institution, where per-

[25]The correlation coefficient between both measures is -0.44 and statistically significant.

[26]The link between performance and promotion is even steeper for connected officers during periods of war (Appendix Table A7).

sonal connections could make a huge difference to promotion prospects. How do we square this with the Royal Navy's outstanding fighting record? One interpretation is that it excelled despite its shortcomings, perhaps thanks to the even greater weaknesses of its adversaries.

An alternative interpretation is that it succeeded *because* of its use of patronage. That patronage can be "a good thing" has long been argued in economic theory, but there was no hard evidence to suggest that it offered tangible benefits. By using individual-level data on officer's fighting record during the long eighteenth century, we first establish that connected promotees on average outperformed unconnected ones.

Two factors could be driving this result. Connected officers could expect greater rewards for performance: For example, with an uncle at the head of the Admiralty, their accomplishments might be notice more readily. Alternatively, Admirals might simply know their relatives better, factoring in intangible factors that predict who will be an effective officer. We first establish that merit paid, on average, for both the connected and unconnected – but it offered greater rewards to those with family ties to top admirals. This empirical pattern is consistent with better information.

Post-promotion performance shows that connected officers made, on average, better fighting captains. Promoted officers were not only given larger ships but also more autonomy in their command. We find that connected officers outperformed unconnected ones by a large margin once they were given independent command – whereas before, the connected and unconnected performed similarly on the whole. Selection was thus an important factor behind the effectiveness of patronage in the 18th century Royal Navy. To reinforce this point, we show that admirals who emphasized merit in general in their promotion decisions were also better at picking relatives who subsequently performed.

These findings have broader implications because they emphasize the importance of selection: In an institutional environment where promotions are discretionary, *how* discretion is used is critical. If "good" principals use their discretion to promote the highest performing subordinates, propitious patronage will prevail. In contrast, "bad" principals will beget nepotism by promoting subordinates who, once risen to the rank of admiral, are more likely to abuse patronage. Of course, these results do not suggest that patronage itself is always beneficial for organizational performance. What our results do show, however,

is that personal ties might help resolve information asymmetries in environments where true talent is difficult to observe. As such, patronage can serve as a second-best solution.

Tables

Table 1: Descriptive statistics of naval officers

	(1) Mean	(2) SD	(3) IQR	(4) Obs.
Years of service	14.18	15.14	17	5,848
Total years commanding ship	7.51	6.36	8	5,848
Number of ships commanded	3.65	3.58	4	5,848
Ship of the line (1-3)	0.182	0.39	0	5,848
Average guns	29.54	20.02	29.23	5,801
Enemy ships captured	1.04	2.23	1	5,848
No. of flotilla/fleet actions	0.50	1.17	0	5,848
Enemy ships sunk	0.02	0.18	0	5,848
Own ships lost	0.14	0.37	0	5,848
Made post	0.52	0.49	1	5,848
Made admiral	0.03	0.17	0	5,848

Note: Unit of observation is the naval officer (i.e. all lieutenants, commanders, post-captains, and admirals). The sample covers all naval officers in our study period 1690-1849. We report the mean (Column 1), standard deviation (Column 2), the interquartile range (Column 3) and the total number of officers (Column 4).

Table 2: Promotion to post-captain, battle performance and connectedness

	(1)	(2)	(3)	(4)
	Promoted to post-captain=1			
Mean of dep. var	0.0958	0.0958	0.0958	0.0958
Battle performance	0.056***	0.050***	0.091***	0.093***
	(0.007)	(0.007)	(0.008)	(0.009)
Connected	0.084***	0.065***	0.014	-0.003
	(0.010)	(0.009)	(0.023)	(0.022)
Battle performance × Connected		0.067***	0.057***	0.058***
		(0.016)	(0.019)	(0.017)
Year FEs	Y	Y	Y	Y
Tenure FEs	Y	Y	Y	Y
Entry year FEs	Y	Y		
Officer FEs			Y	Y
Ship FEs				Y
Observations	36,251	36,251	36,251	36,251

Note: Unit of the observation is the officer-year level. Relating promotion to post-captain to battle performance, connectedness and their interaction. Battle performance is measured as the cumulative number of actions, enemy units destroyed and captures up to the previous year. Connectedness is a dummy that is 1 if the officer shares family ties to the Admiralty. Sample covers all officers between 1690-1849. Standard errors clustered at the officer and officer × admiral-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Battle performance around promotion to post-captain

Panel A:	(1)	(2)	(3)	(4)	(5)
	Battle performance				
Mean of dep. var	0.832	0.832	0.832	0.828	0.894
Connected promotee	-0.142				
	(0.103)				
Connected promotee × Post	0.596***	0.516**	0.516**	0.541**	0.606*
	(0.207)	(0.201)	(0.201)	(0.215)	(0.318)
Connected			0.225	0.256	0.247
			(0.185)	(0.188)	(0.186)
Year around promotion FEs	Y	Y	Y	Y	Y
Promotion year FEs	Y				
Officer FEs		Y	Y	Y	Y
Sample		Full sample		Rotate out	Switcher
Observations	8,403	8,403	8,403	7,720	1,601
Panel B:	(1)	(2)	(3)	(4)	(5)
	Command	Battle performance			
Mean of dep. var	0.588	1.099	1.092	1.092	1.109
Connected promotee × Post	0.126**	0.399*	0.370**	0.367**	0.352*
	(0.053)	(0.222)	(0.184)	(0.184)	(0.201)
Year around promotion FEs	Y	Y	Y	Y	Y
Officer FEs	Y	Y	Y	Y	Y
Ship FEs			Y	Y	Y
Ship-year controls				Y	Y
Ship-Crew FEs					Y
Sample	Full	Commanding ship			
Observations	8,403	4,928	4,695	4,695	4,221

Note: Unit of the observation is the officer-year level. Relating performance to connectedness in the year of promotion to post-captain in a five year window around the promotion to post-captain. Performance is measured as the cumulative number of actions, enemy units destroyed and captures up to the previous year. Connected promotee is a dummy that is 1 if the officer shared family ties to the Admiralty in the year of promotion to post-captain. Post is a dummy that is 1 in the year and after a officer was promoted to post-captain. The balanced sample covers all post-captains in a five year promotion window around the year they made post between 1690-1849. In Panel A, Column 4, the sample comprises the subset of officers who saw their promoting Admiral rotate out by the fifth post-promotion year. In Column 5, the sample comprises the subset of officers who ever experienced a switch in their connections to the Admiralty during their career. In Panel B, Columns 2-4, the sample comprises those officers who command a ship. Ship-year controls are: age of ship, and a dummy that is 1 if the ship was repaired in the year. Standard errors clustered at the officer and officer × admiral-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Battle-level performance and connected promotions

Panel A: Fleet and flotilla actions	(1)	(2)	(3)	(4)	(5)
	Captured enemy ship				Lost
Mean of dep. var	0.139	0.139	0.139	0.139	0.0207
Connected promotee	0.083***	0.081***	0.080***	0.078***	-0.015**
	(0.026)	(0.028)	(0.028)	(0.027)	(0.007)
Ratio ships British fleet/enemy fleet				-0.592***	-0.103
				(0.171)	(0.109)
Ratio guns British fleet/enemy fleet				0.314*	0.083
				(0.161)	(0.108)
Battle type FEs	Y	Y	Y	Y	Y
Promotion year FEs		Y	Y	Y	Y
Years since promotion FEs		Y	Y	Y	Y
Order of battle FEs			Y	Y	Y
Observations	1,959	1,936	1,936	1,936	1,936
Panel B: Single ship actions	(1)	(2)	(3)	(4)	(5)
	Wins single ship action			Loss	Draw
Mean of dep. var	0.669	0.669	0.663	0.0964	0.241
Connected promotee	0.200***	0.231***	0.226***	-0.008	-0.218***
	(0.071)	(0.075)	(0.075)	(0.055)	(0.062)
Ratio guns British ship/enemy ship			0.167***	-0.072***	-0.095*
			(0.056)	(0.022)	(0.049)
Controls		Y	Y	Y	Y
Observations	172	172	166	166	166

Note: Relating performance in fleet, flotilla and single-ship actions for post-captains to whether a officer was promoted to post-captain while being connected to the Admiralty. In **Panel A**, the unit of the observation is the officer-ship-battle level. In Columns 1-4, the dependent variable is a dummy that is 1 if the officer successfully captured an enemy ship. In Column 5, the dependent variable is a dummy that is 1 if the officer lost its ship and was captured by the enemy. Battle type FEs distinguish between flotilla and fleet actions. Order of Battle FEs denote the position of the ship in the line. These are: Vanguard, Centre and Rear. Ratio ships British fleet/enemy fleet is the ratio between the total number of British ships over the total number of enemy ships that were involved in the fleet or flotilla action. Ratio guns British fleet/enemy fleet is the total number of guns across all British ships over the total number of guns across all enemy ships that were involved in the fleet or flotilla action. In **Panel B**, the unit of observation is single ship action. Winning is defined as either capturing or sinking the enemy ship. Losing is defined as either being captured or sunk by the enemy. Draw stands for inconclusive engagements. Ratio guns British ship/enemy ship is the own number of guns over the enemy number of guns. Controls comprise the year of post-captain promotion and the years since promotion to post-captain. Standard errors clustered at the officer-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

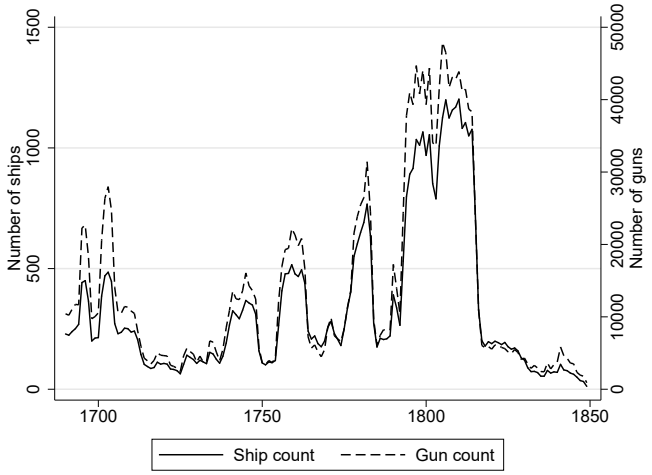
Table 5: Battle performance of connected promotees by Admiralty style

	(1)	(2)	(3)	(4)
	Battle performance			
Mean of dep. var	0.832	0.832	0.832	0.832
Connected promotee × Post	0.516**	0.467**	0.565***	0.496***
	(0.201)	(0.194)	(0.208)	(0.183)
Merit × Post		0.038		
		(0.049)		
Connected promotee × Merit × Post		0.306		
		(0.207)		
Biased promotion × Post			0.029	
			(0.061)	
Connected promotee × Biased promotion × Post			-0.351**	
			(0.147)	
War × Post				0.501***
				(0.053)
Connected promotee × War × Post				0.319**
				(0.125)
Year promoted FEs	Y	Y	Y	Y
Year around promotion FEs	Y	Y	Y	Y
Officer FEs	Y	Y	Y	Y
Observations	8,403	8,403	8,403	8,403

Note: Relating battle performance for connected promotees by Admiralty style. Battle performance is measured as the cumulative number of actions, enemy units destroyed and captures up to the previous year. Post is a dummy that is 1 after the officer was made post. Connected promotee is a dummy that is 1 if a officer was promoted to post-captain while being connected to the Admiralty. Merit is elasticity between performance and promotions by the promoting Admiralty (See Table 2), normalized to mean 0 and SD 1. Biased promotion is the gap in promotion rates to post-captain between connected vs. unconected officers by the promoting Admiralty, normalized to mean 0 and SD 1. War Admiralty is a dummy that is 1 if the promoting Admiralty served during a period of war. The balanced sample covers all post-captains in a five year promotion window around the year they made post between 1690-1849. Standard errors clustered at the officer-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figures

Figure 1: Size and Fighting Power of the Royal Navy, 1690-1849



Number of British Royal Navy ships and the total number of guns over time.

Figure 2: Selection of officers and performance

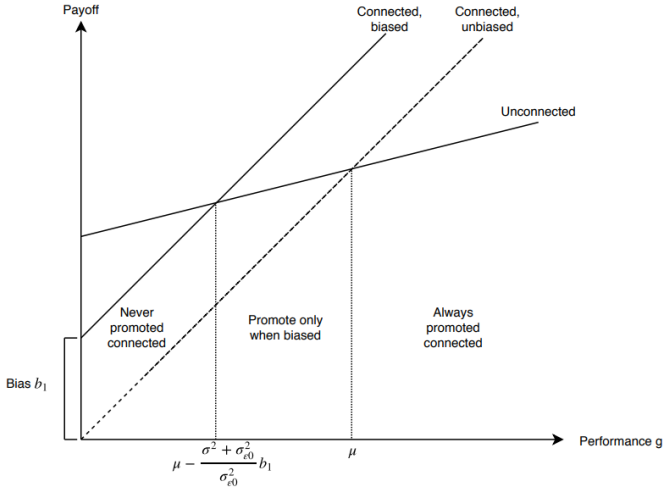
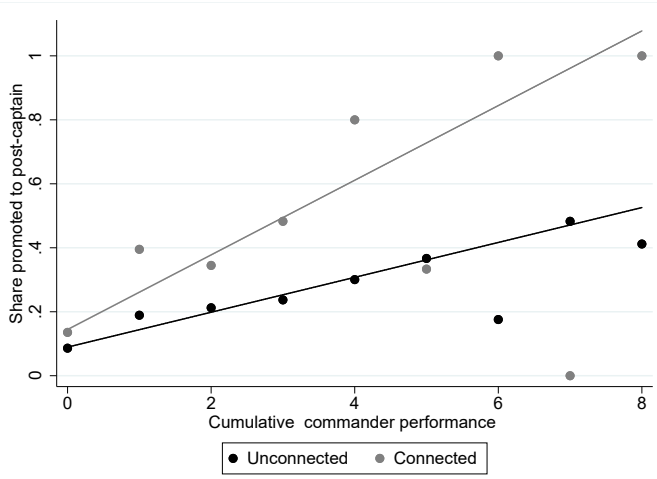
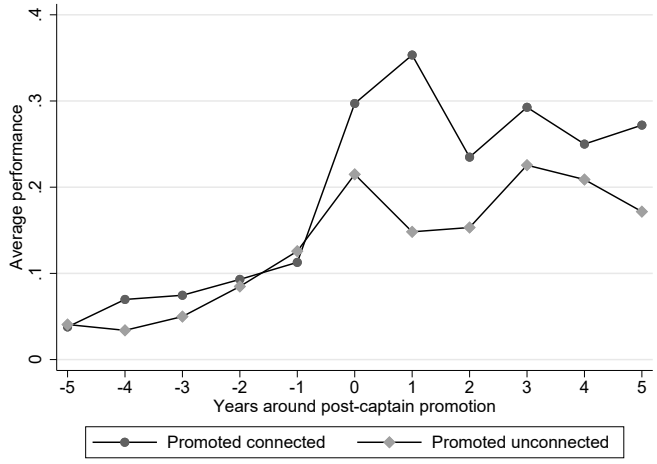


Figure 3: Merit-based promotion to post-captain by ties to Admiralty



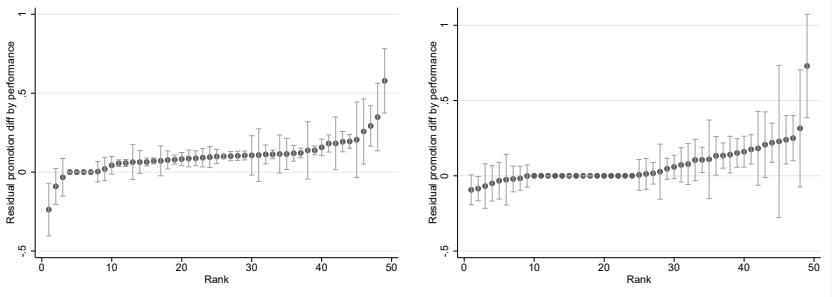
Note: Binscatter of relationship between the share of commanders promoted to post-captain and their cumulative performance, broken down by connectedness to Admiralty.

Figure 4: Battle performance around promotion window, by connectedness



Note: Battle performance of connected and unconnected officers in a five year window around the year of promotion to post-captain.

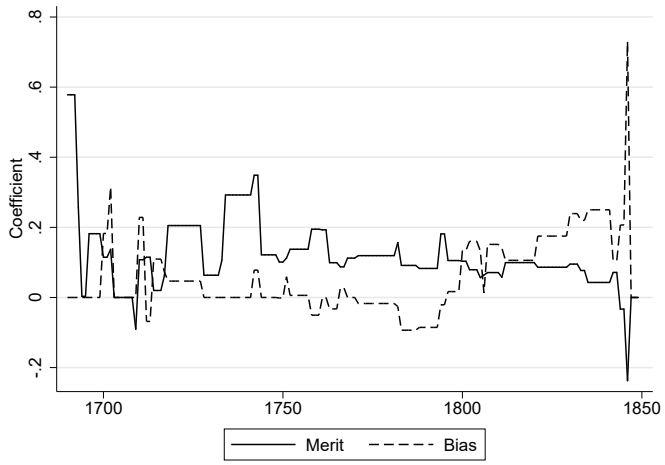
Figure 5: Heterogeneity in merit promotions and bias by Admiralty



(a) Merit (b) Biased promotion

Note: Showing elasticities between battle performance and promotion (Panel A), and the average promotion gap between connected vs. unconnected officers (Panel B), estimated for each Admiralty (Head of the Admiralty - Admiral of the Fleet pair).

Figure 6: Merit promotions and bias by Admiralties over time



Note: Variation in the degree of merit and bias in promotions (both standardized) over time.

A Appendix Tables

Table A1: Dropping those who never commanded pre-promotion

	(1)	(2)	(3)
	Battle performance		
Mean dep. var.	0.819	0.899	0.496
Connected promotee × Post	0.426**	0.412*	0.386
	(0.174)	(0.216)	(0.373)
Year around promotion FEs	Y	Y	Y
Officer FEs	Y	Y	Y
Ship FEs	Y	Y	Y
Sample	All	Commanded	Never
Observations	8,165	6,442	1,656

Note: Unit of the analysis is the officer-year level. Robust standard errors, clustered at the officer and officer × admiral-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2: Counterfactual performance for non-commanding officers

	(1)	(2)	(3)	(4)
	Battle performance			
Mean dep. var.	0.832	1.453	6.739	9.753
Connected promotee × Post	0.516**	0.612***	1.073***	1.336**
	(0.201)	(0.204)	(0.379)	(0.526)
Year around promotion FEs	Y	Y	Y	Y
Officer FEs	Y	Y	Y	Y
Ship FEs	Y	Y	Y	Y
Imputed performance	Median	Mean	Top 5%	Top 1%
for non-commanding	0	0.246	2	3
Observations	8,403	8,403	8,403	8,403

Unit of the analysis is the officer-year level. Robust standard errors, clustered at the officer and captain × admiral-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3: Performance and promotions to Admiralty

	(1)	(2)
	Promoted	Admiral
Mean of dep. var	0.010	0.010
Battle performance	0.001	0.001
	(0.001)	(0.001)
Connected	0.001	0.004
	(0.003)	(0.005)
Battle performance × Connected	-0.000	-0.001
	(0.001)	(0.001)
Year FEs	Y	Y
Tenure FEs	Y	Y
Entry year FEs	Y	
Officer FEs		Y
Sample	Post-captains	
Observations	24,598	36,251

Unit of the analysis is the captain-year level. Standard errors are clustered at the captain and the captain × Admiralty level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: Heterogeneity by naval family ties

	(1)	(2)	(3)	(4)
	Battle performance			
Mean of dep. var	0.832	0.832	0.832	0.832
Connected promotee × Post	0.516**	0.638***	0.460**	0.577**
	(0.202)	(0.228)	(0.206)	(0.232)
Father naval officer × Post		1.026***		1.004**
		(0.396)		(0.401)
Connected promotee × Post		-1.331**		-1.297**
× Father naval officer		(0.537)		(0.551)
Uncle naval officer × Post			0.703	0.546
			(0.557)	(0.585)
Connected promotee × Post			0.084	0.234
× Uncle naval officer			(0.956)	(0.961)
Year around promotion FEs	Y	Y	Y	Y
Officer FEs	Y	Y	Y	Y
Observations	8,403	8,403	8,403	8,403

Unit of the analysis is the captain-year level. Standard errors are clustered at the captain and the captain × Admiralty level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5: Descriptive statistics - Fleet/Flotilla actions

	(1) Mean	(2) SD	(3) IQR	(4) Obs.
Enemy ship captured	0.138	0.419	0	1,959
Own ship captured	0.020	0.141	0	1,959
Ship guns	52.18	24.61	42	1,959
Ratio # own ships/ # enemy ships	0.577	0.196	0.268	1,959
Ratio total # guns / total # enemy guns	0.626	0.201	0.316	1,959
Connected promotees	0.207	0.405	0	1,959

Unit of observation is the captain-ship-action.

Table A6: Balance table - Single ship actions

	(1)	(2)	(3)	(4)
	Promoted		Diff	
	Connected	Unconnected	(1)-(2)	Obs.
Own guns	35.91	28.58	7.33***	172
			(2.58)	
Enemy ship guns	31.57	30.49	1.07	166
			(3.05)	
Ratio # own guns / # enemy guns	1.28	1.10	0.17	166
			(0.11)	
Enemy men	268.07	248.70	19.36	128
			(31.95)	
Own capture	0.083	0.088	-0.005	172
			(0.048)	
Enemy capture	0.791	0.556	0.235***	172
			(0.080)	

Unit of observation is the single ship action. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7: More meritorious promotions during wartime

	(1)	(2)	(3)
	Promoted to post-captain=1		
Mean of dep. var	0.096	0.096	0.096
Battle performance	0.091***	0.073***	0.078***
	(0.008)	(0.011)	(0.011)
Connected	0.016	-0.006	0.001
	(0.023)	(0.027)	(0.027)
Battle performance × Connected	0.058***	0.056***	-0.014
	(0.019)	(0.018)	(0.033)
Connected × War		0.035*	0.026
		(0.021)	(0.021)
Battle performance × War		0.019*	0.014
		(0.011)	(0.011)
Battle performance × War × Connected			0.076**
			(0.035)
Year FEs	Y	Y	Y
Tenure FEs	Y	Y	Y
Entry year FEs	Y	Y	Y
Officer FEs	Y	Y	Y
Observations	36,251	36,251	36,251

Unit of the analysis is the officer-capture event. Standard errors clustered at the officer-level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B Appendix Figures

Figure A1: Royal Navy size and fighting events

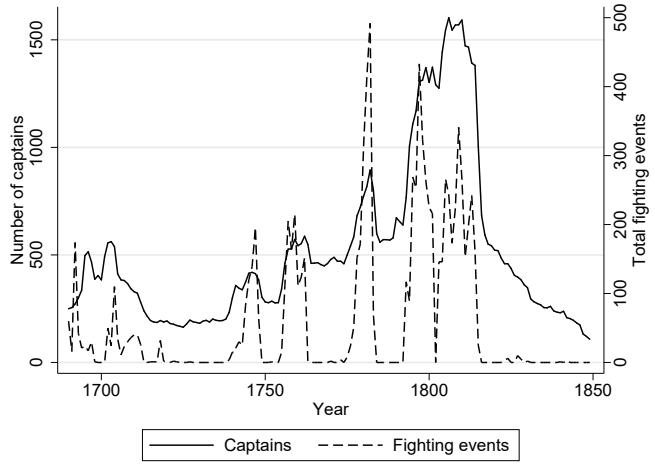
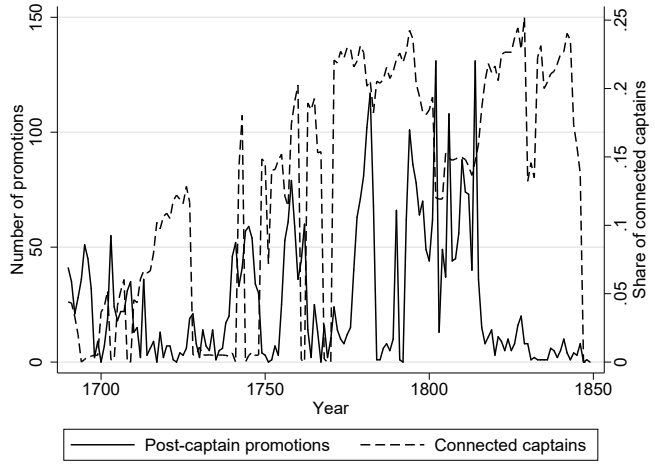


Figure A2: Post-captain promotions and share of connected captains



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A Model proofs

Proposition 1: Complementarity in performance and connections. *The link between promotion and performance will be stronger for agents connected to the principal:* $\frac{\partial E[U|g,j=1]}{\partial g} > \frac{\partial E[U|g,j=0]}{\partial g}$.

Proof: Use equation (1), differentiating with respect to g:

$$\frac{\partial E[U|g,j]}{\partial g} = \frac{\sigma^2}{\sigma^2+\sigma^2_{\varepsilon j}} \tag{4}$$

$$\frac{\partial E[U|g,j=1]}{\partial g} - \frac{\partial E[U|g,j=0]}{\partial g} = 1 - \frac{\sigma^2}{\sigma^2+\sigma^2_{\varepsilon 0}} > 0 \tag{5}$$

using $\sigma^2_{\varepsilon 0} = 0$ (Assumption 2) and the fact that $0 < \frac{\sigma^2}{\sigma^2+\sigma^2_{\varepsilon 0}} < 1$.

Proposition 2: Performance and promotions. *In the absence of bias, connected promotees always outperform unconnected promotees. The positive performance gap between connected and unconnected promotees is declining with bias. While connected promotees outperform unconnected promotees if bias is sufficiently small, there will be a threshold* $b > \bar{b}$ *above which connected promotees underperform relative to unconnected promotees.*

Proof: Using equation (1) and Assumption 2 ($\sigma^2_{\varepsilon 0} = 0$), the principal will only promote the connected agent over the unconnected agent if $E[U|g,j=1] > E[U|g,j=0]$,

$$g + b_1 > \frac{\sigma^2}{\sigma^2+\sigma^2_{\varepsilon 0}} g + \left(1 - \frac{\sigma^2}{\sigma^2+\sigma^2_{\varepsilon 0}}\right)\mu_0 \tag{6}$$

$$g > \mu_0 - \frac{\sigma^2+\sigma^2_{\epsilon 0}}{\sigma^2_{\epsilon 0}} b_1 \tag{7}$$

No bias benchmark: Setting $b = 0$ in equation (7), the principal only promotes connected agents if their performance is above the average of the unconnected agents.

Using equation (7), the expected performance difference of con-

nected vs. unconnected agents is:

$$E[g|g > \mu_0 - \frac{\sigma^2 + \sigma^2_{\epsilon 0}}{\sigma^2_{\epsilon 0}} b_1, j = 1] - E[g|j = 0] \tag{8}$$

$$= -(\mu_0 - \mu_1) + \sigma \frac{\varphi\left(\frac{(\mu_0 - \mu_1) - \frac{\sigma^2 + \sigma^2_{\epsilon 0}}{\sigma^2_{\epsilon 0}} b_1}{\sigma}\right)}{1 - \Phi\left(\frac{(\mu_0 - \mu_1) - \frac{\sigma^2 + \sigma^2_{\epsilon 0}}{\sigma^2_{\epsilon 0}} b_1}{\sigma}\right)} \tag{9}$$

where $\sigma^2_x = \sigma^2$ using the fact that the sum of two normally distributed random variables $g = a + \epsilon$ is distributed $N(\mu_j, \sigma^2 + \sigma^2_{\epsilon 0})$, with $\sigma^2_{\epsilon 0} = 0$ (Assumption 2). Setting $b = 0$ yields,

$$E[g|g > \mu_0, j = 1] - E[g|j = 0] = -(\mu_0 - \mu_1) + \sigma \frac{\varphi(\frac{\mu_0 - \mu_1}{\sigma})}{1 - \Phi(\frac{\mu_0 - \mu_1}{\sigma})} \tag{10}$$

which is always positive given $\mu_0 \geq \mu_1$ (Assumption 1) and the fact that $\frac{\varphi(z)}{1-\Phi(z)} > z$ for $z = (\mu_0 - \mu_1)/\sigma$.

Positive bias: Start with equation (9). If $b_1 \to 0$, we are back to the first best where connected agents weakly outperform unconnected agents in expectation (Proposition 1). If $b_1 \to \infty$, the performance gap will be: $-(\mu_0 - \mu_1) \leq 0$ (Assumption 1). Since equation (9) is a continuous function and monotonically declining in b_1, there must be a threshold $\bar{b}$ below which connected outperform and above which connected underperform.