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The British Navy Rules: Monitoring and Incompatible Incentives in the Age of Fighting Sail

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The British Navy during the age of sail was systematically successful against its opponents, most notably the French. This paper documents this success, shows that it cannot be explained by superior ships, training, or other naval capital, and puts forth the hypothesis that the British Navy governance structure provided better incentives to fight than those of their opponents. The hypothesis is tested by examining the structure of the rules and then contrasting them with the rules governing privateers, the army, and the navy over time. The paper concludes with a discussion of why the French did not copy the British strategy.

He asked who the stout man was who had just been so ceremoniously disposed of. "He was an admiral," they told him. "But why execute this admiral?" he enquired. "Because he had not enough dead men to his credit," was the reply; "he joined battle with a French admiral, and it has been established that their ships were not close enough to engage." "But surely," exclaimed Candide, "the French admiral must have been just as far from the English as the English admiral was from the French!" "True enough," was the answer; "but in this country we find it pays to shoot an admiral from time to time to encourage the others." *Voltaire*, p. 111

1. INTRODUCTION

By 1815, the British Navy was arguably the largest firm in the world—employing tens of thousands of people, and achieving a degree of success allowing the claim "Britannia rules the waves."[2] For over 150 years between 1670 and 1827—virtually the entire age of fighting sail—the British Navy was successful in fighting the Spanish, Dutch, French, and a host of other smaller

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[2] According to Rodger, the British Navy was "the largest industrial unit of its day in the western world, and by far the most expensive and demanding of all the administrative responsibilities of the states" (1986, p. 11).

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European countries. Although the British Navy lost various individual ships and possessions, in the larger picture it dominated the seas and allowed Britain to rise from a fringe country to a world power with major overseas colonies and trade routes. Historians have mostly marveled and occasionally speculated at this streak of victories. The theories of success range from social upheaval and class struggles on the continent that prevented systematic organized opposition, psychological expectations of victory on the part of the British which were self-fulfilling, to the British preference for eating beef.[3] The success of the British Navy provides a fascinating case study of the modern theory of the firm because the British Navy succeeded in light of severe asymmetric information between itself and its officers, and in light of an inherent incompatibility of incentives between captains and admirals and the Admiralty.[4]

All navies during the age of fighting sail (approximately 1580–1827) faced a serious agency problem. Ships of war were expensive, powerful, and critical for the protection of overseas trade. Yet they were put in the hands of a captain who was sent out with the most general orders: to blockade a port, patrol for pirates and privateers, escort merchant vessels, and in times of war, engage the enemy. The captain had a large informational advantage over the Admiralty in terms of local conditions; in fact, it is hard to imaging a more severe case of asymmetric information. During the age of sail communication was intermittent, slow, and limited; the world was still generally unexplored, with shoals, waterways, and trade winds not mapped, and even finding positions of longitude were only developed towards the end of the Eighteenth century. Worse, given that ships were propelled by wind, disasters, losses in battle, and other failures of duty could be blamed on the ill fortunes of nature.

Added to the severe information asymmetry was the temptation of a captain or admiral to seek out private wealth and safety rather than engage in more dangerous and less profitable assignments. For example, what prevented captains from using their ship to seek weak, but wealthy, merchant prizes rather than enemy frigates or avoid monotonous and dangerous blockades for profitable raiding shore parties? What incentives existed to put his ship and life in harm's way for King and country? Although the British Navy dominated the open seas

[3] The standard historical explanation—social upheavals on the continent—seems lacking. First, it only applies to France during the Revolutionary wars and the British dominated long before this. Second, the British were just as successful against the navies of Spain and Denmark. Third, during the age of sail Britain also experienced domestic revolution and colonial setbacks. Finally, although constitutional democracy was well underway, Britain also remained class structured. Hence it seems unlikely that British naval dominance over the entire period of sail can best be explained by differences in government structure or poorly trained opponents, even though the purging of the French officer class after 1790 had its toll.

[4] The only other economic attempt to explain the British success is Benjamin and Thornberg (2001). Their paper complements this one with an analysis of the warrant officers on board. They argue that the tournament structure of promotion encouraged monitoring where team production is important. We both argue that battle outcomes were significantly affected by organizational structure.

for most of the period in question, the obvious explanations are refuted: their ships were not better, their tactics were flawed according to the experts of the time, and the raw material of their sailors and officers had no distinct advantage over the navies of Spain, France, or Holland.

My conjecture is that the British Navy was an effective fighting force, not because of its physical and human capital, but rather because of the set of rules under which the British fought. Although there were rules for all men at sea, here I focus on the critical rules for the captains and admirals.[5]

The British Admiralty created a set of clever monitoring devices that were only slowly copied by their opponents[6] and which worked even for single ships thousands of miles from home. Most interesting is the fact that on the surface, many of these rules technically hindered the ability of the Navy to do battle. That is, from a purely "first-best military" point of view, one that ignored issues of incentives, the British should have fought differently.

The central compensation scheme in the British Navy was a wage arrangement that rewarded captains well if they were successful and remained at sea. This system revolved around the taking of prizes or spoils of war. Unlike on land, where prizes are located in specific places, enemy prize vessels float about. Unlike the army then, the use of prizes in the navy was a two-edged sword—it motivated captains to be active at sea, but encouraged them, at the margin, to hunt for lucrative prizes instead of pursuing more strategic objectives.[7]

In order for this system to work, some form of monitoring was necessary. Thus, in conjuction with the system of prizes the British Navy used the Articles of War, battle formations and fighting instructions, discontinuous promotions, and patronage to monitor their captains. The entire governance structure encouraged British captains to fight rather than run. The creation of an incentive to fight led to an incentive to train seamen in the skills of battle. Hence, when a captain or admiral is commanding a ship that is likely to engage in fighting, then that commander has an incentive to drill his crew and devote his mental energies to winning. Although these indirect forms of monitoring were clearly second best, and were replaced with more direct forms with the advent of steam, at the time they achieved the intended purpose of increasing the chance of defeating the enemy.

[5] Again, see Benjamin and Thornberg (2001) for an analysis of the wage structure for the warrant officers.

[6] This in itself is an interesting question since successful strategies in any enterprise, and especially in military activities, tend to be copied quickly. I return to this point later.

[7] I will *not* argue that use of prizes created a perverse incentive structure. On the contrary, it was an essential part of the incentive structure of all navies and armies of the time. Nor will I argue that actual combat was not lucrative in its own right. What I argue is that payment by prizes in the navy had a drawback, namely that captains preferred the most valuable prizes net of the costs of capture. These prizes were not always the ones of most military value.

2. THE PUZZLE: SUCCESS IN THE SHADOW OF TEMPTATION

2.1. What Was the British Record?

Rodger (1986), in his excellent study of the Eighteenth century navy, gives some idea of the difference in effectiveness of the British Navy through the differences in casualties of single-ship actions during the Seven Years War (1756–1763) where the ships involved were of approximately equal size. Of the 10 encounters, the British had 195 men either killed or wounded, while the French had 1365 men either killed or wounded—a remarkable seven-fold difference.[8] In the Battle of Copenhagen 1801, the British had 1000 killed. The Danes, on the other hand, had their entire fleet destroyed, 2000 dead, and 3500 prisoners taken.[9] In fact, over the six major naval battles from 1793 to 1805, the British had just 5749 killed or wounded compared to 16,313 killed and wounded and 22,657 prisoners of the enemy.[10] Not only was there a major difference in casualties, but there was a corresponding difference in the number of ships taken or destroyed as well. During the Napoleonic wars from 1793 to 1815 the British lost only 17 frigates to the French, of which they recaptured nine, while the French lost a total of 229.[11] Over this same period 166 British warships of all rates were captured or destroyed by the enemy, of which five were ships of the line. However, 1201 enemy ships were captured or destroyed, of which 159 were ships of the line.[12] Again, a five-fold difference in total ships, and an amazing 30-fold difference in the largest rates of battleships.

By the War of 1812, the British Navy had developed a reputation of virtual invincibility. C.S. Forester, in his history of the war, writes:

> In 1812 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

[8] See Rodger (1986, p. 57).

[9] Tunstall and Tracy (1990, p. 234).

[10] Lewis (1960, p. 362). These battles were The Glorious First of June, Cape St. Vincent, Camperdown, the Nile, Copenhagen, and Trafalgar. There were approximately 50,000 men present at these battles (see Keegan, 1988, p. 48). Indeed, a sailor in the British Navy was much more likely to die of disease or accident than from battle. The fact that the British were more successful in the Seven Years War than in the Napoleonic period in terms of casualties provides some evidence against the claim that their success only resulted from the French revolutionary purges of the military class after 1789.

[11] Henderson (1971, pp. 9–10). War ships were classed in terms of *rates*. The largest were the 1st, 2nd, and 3rd rates—also known as ships of the line. These ships would have between 80 and 120 guns, spread over three decks, and would have as many as 800–900 men on board. These were followed by the 4th, 5th, and 6th rate ships. A frigate could be a 5th or 6th rate ship. It usually had a single gun deck and carried between 20 and 40 guns and between 150 and 300 men. The size of guns on the ships varied, which makes counting the number slightly misleading. The British Navy was dominated in the latter part of the age of sail by 3rd rates (2 decks, 60–80 guns) and 5th rate frigates.

[12] Most of these ships (712) were French (Lavery, 1989, p. 317).

> 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. The British public, and even the Navy, could be excused for forming the belief that there was something intrinsically superior in British seamanship and perhaps in British material. (1960, p. 29)

Indeed, by the end of the age of sail it was absolutely expected that a British warship would be victorious, even with uneven odds:

> 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, 1989, p. 317)

The fateful meeting between the British *Guerriére* and the USS *Constitution* on August 19, 1812, demonstrates this reputation. Though the *Guerriére* was smaller (38 18-pound guns to 44 24-pounders, 1092 tons to 1533, 244 men to 460),[13] in need of refitting, leaking, and recently hit by lightning, its Captain Dacres engaged rather than flee, with the inevitable result of defeat. In England the loss, the first of five ship-to-ship defeats against the Americans and the first loss in 9 years, caused massive media attention and the calling for heads.

> The British public was as shocked at the news of the loss of the *Guerriére* as the American public was delighted. . . . The Press displayed uncalculating annoyance and dismay. There was even a hint of condemnation for Dacres because he had surrendered and had not gone down fighting. . . . Even the more sober press was startled and disappointed. The measure of the public interest is displayed in the amount of editorial comment devoted to this one frigate action at a moment when events of immense importance were happening elsewhere. (Forester, 1960, pp. 56–57)

In the larger picture, the British Navy dominated the War of 1812, but the loss of the *Guerriére* and four other frigates and the massive attention they received are the exceptions that proved the rule: Britannia ruled the waves.

2.2. Did the British Have a Technical Advantage?

One easy reason for British naval success might simply have been technological. This advantage may have come from better ships, cannons, maps, or other types of ordinance used in fighting. The evidence on this point is weak, but it would appear, if anything, that the British suffered a marginal technical disadvantage. In terms of ships, it is generally acknowledged that after the Seven

[13] All of the U.S. frigates were larger and more powerful than the British frigates due to a congressional loophole. Congress had requested the building of several ships, but specified only the size, not the quality of timber, number of guns, or other important dimensions. In effect, the U.S. frigates were the same dimensions of a 74-gun ship and simply lacked the extra deck of guns.

Years War, and throughout the Napoleonic wars, France had marginally better built ships. The following quotes are common in the historical literature:[14]

> The sailing qualities of new French ships showed the result; they were generally faster and more maneuverable than their British counterparts, and more carefully constructed. (Whipple, 1978, p. 23)
> In Britain, it was the rule rather than the exception for the navy's largest ships of this period to be compared unfavorably with those of the enemy. (Baugh, 1977, p. 196)

Although their ships were no better, the British were often considered to have a faster rate of fire, which is sometimes credited to modest differences in equipment. Unfortunately, no records were kept of how long the British or their enemies took to fire, but Rodger (1986, p. 58), perhaps the leading expert in this field, states "With no useful averages of either British or French rates of fire little more can be said than that the French certainly spoke of British gunnery with respect." To the extent there was a faster rate of fire it seems more likely due to differences in discipline aboard the ship rather than differences in technology. The best evidence suggests that differences in construction and other war technology was minimal.[15] Countries at war quickly adopt the obvious *tools* that advanced their relative position—whether cutting out portholes for guns or using a new gun-lock, advances in technology spread quickly.[16]

2.3. The Problems of Cowardice and Private Wealth Accumulation[17]

From the Crown's point of view, a successful captain had to overcome the temptations to preserve his own life and to seek after private fortune at the expense of the King. Although sea battles were rare, and though a captain stood a much higher chance of dying of disease than battle, on occasion the enemy would have to be engaged, and at that moment it was imperative that the captain

[14] The following sentiment is along the same line, but seems rather exaggerated.

> Quite surprisingly for a leading maritime nation, Britain produced no outstanding naval architect during the eighteenth century, and most of the frigates were built on the lines of captured French vessels, which were always superior in size and speed to their British counterparts. (Henderson, 1971, p. 3)

[15] Rodger is on the mark when he notes that:

> If there was a British "secret weapon" at sea, it was not good gunnery so much as the high state of discipline of which that was a symptom. (1986, p. 60)

[16] Unlike differences in tactics, which were often more subtle. Until the 16th century, the standard naval tactic consisted of loading a ship with soldiers and boarding an enemy vessel. Large guns, though limited in number, were placed on the upper deck. Once portholes were introduced many more guns could be loaded onto the ship since the lower center of gravity provided enough stability. Within a very short period of time all navies had portholes.

[17] Although I use the term "cowardice," I mean nothing more than the rational failure to fight based on one's private incentives when they are in conflict with the overall military objectives of the Crown. For a similar example, see Axelrod's (1984) discussion of trench warfare in WWI.

behave according to the objectives of the Crown. Unlike warships today, however, during the age of sail a captain was perhaps the most vulnerable person on ship. His position was on the quarterdeck, a raised deck running from the stern to about the middle of the ship. From this position he could see the enemy, the fleet, most of his ship, and issue the appropriate orders. Unfortunately for him, the quarterdeck was virtually unprotected from enemy fire—not only cannon fire, but musket fire from the other ship's decks and platforms up in the masts.[18] This open position, plus the added peril of being one of the few uniformed men on deck, made the captain particularly vulnerable. For this reason, most tried cases of cowardice dealt not with the crew and junior officers—who were busy below decks carrying out their orders in relative safety—but with captains, admirals, and masters.[19] Examples of cowardice abound in the historical literature. At Trafalgar, for example, one third of the French fleet stood aside and watched the battle.[20] Ships were constantly heading to port with minor damage that could have been repaired at sea with no interruption in fighting. And in given battles, many ships simply did not engage the enemy.[21] Lavery states that:

> No captain was penalized for surrender in itself during these years, but any sign of cowardice was severely punished. [For example] Captain John Williams of the *Agincourt* was put to the bottom of the captains list and rendered incapable of ever serving at sea again for "keeping back and not coming into the fight with the enemy." . . . [A long list of other examples follows] (1989, p. 318)

[18] Nelson was killed by a sniper's bullet shot from the rigging of the French *Redoutable* at Trafalgar.

[19] A master was in charge of the safety of the ship and also took a position on the quarterdeck with the captain. Rodger notes the problem quite explicitly:

> The Navy . . . had a real problem of cowardice . . . confined to three ranks of officer, .. and was several times the cause of serious failures in action. This was in part because the three ranks in question were admirals, commanders, and masters. (1986, p. 244)

Elsewhere Rodger states the same thing:

> Cowardice and indiscipline on the part of captains and flag officers was then, and was to remain for at least a century, one of the gravest weaknesses of the Navy. . . . (1982, p. 8)

[20] Positive comments about Nelson indicate that he was an exception in terms of bravery. Earl Howe, inventor of the signal system of the time, remarked that Nelson's victory at the Nile "stood unparalleled, and singular in this instance, that every captain distinguished himself " (as quoted in Palmer, 1997, p. 699). Keegan notes that Trafalgar "emphasized how half-hearted had been the urge to victory of all European admirals before Nelson" (1988, p. 90). Clearly failures to act in the interests of the Crown were not uncommon.

[21] To quote Rodger again:

> A flagrant example occurred during the attack on Havana in 1762. Augustus Hervey proposed and commanded a characteristically dashing and hazardous close attack on the Morro Castle, and the *Stirling Castle* which was supposed to lead the line in, instead hauled off out of range and watched the other ships get badly damaged. (Rodger, 1986, p. 246)

So common was the problem of cowardice that of the 443 captains promoted between 1720 and 1750, 8.5% were dismissed or disgraced by court martial compared to less than 4% killed in action.[22]

The second temptation facing a captain was to seek private wealth at the expense of the naval objective. Most naval officers no doubt had a tremendous sense of duty and were well aware of the prizes, promotions, and job security that could result from a successful military victory. However, at the margin, with an armed vessel at his disposal, a captain could avoid bloody battles and enrich himself at the same time. The most distracting temptation was prize money from merchant vessels.[23] Generally speaking prizes came from two sources: enemy merchant vessels and enemy military ships. Sea captains were allowed to take merchant prizes because they disrupted enemy trade; however, they were not to chase merchant prizes at the expense of their stated military missions. The primary objective of the Navy was generally not to interrupt foreign trade.[24] Capturing an enemy military ship was also valuable to the captain. The British Navy would purchase the ship at market value (as it would with a commercial ship) and would pay head money of 5 pounds for each enemy sailor on board when the battle started. An added advantage of capturing an enemy naval ship was the building of a reputation which would be rewarded with future lucrative ships and stations.[25] However, despite these advantages, there were major costs of engaging an enemy naval ship—naval ships fight back. Ships are damaged in battle, they carry small amounts of valuable cargo, and as mentioned above, a captain stood a reasonable chance of being killed during battle.

All of these factors lowered the net value to a captain of engaging an enemy naval ship. An extreme example is the case of pirate ships. The value of the ships was generally low, they carried no cargo, and pirates would fight to the death to avoid capture. As a result, captains did not go out of their way to fight pirates. At the margin, a captain would be tempted to go after a merchant ship that does not fight back and might be loaded with a very valuable cargo.[26]

Captains could also use their ships to carry cargo and private goods. With the exception of certain types of gold, this was usually a forbidden activity. Captains

[22] Rodger (1986, p. 256). Of course, not all of these court martials were for cowardice. The most common termination of a naval career was death by natural causes (18.5%).

[23] Baugh states: "remuneration by prize money was not to be scoffed at, but it was a method that often enticed officers from their proper duties and missions" (1977, p. 41).

[24] As I argue later, the Crown had a "second navy" called the privateers, whose job it was to pursue enemy merchant ships exclusively.

[25] Interestingly, the larger ships were not always the most lucrative to be on. Frigates were fast and at the fringe of a fleet, and offered better opportunities for capturing enemy ships. I thank a referee for pointing out that Nelson was rewarded with a valuable station in the Mediterranean after distinguishing himself at the Glorious First of June.

[26] This is not to say that the use of prizes was a mistake. Later I explain that the use of prize money was in itself a form of compensation that was used to encourage fighting, particularly on land. It simply was not always in harmony with naval objectives, as I discuss later.

could also spend more time in the comfort of port than at sea, and the more comfortable the port, the more time they spent there. Rodger observed that:

> In home waters and the waters around northern Europe in general, men-of-war spent only 39 percent of their time at sea, while in the Mediterranean it was 57 percent. (Rodger, 1986, p. 38)

Interestingly, he acknowledges that " a cynic might point to the proximity of England, home and beauty to leeward, and the well-equipped dockyards inviting the minor defect." Foreign ports were also sources of disease, which took the highest toll among sailors of the time.

Captains were well aware of these temptations, and made pains in their reports to point out that they withstood them: "Officers might easily find themselves having to choose between private profit and public duty; the very terms with which they congratulated themselves in their reports . . . testify to the suspicion they needed to dispel."[27] In addition Rodger notes:

> It does not appear a very promising means of keeping officers to their duty when there were so many chances of making money or avoiding trouble and danger by neglecting it. It is therefore surprising and note worthy how infrequently the service in fact suffered from serious dereliction of duty by officers. (1986, p. 314)

As much as these temptations were present, the equilibrium amount of cowardice and private wealth accumulation appears low. We might think that in an age of the cat-of-nine-tails, that the British simply beat their sailors into submission and that captains, being no more than glorified sailors, were under similar threats of punishment for dereliction of duty. Yet, though captains were court-martialed and sailors beaten, the total collection of incentives in the British Navy rules were more subtle. Rodger puts it well in saying:[28]

> Some . . . have represented the navy as a strictly ordered, hierarchical society, brutally repressing the slightest deviance and entirely controlling the public and private lives of its personnel . . . . This fantasy is [far] from the facts . . . . "Government"—that is, discipline—was the conditions upon which survival at sea and success in war depended. (1986, pp. 210–211)

So here remains the puzzle: although there were examples of cowardice and cheating, overall the British Navy fought well relative to its opponents for a long period of time, with no distinctive advantage in technology—what set of rules allowed this?

[27] Rodger (1986, pp. 314–315).

[28] Rodger at p. 60. Note that Rodger uses the term "discipline" not in the present meaning of "punishment," but rather in the way it was used at the time, namely to mean good management and organization.

3. EFFICIENCY WAGES

The cornerstone of the British Navy's organizational incentives was its method of remuneration. Compensation for captains and admirals was a combination of wages and prize money.[29] Shares in prizes were based on rank: the more senior the officer, the larger his share. An admiral could receive between 1/8 and 1/4 of all prizes taken by his *squadron*, a captain usually received 1/4 of the prize he captured, with the other officers sharing 1/4, and the remaining crew sharing the rest.[30] However, there is an additional feature of the prize system that requires explanation. The prizes paid were very large and generally were higher than those necessary to induce a sufficient supply of naval officers. In effect, the total compensation package amounted to an efficiency wage because the level of pay was higher over the lifetime of the contract than the pay necessary to induce an efficient supply of labor. By creating an excessive wage, the navy created a surplus of captains and admirals that had to live on half-pay. This unemployment pool acted as a discipline device for those in command.

The major source of wealth for a captain and an admiral was prize money. The capture of one single merchant ship laden with cargo could set a captain for life. At a time when an admiral of the fleet might earn £3000 per year, some admirals amassed £300,000 of prize money. Prizes came in several ways. When at war, ships could capture enemy vessels and share the value of the ship and cargo.[31] If the ship was sunk *head money* was paid based on the number of sailors in the opposing vessel. Ships that captured pirates received the cargo, bounty prices for each pirate, and the ship.[32] Capturing a slave ship could also lead to large rewards. After 1807, the British government paid £60 per male slave freed, and between 1807 and 1822 paid out £318,380 for freed slaves.[33] Howarth notes that "British seamen were as patriotic as anyone else, but what they talked about when they sighted an enemy fleet was not the victory they might win for Britain,

[29] This was true of all navies during the age of sail. Indeed, payment through shares is a common method of aligning incentives and exists in everything from marriage to farming. On the high seas pirates, privateers, and whalers shared their captures. For an exhaustive study of American whaling, including the method of payment, see Davis, Gallman, and Gleiter (1997).

[30] These shares varied over time, and captains within a fleet were known to make alternative sharing arrangements (Rodger, p. 316, 1986). In addition, ships in sight of a battle also participated in the sharing. However, admirals generally received more than captains, and captains always more than junior officers.

[31] Although rare, this form of prize money could be enormous. When the British defeated the Spanish in 1762 at Havana, the commanders in chief each received £70,000 (Warner, 1975, p. 74). In another instance, in 1799, three frigates brought two Spanish ships into Plymouth. According to Howarth, "Each frigate captain got £40,730, lieutenants £5091, warrant officers £2468, midshipmen £791 and seamen and marines £182 4s" (1974, p. 227). A seaman's pay at the time was about £14 per year.

[32] Lewis (1965) notes that given the incentives for pirates to fight, their tendency to minimize the time cargo was kept on ship, and the low quality of their vessels, very few ships went out of their way to catch them.

[33] Lewis (1965, p. 234).

it was the prize-money they could hope to win for themselves."[34] However, in order to obtain these prizes a captain must have command and be at sea.

When a captain or admiral was not at sea they were on half-pay. As the term indicates, this was a form of unemployment insurance. Half-pay for a captain was not an income to aspire to, and yet a captain could expect to earn it for part of his career because the Navy always had more captains than ships. Henderson states "There was always a sufficient cadre of commissioned officers to command any probable number of ships."[35] As a result, most captains were on half-pay, waiting for a commission. For example, in 1715, there were only 70 ships of war in the British Navy which employed 70 captains and 98 lieutenants, leaving 188 captains and 261 lieutenants on half-pay.[36] In 1812, there were 1017 ships and vessels in the British Navy, but 1531 commanders, captains, and admirals.[37]

There is one final institutional piece of evidence to suggest that naval officers at sea earned rents: they did not purchase their commissions. The British Army, along with other European armies, also paid their officers in terms of prizes; however, there the officers had to purchase the right to the prize income stream from other officers. Better commissions fetched better prizes, and higher ranked commissions that received the largest share of prizes sold for higher prices than lower ranked commissions. The price of a commission was not trivial, and during the age of sail a colonel might pay £40,000 for the privilege. It is reasonable to assume that the talents of command are somewhat transferable between the Army and the Navy. If so, then it is likely that the value of naval commissions was comparable to that of an Army commission. Yet naval officers, for reasons spelled out later, did not purchase their commissions. This rent was partly dissipated through waiting on half-pay.[38]

This dissipation was not a social waste, however. The purpose of an efficiency wage is to create an unemployment pool that acts as a discipline device. There is every indication in the historical record that half-pay was given to those captains that made marginal mistakes, failed to capture an enemy ship, or failed in some other minor duty. Half-pay was discontinued if an officer took up some other position.[39]

[34] Howarth (1974, p. 227).

[35] Henderson (1970, p. 31).

[36] See Baugh (1977, p. 44).

[37] Lavery (1989, p. 40). The referee has pointed out that these two data points may be explained by increases in the service during the Napoleonic wars and the reduction in ships in 1715. However, though the actual numbers varied over the age of sail, the general evidence is that an oversupply of captains was the norm.

[38] The entire rent, of course, would not be dissipated since the quality of captains and other officers varied a great deal. Those exceptional officers might spend very little time on half-pay. Only at the margin would there be total dissipation.

[39] Lavery notes:

> Officers who took up civil appointments, or duties in other branches, normally had their half-pay stopped while the appointments lasted. (1989, p. 99)

While at sea, a captain made twice the wage and had the potential to earn spectacular profits through prizes.[40] Although seniority on the captain's list played some role in choosing a captain for command, the British Navy was free to choose any captain on its list. This meant that a captain suspected of some offense could be punished severely by placement on half-pay. The anticipation of life on half-pay would have a strong influence on a captain and would induce him to do his duty. The real question is how the Navy monitored its commanders in order to enforce this form of compensation given that the prize system contained the drawback disincentives discussed above.

4. MONITORING CAPTAINS AND ADMIRALS

During the age of sail, the methods available to the Admiralty for monitoring their captains were limited, and yet monitoring is critical if wages containing prizes are used.[41] Sail power meant that ships were literally at the mercy of the winds, and ill winds could easily prevent a ship from entering battle, from arriving on time, or from avoiding a lee shore.[42] The large role played by nature meant that it was difficult to infer incompetence or cowardice on the part of a captain simply because there was a negative outcome. Furthermore, in the age of sail communication was primitive at best. Even ship to ship communication was limited mostly to flag signals, which depending on distance and weather, were difficult to read and easy to misunderstand. Finally, unlike land battles where a target is often fixed in terms of location, at sea the target is also moving—meaning that entire fleets could sweep the ocean for months without intersecting an enemy vessel. One of the more famous episodes of this sort was Nelson's pursuit of the combined French and Spanish fleet. The combined fleet managed to escape a blockade of the French Mediterranean port of Toulon in March 1805. Nelson, thinking they were headed for Egypt, went East. On realizing his mistake, he crossed the Atlantic, searched the Caribbean, and then crossed back to Europe. He did not engage Admiral Villeneuve's combined fleet at Trafalgar

[40] An alternative arrangement would have simply paid officers higher wages and allowed the prizes to flow directly to the King. Ignoring the problem of stealing the prize, another problem arises from the fact that officers were not permanent employees of the Navy, they accepted commissions for various assignments, and depending on their foresight could reject or resign a commission. Despite attempts to extend the Articles of War to officers on half-pay, this option of abrogating the contract remained in place throughout the age of sail. This, though, leads to a classic adverse selection problem where the captain only accepts those commissions for which the pay is acceptable. Allowing prizes creates a share contract for officers and creates an incentive for them to accept commissions even though the environment may be less than favorable. See Sappington (1983) for a discussion of efficiency wages.

[41] This point is made by Eaton and White (1983), who show that a strictly positive amount of monitoring is necessary to induce effort when efficiency wages are paid.

[42] A *lee shore* is where the wind blows from the sea to the shore, hence threatening the ship to run aground.

until October—almost 8 months of chase.[43] Under such circumstances, direct monitoring of captains by the Admiralty is not feasible. But if not feasible, then how did the British Navy continue to use a structure of wages based on prizes?

4.1. Fighting Instructions: The Line and the Weather Gauge

In 1652, Robert Blake, commander of the English fleet, was defeated by his Dutch archrival Maarten Tromp. Though outnumbered, he blamed his defeat on the conduct of his captains under fire. During these Anglo–Dutch wars, naval strategy amounted to having fleets simply charge, pell-mell, into the opposition, choose an opponent of approximately equal size, and begin fighting. However, this led to two problems: failure to engage the enemy and sailing in a fashion that masked the fire of other ships. As a result of this battle a set of rules developed which, though modified over time, became the backbone of British naval tradition. These rules were known as the *fighting instructions*, and they remained remarkably unchanged throughout the age of fighting sail.

In general the fleet was to gain the advantage of the wind, then bear down on the enemy at once and impose as much firepower as possible. Ships were to stay out of enemy harbors, not board other ships until commanded, and the like. Most of the fighting instructions are quite straightforward, but two in particular helped to provide proper incentives to captains and admirals: capturing the weather gauge and fighting in a line.[44] To capture the weather gauge meant to be upwind of the enemy, while to fight in a line generally meant to fight in some type of linear formation. To form a *line of battle* was a revolutionary change in naval tactics during the 17th century and one that remained in the fighting instructions throughout the age of sail.[45]

Problems with the battle line. The rules for fighting in a line were actually quite complicated and evolved throughout the age of sail, attempting to take into account the endless conditions of weather and initial positions of the enemy, and trying to anticipate how they would react to the various attacks. As individual admirals modified the fighting instructions, the logistics of the battle line often became more detailed, but the general idea was always the same: ships formed a line with the admiral somewhere *near the center*, which would then proceed from the van (front) to pass the enemy line, sometimes blasting away as they went, until the two lines were beside one another. Ships would try to match ships

[43] Another famous case was Captain Rodgers' fruitless hunt of British ships in the early years of the War of 1812. The American squadron spent 70 days at sea, from one side of the Atlantic to the other, without running into the British once.

[44] Here we see a significant departure and similarity from French tactics. The French also fought in a line, but the French emphasized *not* acquiring the weather gauge. I return to this point later.

[45] The 1653 instructions state:

> All the ships of every squadron shall endeavor to keep in line with the chief . . . . None of the ships of the fleet shall pursue any small number of the enemy's ships till the main body be disabled or run. (Corbett, 1967, p. 79)

of similar size, then anchor and fight for hours until some sign of a victor became apparent, the sides fell away exhausted, or ammunition ran out. During the three Dutch wars, battles often raged on for days, with the surprising outcome that battles were often a draw.

A puzzling feature of fighting in a line is that, ignoring incentives, it is not a Nash equilibrium strategy—if one side is forming a line the best response is to not form a line. Yet in order to fight in a line, the enemy must also form a line. If the enemy did not wish to fight then, while one fleet is performing the complicated moves to form the line, they could simply sail away or engage in a different tactic.[46] Lining up and fighting one-on-one also provided no particular advantage to either side. Often it was more effective to double-up on a ship or break the line in some way to gang up on enemy ships. Finally, if the fleet downwind in the battle was beginning to lose, all they had to do was set sail and drift away. Hence, the act of fighting in a battle line has often been criticized and was often blamed for the large number of indecisive battles.

Many current day captains and admirals thought little of battle line tactics. The admiral Sir John Jervis once said "Lord Hawke, when he ran out of the line [at the Battle of Toulon] and took the *Podeer* sickened me of tactics."[47] Quite often, the attempt to form a theoretical line at sea proved impossible in practice, and it has been constantly criticized by military historians over the years.[48] Added to this criticism is the appearance that several key victories seemed to result from abandoning the line of formation. In the West Indies on April 12, 1782, Admiral Rodney intercepted a French fleet.

> A shift in the wind suddenly allowed the British to make ground towards the French and, instead of laying along side, Rodney sailed groups of his ships through the French line, encircled groups of theirs and hammered several into defeat. The result of this Battle of the Saints was the first clear cut success the Royal Navy had achieved since the seventeenth century. (Keegan, 1988, p. 48)

[46] This led to a curious feature of many early battle line fighting. If one fleet had superior numbers, these extra ships often sat aside. This was done in order to get the other side to fight! Frigates would also stand aside and it was custom not to fire on an enemy frigate when engaged with a ship of the line unless it fired first.

[47] In other words, Jervis' sentiments were that formal tactics hindered the ability to fight well. See Tunstall and Tracy (1990, p. 96).

[48] For example,

> Ships which must be carried by wind and sails, and the sea affording no firm or steadfast footing, cannot be commanded to take their ranks like soldiers in a battle by land. The weather at sea is never certain, the winds variable, ships unequal in sailing; and when they strictly keep their order, commonly they fall foul one of another, and in such cases they are more careful to observe their directions than to offend the enemy, whereby they will be brought into disorder amongst themselves. (Corbett, 1967, p. 76)

Interestingly, though he defeated the French, many French ships disengaged and fled. When urged on to complete victory Rodney's famous response was "Come, we have done very handsomely."[49]

The battle line as a monitoring device. From a strict military point of view the battle line was clearly not a dominant strategy. Although it reduced the chance of masking another ships fire, and brought the full broadside to bear on the enemy, as mentioned above it restricted movements of ships when other strategies may have worked better. However, the British Navy clung to the line formation as a dominant strategy for the simple reason that the line worked: "The English navy performed better and won more battles fighting in a line than it did with group melee tactics."[50] The critical feature of the battle line was it allowed admirals to monitor their captains over the issue of engagement. Whatever form the line took, it was clear when someone was out of line. The Navy, as mentioned, struggled with problems of cowardice and failures to engage. The great battles are exceptions in this regard, not the norm. In the early Dutch wars, when individual captains were left to their own discretion in battle, there was simply not enough engagement. The battle line was a simple method by which it was relatively clear to identify those ships that broke with the line.[51] The methods of those few admirals that successfully modified the line did so without losing the ability to monitor their fellow ships. For example, Nelson at the Nile simply doubled up the line on either side of the French. In fact, it was perhaps easier for Nelson to monitor his junior captains because his line was shorter.

One of the best examples of the use of the line as a form of monitoring agency problems on the part of captains comes from the battle of Toulon in 1744. The British had been fighting the Spanish since 1739 and had their fleet blockaded in the French harbor Toulon—at the time a neutral harbor. The Spanish came out

[49] A similar incident happened several years later when Nelson, under admiral Hotham in the Mediterranean, made one of two captures in a 1795 battle. Repeating Rodney, Hotham said "We must be contented, we have done very well." Nelson, recognizing the statement for what it was later wrote: "Sure I am, had I commanded our Fleet . . . that either the whole French Fleet would have graced my triumph, or I should have been in a confounded scrape" (as quoted from Palmer, 1997, p. 697).

[50] Palmer (1997, p. 683). Whipple notes this:

> Most of all, fighting in a line gave each captain clear and simple directions: he was to hold his place in line and focus his fire on the enemy ship opposite his own. (1978, p. 45)

In this regard the battle line is similar to an assembly line which reduces monitoring costs of workers.

[51] One piece of evidence of the line as a monitoring device is the placement of the admirals throughout the fleet. The admiral was always located in the middle of the line. Since the line could be several miles long, a position in the middle provided a better opportunity of viewing the entire line. In addition, vice admirals and rear admirals (and within each of these categories there were designated Red, White, and Blue admirals) would be spread out along the line. Each category of admiral may have more than one member, and so there were potentially many to keep an eye on the line. Keegan recognized that the line could be subject to naval discipline, when he states "Linear organization [fighting in a line] recommended itself because it could be prearranged and then enforced by the code of naval discipline" (1988, p. 45). This was only possible because the line allowed for some monitoring.

and a battle began that ended in a defeat for the British, and the most court martials in British naval history. Ironically, the British commander, Admiral Mathews, is viewed by historians and contemporaries at the time as making the right decisions. However, he broke with the battle instructions[52] and seems to have lost because he was unable to keep his ships engaged.

> It would seem that the attack Mathews devised was the best possible under the circumstances, but, being irregular, it had left some of the captains in his own squadron puzzled as to what they should do, *with the result that they did very little*. (Tunstall and Tracy, 1990, p. 89; emphasis added)

They did very little because without monitoring the temptation to freeride in battle was too great.

The weather gauge. All European navies fought in line formations, so although this was used as a method of monitoring, it cannot explain the relative British success. The second critical aspect of the British line tactics, and one not generally adopted by others, was to fight with the *weather gauge*. This meant to fight windward of the enemy ship—a tactic that was considered inferior by the military intelligentsia of the time. Throughout the 18th century French strategists discussed the general benefits of fighting *leeward* of the wind (without the weather gauge). When fighting leeward the ship is tilted by the wind away from the enemy and all of the ship's gunports are above the water line. In heavy seas a ship with the windward position might not be able to open its lower gun decks and as a result its fire power was drastically reduced. A more important advantage of the leeward position was that if the battle was going poorly, the fleet had the opportunity of simply sailing downwind to escape. Likewise, if an individual vessel became severely damaged it stood a chance of escaping behind its own line. The French proclivity for shooting the masts and rigging of the enemy ships, as opposed to the hull, increased the opportunity of escape and increased their preference for the leeward position. Given the advantages of not having the

[52] Breaking with the battle instructions was risky, and if it led to defeat it meant a guilty verdict at a court martial and the end of one's career; however, the Admiralty was willing to reward initiative at sea that led to victory. Nelson, as a captain, had demonstrated his zeal for total victory, but his first significant victory came in the Battle of Cape St. Vincent in 1797. The British fleet met up with the Spanish who marginally outnumbered them 19 to 15 in terms of ships, but outmatched the British 2 to 1 in number of guns and weight of fire. Despite this advantage, as the British formed a battle line, the Spanish attempted a retreat. Nelson, who was commodore at the time under Admiral Jervis, was third from the end in the rear of the fleet. He saw the retreat and broke with the line to cut off the Spanish escape. Fortunately for him, some other British ships followed and four ships were captured, two by Nelson himself, and the Spanish suffered a major defeat. Both Nelson and Jervis were rewarded for the victory. Hence, the rigid use of the line was not for its own sake, but with the intention that it generally enhanced victory. On the surface it almost appears that Lord Nelson, in each one of his famous battles, went out of his way to avoid fighting in a line. Yet Nelson, like virtually all other British admirals, fought according to battle lines. See Tunstall and Tracy (1990, p. 225) or Palmer (1997, pp. 703–704) for evidence that, in this regard, Nelson was not unlike other commanders.

weather gauge, why were the British so insistent upon having it? The answer lies in that it both increased the incentive to fight and prevented captains from drifting away from battle.[53]

A square rigged ship from the age of fighting sail was difficult to maneuver and could only sail at most six points into the wind.[54] Hence, when attacking from the weather gauge a square rigged ship had little choice but to drift upon the enemy. It would have been very difficult for a captain of a British ship in the fleet to casually or inadvertently not engage the eneme once the fleet had formed a line with the weather gauge.[55] This was not generally true with the leeward position. Both at Trafalgar and the Nile leeward ships among the combined and French fleets failed to engage even though there is evidence that the possibility was open to them.[56] The incentive mechanism of the weather gauge is that once engagement is certain, it was in the interests of the British ship to fight most effectively. Just as the weather gauge ensured engagement, failure to fight well meant that the ship would eventually drift into the enemy fleet where it would certainly be captured. Thus the weather gauge was an easily monitored action that encouraged engagement and effective fighting.

4.2. The Articles of War

As Rodger (1986) states, the articles of war were a "haphazard collection of regulations and admonishments largely concerned with court martial offenses by officers."[57] The articles of war were first passed by Charles II in 1661 and were based on regulations dating back to 1652 after the Dutch had defeated the British Navy in several major battles. The articles were modified in 1749 and then again in 1778, and were finally replaced in 1866 with the *Naval Discipline Act*. These regulations were not used, as a general rule, for ordinary seamen, but were mostly intended to police captains and admirals.[58] As with the fighting instructions, many of the Articles of War are irrelevant for this study, but one article is worth stating:

[53] I thank historian Nicholas Tracy for pointing this out to me. Choosing the weather gauge is an act of commitment, similar to Cortez burning his ships, that forced engagement and encouraged hard fighting.

[54] That is, the ship could not sail well into the wind at all. Not only could it not sail into the wind at any great angle, but the ship would often drift backward as well, often making no progress at all.

[55] This would also be true in ship-to-ship engagements. In these more common battles a captain downwind could always blame the wind for a failure to engage.

[56] An earlier example is in 1582 when a Spanish fleet acquired the weather gauge over a French fleet off the Azores.

> added to this [the weather gauge] was the French defection. There were those who spoke of treachery, as was so often to be the case in sea fighting. (Cassell, 1979, p. 12)

[57] Rodger (1986, p. 218).

[58] Indeed, only the article relating to sleeping on a watch seems aimed at ordinary seamen.

Article 10 *Every flag officer, captain and commander in the fleet, who, upon signal or order of fight, or sight of any ship or ships which it may be his duty to engage, or who, upon likelihood of engagement, shall not make the necessary preparations for fight, and shall not in his own person, and according to his place, encourage the inferior officers and men to fight courageously, shall suffer death, or such other punishment, as from the nature and degree of the offense a court martial shall deem him to deserve; and if any person in the fleet shall treacherously or cowardly yield or cry for quarter, every person so offending, and being convicted thereof by the sentence of a court martial, shall suffer death.*

The sentence of death is a common theme running through the articles of war, and often with no room for discretion.[59] If a British ship came upon an enemy vessel, then it was the captain's duty to engage. Throughout the 18th century, it was expected that one should engage a ship even if there was a considerable difference in size. Though no one expected a frigate of 30 guns to engage a ship of the line, ships in the same class were expected to fight, even if there was a difference of up to 50% in guns. Given the infrequency in which ships might come into contact on the open ocean, the large role of nature, and the difficulty in monitoring a battle from several thousands of miles away, the rule to always engage is efficient because it effectively rules out using poor winds, bad eyesight, and other excuses.[60] Had the British allowed engagement to be an option, there would have been many fewer battles, and relatively fewer victories as well.[61] The strategy seems to have worked remarkably well over 200 years. The British were constantly outnumbered in terms of ships or guns, and yet they still managed to win most of the time. Article 10 is similar to the preference for the weather gauge in the fighting instructions and would have provided a similar motivation. Captains, knowing that they would have to engage, would ensure that their crews were properly trained and ready to fight.

The Articles of War were not just an idle threat. Their most famous application came at the beginning of the Seven Years War. In 1756, the small island of Minorca just off the Spanish coast in the Mediterranean came under siege by the French. The island was of strategic importance to the British because it was one of their few ports in the area at that time. The British sent Admiral Byng to command a fleet to relieve the pressure. The French, engaging in their favorite

[59] In 1778, the punishment for Article 10 was amended to allow for something less than death, but the officer still had no choice but to engage. The commander that only partially sought engagement did so at his peril. Vice Admiral Sir Robert Clader engaged Villeneuve's combined fleet in July 1805, just months before the latter would meet up with Nelson at Trafalgar. After the initial successful action Calder, who was outnumbered, in a poor tactical situation with damaged ships, and worried about blockading other French squadrons, decided not to renew the battle. Yet he was still found guilty at a court martial and censured. See Tracy (1991) for a detailed discussion of the battle.

[60] Setting a standard of mandatory engagement is similar to other standards where information is extremely costly. For example, slave owners set mandatory standards for production regardless of differences in slaves (Barbel, 1977). The losses caused by punishing someone for being unlucky are offset by the reduced shirking from the others.

[61] There would have been fewer victories because forcing engagement encouraged captains to train their crews for battle.

tactic of blasting up his spars and sails, crippled the British ships to the point they could not give chase to the French ships.[62] Byng, rather than seek local repairs and continue the fight, decided to return home to England. He was court martialed and convicted under Article 12 of the articles of war, which state in part that "Every person . . . who through cowardice, negligence, or disaffection, shall in time of action withdraw or keep back, or not come into the fight or engagement, or shall not do his utmost to take or destroy every ship which it shall be his duty to engage . . . being convicted thereof by the sentence of a court martial, shall suffer death." Byng was shot by a firing squad on board the *Monarque* in 1757.[63]

4.3. Discontinuous Promotion

The critical question remains, although clear rules of conduct existed, how the Admiralty ever found out that a captain had chased a pirate ship and failed, not engaged an enemy of equal size, or pursued merchant ships when assigned to a blockade. The answer lay in a clever form of promotion that essentially provided an incentive to report on the captain.

Promotion in the officer ranks was discontinuous. A young teen would enter the service as a midshipman and after a specified time could be recommended for the exam to lieutenant. If he passed and was appointed to a ship he was promoted to lieutenant, and after a period of 3 to 6 years qualified for promotion to post captain. There are two critical features to the lieutenant's position. First, unlike the officers beneath him, he could not be removed or demoted on the sole authority of the captain.[64] Second, having qualified for captain, someone could remain a lieutenant for their entire career—there was no automatic promotion.[65]

[62] A *spar* is a timber in rigging to spread sails.

[63] Another striking example of the Articles in use comes from the battle off Cape Santa Marta (off the coast of Columbia) in 1702. Hattendorf, who edited the court martial documents, calls this "one of the most notorious cases of cowardice in naval warfare" (1984, p. 143). Here the British squadron, led by admiral Benbow, had superior numbers yet failed to defeat a French squadron because "the English captains ran away from the fight and failed to support their wounded admiral" (1984, p. 143). It is an interesting case for several reasons. First, the winds did not favor the British, their ammunition was low, their ships in disrepair, and most of the captains in agreement that a fight could not be won, yet the captains were all convicted and two were executed. Second, testimony was given at the court martial from many individuals not on board the relevant ship, testifying to the fact that the accused captain was either out of line, or not close enough for engagement. Third, Crown testimony came from up to 21 individuals. Clearly, the line was used as a method of enforcement, the Articles were applied with no consideration of circumstance, and lessor officers testified against their captain.

[64] Dandeker notes this: a young officer's "position could be revoked by the Captain's summary authority; only on receiving a commission as lieutenant was a man's position secure" (1978, p. 304).

[65] Quite often a lieutenant might be made a commander of a small vessel, but this position was terminated with the end of his commission. Out of courtesy a commander was called a captain, but a true captain was a post captain. The actual process of promotion was quite complicated. Often admirals of the fleet made promotions, but the Admiralty had veto power. Regardless of who made the actual promotion, the role of discontinuous promotion remained.

On the other hand, once a lieutenant was made a post captain (that is, his rank did not end with his commission), it was only a matter of time before he became an admiral, and if he lived long enough, admiral of the fleet—promotion above the captain's rank was automatic.[66]

There was then "except for the favoured few . . . a large gap between lieutenant and captain,"[67] and the process of making post captain was the most significant step in an officer's career. The process of promotion to captain in the British Navy was complicated indeed. Perhaps the most important factor was patronage.[68] A necessary condition, of course, was proper performance of duties as a lieutenant. Having said this, and although there were always more captains than ships to sail, the Navy did not promote lieutenants merely because they qualified. In order for a promotion there generally needed to be vacancies in the captains list.[69] In the normal course of events attrition in the captain's list would occur through old age, disease, battle, and court martial. The bottom line for a qualified lieutenant was that an opening in the captain ranks increased the chance of a promotion. Thus the lieutenant had an incentive to report improper activity on board the ship and to testify against his captain at court martial or when the ship returned to port.

Indeed, it was part of the lieutenant's job to keep a log of the captain's actions. Aside from the fighting instructions and the articles of war, the Admiralty issued general regulations and instructions which, although they held less authority over the first two, were nonetheless important in the duties of officers. Although they were first issued in 1663, the final instructions during the age of sail were in 1806. Article VIII for lieutenants states:

[66] One of the most famous ship-to-ship contests of the War of 1812 was between the USS *Cheapeake* and HMS *Shannon*, in which the *Shannon* won a quick but bloody victory. On board was a young 20-year-old second lieutenant named Provo Wallis. This was to be the first, and only naval contest of his life. Five years later he was promoted to post captain, and he lived until 1892 when he died at the age of 100. At the time of his death he had held the title of Admiral of the Fleet for 15 years (Henderson, 1970, p. 144).

[67] Baugh (1977, p. 41).

[68] The patronage system was an important aspect of the navy. Rodger states:

> An inability to attract good men was a fatal weakness in the career of an officer, however brilliant, for successful patronage was the key to a successful career, the principal means by which a reliable ships company was cemented, and one of the strongest social forces within the Navy. (Rodger, 1986, p. 124)

Rodger emphasizes how patronage policed captains, but it must also have kept subordinate officers in line. Rodger elsewhere states that:

> This 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. (1984, p. 245)

[69] By this I do not mean there existed a fixed number of captain "slots." The Navy would have targeted an optimal number of excess captains, and this number was not completely open ended. (Regulations, 1790, p. 94; emphasis added)

> It is expected that he do provide himself with the necessary instruments, maps and books of navigation, and *he is to keep a journal* . . . and at the end of the voyage to deliver copies thereof signed by himself in the Admiralty and Navy Offices.

Some view the lieutenant's log as simply a matter of training to be a captain, similar to the navigational exercises they performed on board. However, unlike the exercises, upon arriving in dock, the lieutenant was required to deliver his log to the Admiralty. In case of a court martial, the Admiralty or flag officer of the fleet would interview the lieutenant to see if the captain's log had any discrepancies. There would be no point to this if the purpose was simply an issue of training.

In addition to these general instructions, a captain would receive orders from the Admiralty with every commission. These orders often allude to the fact that lieutenants are keeping tab. For example, the captain's orders for *HMS Amazon* in 1799 state: "As it is the duty of the lieutenants to keep journals in which are included the ship's reckoning . . .."[70] These same orders also state that the first lieutenant must "know everything, see everything and have to do with everything that is to be known, seen or done in the ship".[71] In effect, the lieutenant was the watchdog of the Admiralty.[72]

It would appear that this system might create the perverse incentive to lie. Aside from penalties for perjury and the formal aspects of a trial with cross examination, there were three safeguards. First, there was the master of the ship. The master was the highest ranking noncommissioned officer on board, and like the lieutenant he could not be removed by the captain of the ship.[73] The master was responsible for the safety of the ship and also kept a log similar to the lieutenant's. In fact, Article IX for the master is almost identical to Article VIII for lieutenants, except the master also had to keep an eye on stores. The regulations provide an example of a journal entry, and indicate that "remarkable observations" are to be included.[74] Second, large ships had more than one

[70] Lavery (1998, p. 120).

[71] Lavery (1998, p. 128).

[72] Consistent with this is that every ship, no matter what its size, had at least one lieutenant on board. A small ship might only have a lieutenant in charge, but if the same size ship had a captain, then it also had a lieutenant. One might ask who would monitor the lieutenant in cases where he was the commander. It appears, however, in these cases lieutenants were often put in charge of single task missions (such as returning a prize to port) that would be more difficult to cheat on. Hence they could be monitored by output.

[73] In the very early years of the age of sail, the master was in charge of the ship, a captain merely being the leader of a land force on board. Most of the major warrant officers on the ship (boatswain, purser, etc.) could not be removed by the captain. Since the master was at the top of his career and could not be promoted, he had little to lose in honestly reporting on the captain. The same basic structure exists in modern navies today.

[74] Regulations (1790, p. 159). The infamous voyage of *HMS Bounty* in 1789 shows some of the dynamics of command and control through subordinate supervision. William Bligh was actually a lieutenant in command of the ship, and until he promoted Fletcher Christian to acting lieutenant his second in command was the master John Fryer. In addition to keeping logs, various clerical duties on

lieutenant, several midshipmen, and other lesser officers. Although these other officers might have less incentive to report misconduct, they certainly had little incentive to lie, and would be called upon at a court martial. Collusion is difficult at the best of times, and it seems very unlikely that a lieutenant could lie about specific types of conduct (like the capture of a prize) and get away with it. Third, an important element in promotion was the recommendation from one's captain. A lieutenant who lied, but failed to have his captain removed would have little chance at promotion on any ship in the Navy.

5. SOME EVIDENCE

5.1. Privateers

It is interesting to contrast the differences in the organization of the Navy with those of the private navy known as the privateers. Privateers were not pirates. They were sailors on private ships, licensed by the King to capture enemy merchant, vessels and goods in time of war. Privateers were always an important part of naval warfare during the age of sail. In fact, during the Elizabethan era, there were twice as many private ships involved in the war against Spain than ships owned by the crown.[75] Despite the similarities between the British Navy and the privateers, the institutional rules for privateers were quite different. Most notable, although privateers were paid strictly through a share of the prize that they captured, much as in the Navy, the Crown never directly monitored the ship's owner, nor did the Navy impose any of the rules of promotion or engagement on the privateers.[76]

The reason for the difference is derived from the different objectives of the Navy and the privateers. Privateers were never expected to fight enemy war ships, blockade harbors, or be involved in other forms of combat.[77] The sole purpose of the privateer was to hinder enemy trade. In this case, payment by prizes perfectly aligned the incentives of the sailors with the objectives of the Crown and thus eliminated the need to monitor performance. These *compatible*

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board required multiple signatures. On at least three occasions disputes arose between Fryer and Bligh over missing stores. On one particular instance, Fryer refused to sign. Bligh called all hands on deck, read the Articles of War, and then commanded Fryer to sign. According to Hough:

> Fryer takes the pen, and in a voice so loud that none will miss his words, he says 'I sign in obedience to your orders, but this may be canceled hereafter.' And he does so. According to Morrison [a member of the crew] this was only one of several rows between commander and master before they reached Tahiti. (1972, p. 101)

According to Hough, Bligh was constantly worried about Fryer's log and how it would be interpreted by the Admiralty.

[75] Andrews (1984, p. 24).

[76] The owner of the vessel would be paid a share of the prize, while the crew may be paid by wages, shares, or some mixture. The actual logistics of payment could be quite complicated.

[77] See Tracy (1991) for a detailed discussion of privateers and attacks on maritime trade.

incentives result from the fact that merchant ships were generally the most valuable net of the cost of capture.[78] The Crown knew that privateers would attack merchant ships. Hence, monitoring privateers was unnecessary, and the discipline and hierarchy of the Navy was absent. In fact, privateers were known for their lack of discipline when compared to the Navy. Lubbock notes that:[79]

> The mercantile seamen who has the worst reputation during the Napoleonic Wars were those who manned the privateers, both British and French. Their discipline was considered negligible . . . . (1948, p. 119)

For the Navy prizes were used to create incentive pay, but the easiest prizes were not always in the Navy's best interest to capture. With the Navy the use of payment by prizes created *incompatible* incentives. Hence, the Navy had to engage in other subtle forms of monitoring to ensure fighting.

5.2. The British Army

The British Army provides another striking contrast with the British Navy, and the differences and similarities help to test the hypothesis of this paper. Until the middle of the 19th century, the Army was staffed by officers who were paid essentially through a share of prizes captured in battles—in this respect the officers in both armed services were similar. However, there were two important differences. First, officers in the Army purchased their commission and promotion was based on one's willingness to pay for a higher rank. There were no exams, no selection committees, and certainly no discontinuities at specific ranks. Second, as with the privateers, there was limited monitoring by the Crown in contests where the army was on the offensive.

Again, the reason for the differences stems from the fundamental fact that payment by prizes in the Army created no major incompatible incentive between the officer in charge and the Crown. Prizes in the Army were used to motivate soldiers to fight, and the purchase system was used to ensure that the better soldiers would be self selected to the highest positions of command.[80] Had the Navy not required lieutenants to keep track of their senior officers with official

[78] Andrews, referring to the British privateers in the war with Spain, circa 1600, states:

> The necessities of maritime defense in the war against England thus widened the gap between the favoured and the under-privileged colonies and exposed the latter to continual harassment by the Elizabethan privateers, who preferred to seek their prizes in these less dangerous backwaters. (1984, p. 282)

In other words, privateers could select prizes that put up little resistance.

[79] Hannay has similar sentiments:

> The private ship with its slovenly discipline, and the greater chances of earning booty it offered, attracted all the restless spirits to whom the order of the navy was grievous. (1898, p. 166)

[80] See Allen (1998) for a complete discussion of the purchase system in the army.

logs, and had the Navy not required that captains and admirals earn efficiency wage rents, a purchase system may have arisen in the Navy. However, the need to directly monitor captains and admirals prevented this from occuring.

The Crown engaged in trivial amounts of monitoring with the Army because of a second feature of land battles: the targets are fixed and not floating about at sea. With fixed targets, it was clearer whether or not an army carried out its stated mission. Armies that attacked the wrong city would not get paid. In fact, in Wellington's Spanish campaign, he was quite successful in preventing his soldiers from taking Spanish prizes.

5.3. The Introduction of Steam

Perhaps the most critical factor allowing for incentive problems in the age of sail was the wind. With the large role played by the wind, it was virtually impossible to monitor captains based on output. The age of sail for the Navy ended in the first half of the 19th century with the introduction of steam. The first steam ships used large paddles on the sides of the vessels. Because they reduced the sailing and fighting qualities of the ships, paddle propulsion was more popular among merchant vessels than naval ones. However, with the introduction of screw propulsion, which improved sailing and still allowed for a full broadside of guns, the Navy completely committed to steam power by the mid-19th century. The removal of the most significant role of nature (the wind) from battle made shirking on the part of captains much more difficult if not impossible.

Under the hypothesis of this paper, most of the rules used to monitor captains should have ended with the introduction of steam. Obviously, requirements to enter into battle with the weather gauge disappeared. But less obviously, the Articles of War disappeared as well. The introduction of steam allowed for cheap direct monitoring of captains in most circumstances, and not surprisingly direct monitoring replaced indirect, and reduced penalties replaced the more severe penalties of death. According to Rodger (1982), the new naval act of 1866:

> represented the final stage in the process by which centralised, legalistic naval administration had come to regulate in detail the internal affairs of the Queen's ships, and the daily lives of her officers and men . . . . Treachery and cowardice were not serious problems in the nineteenth century Navy . . . . Once it had been all the authorities could hope for, and more than they could achieve, to keep admirals and captains to their duty, now they could regulate in detail men's responsibilities . . . . (p. 11)

Changes in naval organization did not end with discipline. In the areas of recruitment, promotion, retirement, and general control of officers, the Admiralty eventually replaced the system of individual captain autonomy. Whereas in the age of sail the Admiralty often had only veto power on promotions, by the second half of the 19th century they had complete control. I have argued that lieutenants acted as the watchdog of the Navy and that the discontinuous promotion system provided the incentive for a lieutenant to do this job. Consistent with this is that

with the advent of steam came the phasing out of this practice in the 1860s.[81] The major purpose of having captains play a major role in promotion was to police the perverse incentive of the lieutenant to lie about captain performance. With steam this role was not required and the Admiralty took over. In fact, of all the organizational rules discussed (wages based on prizes, the weather gauge, promotion, etc.) the only one to survive the introduction of steam was the line of battle, and even this changed dramatically.

5.4. The French

Perhaps the best evidence that incentives and rules matter for performance comes from comparing the rules of the British Navy with those of the French. The French, like every other Navy, certainly had a problem with cowardice and shirking of duty.[82] Like the British, the French paid their officers wages supplemented with prize money. But the incentives and French tactics were different and led to different methods of fighting. The French were more wedded to a formal line of fighting than the British, but they also insisted on taking the leeward position. Admiral Tourville issued a set of fighting instructions in 1689 that became the French standard:

> Tourville did for the French navy, and ultimately for all navies, what *marechal* Jean Martinet did for the army. His contribution to the science of naval tactics lay chiefly in drilling his very large fleet into a disciplined and controlled force which could deploy from a relatively sophisticated order of sailing to other sailing formations, or into the line of battle. (Tunstall and Tracy, 1990, p. 48)

In 1727, Paul Hoste, professor of mathematics at the Royal Seminary in Toulon, published the first major work on naval tactics, and it dominated French thinking for much of the remaining part of the century. "Its success was immediate and lasting. It was published in 1727 in its original form, and fifty years later was still a sound text-book."[83] To quote Tunstall and Tracy again:

> Hoste's whole system of sailing and battle formations was based on his five *ordres de marche*. These retained their primacy in the French service throughout the age of sail. The basis of these orders of sailing was that each provided a means of forming a close-hauled

[81] Greenhill and Giffard (1994, p. 75). See also Dandeker for a discussion of the conversion in control over promotion and recruiting in the 19th century. He documents how the Navy became a formal bureaucracy using impersonal procedures during the age of steam.

[82] For example, as mentioned above, in the battle of Trafalgar there was evidence of cowardice when

> the van of the combined fleet [the French and Spanish], under Dumanoir, held its course for another hour after Nelson's breaking of the line, turning back only after the worst had been done . . . . (Keegan, 1988, p. 72)

[83] Tunstall and Tracy (1990, p. 59).

> line of battle, which Hoste strongly favored. . . . The strongly defensive tone of Hoste's work is obvious. Much attention was given to avoiding an engagement . . . . Above all, his defensive cast of mind is revealed by the continuous acceptance of the leeward station as a basis for tactical demonstration. (1990, pp. 59–62)

It was logical to hold the leeward position for all of the advantages it conferred. It was a defensive position, and the French tactics were generally defensive:

> 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)

This was combined with other rules, such as the following, that created a heavy price for a ship's captain if he lost a battle.

> the National Convention had decreed that the captain and officers of any ship which hauled down her colours to the enemy, however numerous, "unless the French ship should be so shattered as to be in danger of sinking" should be liable to the death penalty. (Parkinson, 1977, p. 17)

The French rules were more rigid and provided an incentive *not* to engage unless they thought they could win. While the British fighting instructions "Taken as a whole, . . . tended to concentrate more power in the hands of the admiral, while giving him wider tactical initiative,"[84] the French instructions stressed defensive tactics and an avoidance of the large mistake. Being defensive and cautious played out in other features of the French navy. French ships were generally better and faster, and the French Navy was known for its rigid and difficult fleet maneuvers. The French would have trained more at sailing than at fighting, with the result that they lost most battles when they could not sail away. Certainly the French tactic of shooting up the spars and sails of the enemy and then fleeing away is consistent with this overall philosophy.[85]

[84] Tunstall and Tracy (1990, p. 50).

[85] Although it is beyond the scope of this paper, it is interesting to speculate on why the French did not copy the British tactics exactly. A continental power like France no doubt faced different constraints than its island neighbor when it came to directing efforts on land and at sea. For Britain, its Navy was its chief form of defense, while for France the Navy was primarily used to keep in touch with overseas possessions and to protect merchant trade—neither of which were as vital to France as they were for Britain. Historically, countries that relied heavily on trade by sea have also been naval powers. The first true navies were developed by the Italian states of Venice and Genoa. [See Rodger (1998) for an extensive naval history of Britain prior to the age of sail.] As a result, the French designed rules and built ships that gave them the advantage in flight and in defense. *Ex post*, by 1815 with the loss of hundreds of ships and many colonies, it would appear that the strategy failed, but it also seems reasonable to assume it was a calculated risk. In fact, the great fleet battles of the Napoleonic wars only took place because the British were generally able to trap the French against a lee shore and cut off their escape. It also seems reasonable to suggest that in light of France's strong priors based on theoretical naval tactics and relative vulnerability to sea power along with the noisy information they would have received over any battle that the information they received over the

6. CONCLUSION

The age of fighting sail provides an interesting example of how a governance structure can be designed to generate performance even though direct monitoring is virtually impossible. Though the British Admiralty had limited information regarding the actions of their commanders, they had confidence that dereliction of duty would be minimal. Interestingly, the British success did not depend on superior technology, geography, or luck. The long string of successes depended on a scheme of indirect monitoring that, although inefficient from a sheer technical point of view, proved efficient in light of the problem of cowardice among its commanding officers. I have argued that the organizational rules surrounding these officers were designed to encourage engagement, and that with engagement likely, officers would have an incentive to drill their crews to fight.

By paying its officers through prizes, the British Navy encouraged its officers to want to be at sea. Once at sea, the officers were under the fighting instructions that essentially forced them to engage the enemy and to do so in a way that monitored their actions. At the time fighting in a line with the weather gauge was shunned by scholars and tactician for its obvious shortcomings. However, their success stemmed from the ability they provided in monitoring and the incentives they provided to fight. Once back at port, the Navy could count on an accurate reporting of events given its system of discontinuous promotions and patronage. This system of rules was absent from the privateers and Army where the incentives of those fighting were more compatible with the Crown. Furthermore, the rules were discarded with the introduction of steam which allowed for direct monitoring. I have argued that the French incentives did not encourage fighting and led to a Navy better trained in sailing. When the British were able to trap the French this difference led to an increased chance of British victory, and subsequently to the long string of success.

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century was inadequate to change their behavior. Throughout the 18th century there were only 53 fleet battles, most of which were indecisive, some which the British lost, and all with enough variability in them that the truth was no doubt a casualty as well. The strong priors and noisy information would have contributed to the long period of unchanged tactics.

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