Negotiating Uncertainty with Social Ties in Early-Modern Overseas Trade

Emily Erikson*
Yale University

Sampsa Samila
National University of Singapore

29 April 2013

----This is a draft, please do not circulate without permission of the authors----

*Please address all correspondence to Emily Erikson, PO Box 208265, New Haven, CT, 06520-8265, emily.erikson@yale.edu. The authors are indebted to Paul DiMaggio, Marissa King, John Levi Martin, Adam Slez, and Olav Sorenson for their suggestions. This research was presented at the Comparative Research Workshop and the Center for Research on Inequalities and the Life Course at Yale University, the fifth annual Analytical Sociology conference, and the Social Networks section of the American Sociological Association in Denver, and the Harvard Culture and Society Workshop. We thank all participants for their comments.

Abstract: Individuals engaged in overseas trade in the early-modern period often faced high levels of uncertainty regarding their prospects for trade. One way of managing uncertainty is to gather information from others via social interactions, i.e. through social exchange. Here we consider the valence of social exchange in the early modern commercial world by examining the relationship between uncertainty, social exchange, and behavior. The analysis reveals that (1) repeated exchange has less impact on behavior in conditions of uncertainty than one-shot exchange (2) neither repeated nor one-shot exchange independently alter patterns of behavior that arise in response to uncertainty. Together the evidence indicates that the social ties themselves, as distinct from the information they convey, did not exert a significant effect upon actors' decisions, implying that in this context social ties are mainly conduits of information, not mechanisms of trust or influence.

INTRODUCTION

Social ties can be both affective relationships between individuals and conduits of information. The more affective content a tie has the more likely it is to alter and not just inform behavior. When individuals draw upon weak ties to gather information, they sift through the information presented by ties in order to realize pre-existing preferences and goals (Burt 1992; Granovetter 1974; Uzzi 1999). Social ties characterized by influence or trust, however, have the capacity to alter behavior and pre-existing preferences, particularly by encouraging individuals to take on greater risk than they would otherwise (Buskens 2002:8; Coleman 1990:97-99; Cook et al. 2005; Levi and Stoker 2000:476). Here we use data on early-modern overseas trade to explore the valence of social ties in the early-modern commercial world by examining whether there is evidence that social exchange affected the judgment of individuals, as should be expected in relations of influence or trust, or acted merely as conduits for information. Specifically, we focus on how the use of social ties impacted actors' behavior under conditions of uncertainty.

We use two strategies to consider the impact of social exchange on behavior in the early-modern commercial world. In the first we draw upon well-developed theories of how ties affect behavior based in the distinction between strong and weak ties. This body of work has shown that when faced with uncertainty, individuals prefer to rely upon pre-existing relations (Kollock 1994; Lawler and Yoon 1998; Mizruchi and Stearns 2001; Molm, Takahashi, and Peterson 2000; Podolny 1994; Sorenson and Waguespack 2006; Yamagishi, Cook, and Watabe 1998). Because repeated or strong ties restrict individuals to a smaller pool of information, this tendency is widely expected to decrease the diversity of information available to individuals by virtue of network clustering. Thus individuals relying on strong ties will engage in similar behaviors, whereas individuals drawing from weak ties will pursue a wider array of opportunities (Burt 1992; Erickson 1996; Granovetter 1973; Lin 2001). Alternatively, a history of exchange has been shown to increase trust between individuals, thus individuals relying on repeated instances of exchange for information may be led to explore more diverse outcomes because of the trust they put in the alter (Molm, Whitham, and Melamed 2012). Using these hypotheses, we investigate whether social exchange in uncertainty produced any systematic effect on behavior among our actors. We break down social interactions into repeated and one-shot instances of exchange in order to evaluate which type had a stronger impact on behavior. Our expectation is that if relational strength matters, stronger ties should have a greater impact on behavioral patterns. In the second strategy, we model the decision process of captains as they chose their subsequent port of destination as well as the distribution of information flowing through the system under conditions of greater and lesser uncertainty. In this analysis we model the interaction between behavioral patterns, uncertainty, and social exchange in order to compare the impact of information gathered via social exchange on judgment with judgment under uncertainty that is unmediated by social ties.

Our results indicate that although individuals drew information from social ties, that exchange did little to change actors' patterns of behavior. The findings illuminate two issues (1) the relative importance of social ties as conduits of information versus mechanisms of trust in this period and less centrally, (2) the importance of direct responses to uncertainty and environmental shifts in information flow in determining outcomes often associated with the formal properties of repeated exchange. Centrally, our findings indicate that social ties in this pre-modern commercial world were more instrumental and less influential or trust-based than we would expect in a contemporary context. (Silver 1989; 1990). Repeated exchange in this setting did not have a greater impact on altering behavior, and the association between repeated exchange homogenous behavior is weaker than that with one-shot (or weak tie) exchange. There is little evidence in our results that either type of network exchange had an independent effect on judgment under uncertainty, as should be the case if social ties were mechanisms of trust, rather than vehicles for the distribution of information. This exploration of the valence of social ties in the early-modern commercial world contributes to the literature on emergent social institutions in the conduct and expansion of pre-modern trade (e.g., Goldberg 2012; Greif 1989 2006).

Secondarily, since existing research does not usually take into account individual preferences for more or less homogenous outcomes when faced with uncertainty or the effect of environmental uncertainty on the distribution of information flowing through the system, it is generally unclear in these settings whether repeated exchange produces clustering by changing the information presented to individuals (as predicted by the theory of weak ties) or whether individuals simply use that information differently, i.e. their preexisting preferences are manifested by sifting through the information they get via social networks. In other words, strong and weak ties may present the same information to an actor, but under conditions of uncertainty, individuals may both prefer strong ties as well safer, or more homogeneous, behaviors. Thus, this research also demonstrates that a more detailed analysis of the mechanisms through which information gathered via social networks ties is used and interpreted is needed across a range of different contexts before concluding that repeated exchange or strong ties lead to clustered outcomes via the purely formal consequences local patterns of association have on information flow.

Uncertainty and Early Modern Overseas Trade:

Early-modern overseas trade carried many risks. Because of the long distances involved, merchants were often unaware of market conditions in the locations in which they intended to seek trade until they arrived on site or their agent had returned home. Prices fluctuated, the availability of goods shifted. By the time a voyage was complete, demand in the home market might have dissipated. Weather posed a constant threat, capable of stranding or sinking ships, and most overseas merchants had to rely upon agents to carry out their transactions.

The data we use is drawn from the voyages of the English East India Company, an early-modern overseas trade organization, which existed as a government-sanctioned monopoly from 1601 to 1835. In Asia, it competed against a small number of similar monopolies of other European countries – the largest rival being the Dutch East India Company (VOC) – and numerous Asian merchants, a number of whom possessed resources comparable to the European national monopolies. Goods traded by the English were numerous and varied from the exotic, for example, diamonds, rose attar, and elephant tusks, to items we now consider mundane, such as pepper, cotton, chinaware, and tea. The Company's ships docked at over 270 ports of diverse social organization, spanning from the Cape of Good Hope to Nagasaki and ranging in political and social organization from the centralized bureaucratic state of China to the kin-based villages of New Guinea.

During the voyages, the captains were able independently to alter the course of their travels while at sea by taking into account new information. The East India Company lacked the communication infrastructure that makes the tight organizational control exercised by contemporary organizations possible. Since managers in London could never be sure of the conditions that would face their ships as they arrived in the East three to six months after setting out from the harbor at Downs, captains necessarily were given leeway to adjust to changing local circumstance, such as weather, political turmoil, and market conditions. The organization also had a history of granting their captains significant autonomy, and captains regularly diverted their ships while en route to official destinations in order to pursue their own trade (Barlow 1934; Anderson, McCormick and Tollison 1983; Marshall 1993; Adams 1996; Furber and Rocher 1997; Erikson and Bearman 2006). Thus the captains were the relevant decision-makers as they ultimately decided the course of their ships, fulfilling their duty to the Company, but also pursuing their own trade.

The standard risks presented by overseas trade were present for captains engaged in the trade of the East India Company with the exception of having to entrust their affairs to an overseas agent. They also faced individual level and environmental uncertainty in the forms of inexperience and war.[1] In war, the actions of others are both unpredictable and threatening. The central problem for ship captains in conditions of war was encountering enemy ships or blockades. The penalties associated with bad decisions were costly, and it was difficult for captains to ascertain the location of enemy ships. Since the underlying probability of encountering an enemy ship was clearly unknown to captains, we characterize this situation as one of uncertainty.

Another form of uncertainty arises when individuals lack experience, thus having less knowledge about potential risks. Similar to wartime conditions, captains' inexperience was associated both with significant potential costs and general uncertainty. Individuals usually went into debt in order to cover the expenses associated with acquiring a captaincy, expecting to make the money back through engagement in the private trade (Sutton 1981:72-3).[2] Commercial missteps on the first voyage could ruin individuals financially and destroy prospects for future gain. Although the uncertainties faced by captains could never be fully resolved, they could be mitigated through information gathering strategies.

Social Ties, Early Modern Trade, and the Pre-Modern World

Captains, officers, and crew of the East India Company ships were in contact with each other when docked at port. While at harbor they lived and ate meals together at the English factory, which was a combination of overseas warehouse, headquarters, and

[1] We follow the convention of referring to risk as calculable and uncertainty as a condition in which the information necessary to calculate potential risk is unavailable to actors.

[2] The money made through salaried employment was fairly low. All voluntary employees joined with the hopes of making additional money through engaging in their own private trade while in the East and under the employ of the Company (Sutton 1981:73).

dormitory (Cotton 1949). East India captains spent significant amounts of social time together after they had returned to England, indicating that a social camaraderie arose in these shared circumstances (Bowen 2007).

Unsurprisingly, the topic of commercial information was of particular interest to all those employed in the service of the East India Company. They were not only employed in the business of trade, but had also, as a rule, entered the service in order to pursue their own private trade in the East. The historian K.N. Chaudhuri notes that "the private correspondence of the East India Company's officials, some of whom were country traders on a large scale, are full of very detailed messages on the number and timing of the local shipping and the effect of their arrival and departure on markets and prices" (Chaudhuri 1978:192). While attending a dinner with the factors of Anjengo, William Larkin, then first mate of the *Durrington*, "learned what price he would get in ports up the coast for his fine Bengal silks, what Anjengo pepper and fine cloth and betelnut would fetch at Surat and the rate of exchange of the great variety of coins used in the trade" (Sutton 2010:59). Jean Sutton pointed out that captains had to rely on conversations with other captains about how to safely navigate to different ports as this information was not provided by the Company (Sutton 2010:22).

The importance of social interactions in the conduct and management of trade was part and parcel of how the larger commercial world operated. Gagan Sood found widespread agreement across merchants in Islamic Eurasia that "correspondence is [equal to] half a meeting" (Sood 2007:207). A similar point was made by Adam Smith: "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices" (Smith: Ch. X, pt. II). Richard Grassby was even more forthright about the importance of social interaction in the English business community of the time: "Business operated in a face-to-face society" and, "the inns served as distribution centers and as business offices for merchants" (Grassby 1995:176-7). And Bruce Carruthers found social considerations had a significant effect on market transactions in English commercial society of that time (1994).

The importance of social ties is not surprising; however the status of social ties in this period is a more complex issue. English and European societies were experiencing a rise in formal institutions that were altering the complex web of patronage relations that had previously formed the core of social organization. This process can be seen in the emergence of national political parties via religious patronage prior to the English Civil War (Bearman 1993), in the strains created by the merging of formal organizational structures and patronage networks in the form of the patrimonial company in the seventeenth and eighteenth centuries (Adams 1996 2005), and in the emergence of the same companies in the sixteenth (Padgett 2012).

It has been argued that the emergence of formal contractual relations changed the nature of social relations, creating a division between instrumental and non-instrumental relations whereas positive relations had previously combined self-interest and the sentiments we associate with friendship in a way that individuals in the twentieth and twenty-first centuries would be likely to experience as disingenuous. Allan Silver argued that this change in the nature of friendship as a social institution took place in the early modern period (1990). Paul McLean's in-depth portrait of personal relations in Renaissance Florence provides strong evidence that instrumentalism predominated social exchange in the pre-modern Italian commercial world (2007).

Social Network Theory, Exchange Theory and Uncertainty:

Network research has established a set of linked propositions about uncertainty and social ties. A number of experimental studies have found that uncertainty leads individuals to both form and increasingly rely upon existing relationships (Kollock 1994; Lawler and Yoon 1998; Molm, Takahashi, and Peterson 2000; Yamagishi, Cook, and Watabe 1998). Further these findings have been supported by empirical work in the field of organizations and economic sociology (DiMaggio and Louch 1998; Mizruchi and Stearns 2001; Podolny 1994; Sorenson and Waguespeak 2006). This preference can be viewed as a compensatory mechanism where environmental uncertainty is mitigated by trust in the relationship or alter.

In this line of research, repeated ties with known or trusted alters is frequently linked to homogeneity of information and outcomes via the mechanism of local network density. For example, in their study of the decision-making process of bankers, Mark Mizruchi and Linda Stearns (2001) found that heavy reliance on social ties was associated with job failure, i.e. bankers who rely on social ties to close deals, fail disproportionally at that task. Further, because uncertainty drives more bankers to rely on strong ties, the failure rate increases in that context. In keeping with the idea that weak ties present greater informational diversity to individuals and strong ties decrease information diversity, Mizruchi and Stearns hypothesize that strong ties chosen during periods of greater uncertainty increase ego network density, which increases redundancy and decreases the overall range of information available to actors. This information effect then translates into an increased rate of failure. In the above cases, the contents of the interaction – i.e. the heterogeneity or homogeneity of the information transferred across strong and weak ties – is not available for analysis, but the theory of weak ties provides a strong theoretical foundation for this interpretation.

On the other hand, experimental research has found that a history of exchange, i.e. repeated interactions, increases trust (Molm, Whitham and Melamed 2012) and empirical research has also supported this finding. Paul DiMaggio and Hugh Louch found that consumers are more likely to engage in risky transactions with trusted alters (1998). These findings suggest that an increase in the strength of a tie, through repeated interactions, may free individuals to engage in more diverse behaviors.

Our data allows us to consider some aspects of the information that was transferred via social ties and the behaviors they produced. We are interested in how the transfer of information about ports across instances of social exchange influenced captains' decisions to travel to those ports. In this case, the information about the port is flowing through the social tie, and the behavior we observe is travel to a port. Early modern East-Indies ports had varying amounts of traffic, but did not operate at capacity. Rates of traffic at ports were linked with commercial prospects and risk. Markets were very sensitive to demand and a large number of English ships seeking the same good at one port would significantly raise prices (Chaudhuri 1978:136). Similarly, a large influx of English goods could significantly lower prices (Sutton 1981:83). Less-trafficked ports, that still retained sufficient market capacity, would, on the whole, provide more lucrative opportunities for trade. However heavily-trafficked ports had larger markets offering a wider array of goods, suppliers, and buyers. Thus less-frequented ports also indicate increased risk. We consider travel to more heavily trafficked ports as homogenous behavior (similar to others) and travel to less-frequently traveled ports heterogeneous, or more diverse, behavior (dissimilar to others).

Instances of repeated exchange between captains occurred less frequently than instances of one-shot exchange, thus individuals were exposed to a smaller pool of information via repeated exchange. Building from existing network theory, we are interested in (1) whether repeated, or strong, ties are associated with more heavily trafficked ports, thereby building in clustering and homogeneity, and (2) whether one-shot, or weak, ties are associated with less-trafficked ports, indicating greater in diversity and heterogeneity. If repeated exchange is associated with homogeneous outcomes, this would provide evidence that individuals were willing to trade diversity of information for the security of relying on a trusted or influential alter. However, we are also interested in whether repeated exchange led to more diverse outcomes, indicating greater trust. Thus we use tie strength, in the form of repeated instances of exchange, to evaluate the relationship between exchange of information via social ties and systematic alterations to behavioral patterns in the form of preferences for more or less trafficked port.

Prospect Theory and Uncertainty:

A limitation of much current research on social networks is that individuals are seen largely as vessels that express changes in the distribution of information available to them. This is a thin conception of the individual. We incorporate a thicker conception of the individual into our structural analysis by considering how individuals may interpret or use information transferred via social ties differently under conditions of greater and lesser uncertainty. In order to do so, we draw on well-known work on strategy and decision theory. This thicker conception of the individual allows us to also consider in greater detail the meaning of social ties for actors.

Well-established research in psychology and the decision sciences indicates that uncertainty, or lack of knowledge, has an independent effect on leading individuals to more homogenous outcomes. For example, when researchers asked individuals to choose the largest city out of list of cities they know little about, they chose based on name recognition – rather than any specific knowledge about the cities (Gigerenzer and Goldstein 2002). In a different research context, Thomas Schelling found that, when faced with uncertainty, individuals will choose focal points in order to direct their actions. Famously he conducted an experiment in which he presented subjects with the following dilemma. They were to meet another individual in New York City without having any opportunity to communicate with that person in order to arrange a meeting place. A surprisingly large number chose Grand Central Station at noon, providing an emergent solution to the problem (Schelling 1960). Schelling suggests that individuals choose more common solutions in uncertain circumstances because in this way they "expect to fulfill the expectations of others" (Schelling 1960), which may be their only sense of what course of action to pursue when otherwise operating in unknown or unknowable circumstances.

The different strands of research converge in suggesting that individuals in uncertain circumstances are likely to choose the more common solution, thus creating homogenous outcomes -- and that convergence will occur independently of a change in the pattern of relations between actors or indeed independently of communication between actors. These findings suggest the importance of disentangling the actors' response to uncertainty from their use of social network ties. This component of the analysis also makes possible a consideration of the effect of a tie, independent of a pre-existing preference for certain types of outcomes under conditions of uncertainty.

Consider an individual choosing a restaurant for a first date. In this case, we take it as a given that their pre-existing preference is for a popular restaurant that will impress their date. In order to locate the best option, the individual asks a friend for suggestions. The friend suggests a range of options including both well-known venues as well as favorite, new, and as yet undiscovered spots. How the advice seeker evaluates this information depends in part on their relationship with the advice giver. In relationships with high trust or influence, the advice-seeker is likely to choose the as-yet-unknown site to which the friend gave their highest recommendation. In relationships with low trust or influence, the individual is more likely to choose the most popular venue of those options -- rather than the restaurant to which their friend gave their highest recommendation. In both cases, the individual draws information via a process of social exchange; however in the first case, the presence of the relationship changes the interpretation of information, whereas in the latter case, the advice seeker is manifesting a pre-existing preference for a more popular alternative by choosing from the range of options presented to them by their friend. In the first case, the change in behavior, from popular to less popular, demonstrates the impact of the social tie, whereas in the second it does not function as more than an information-gathering device. Evidence that social exchange produces changes in behavior would indicate that network exchange had greater valence, or meaning, for the individuals in this period. Such an interpretation is consistent with the literature on trust in which "trust judgments are expected to inspire courses of action" (Levi and Stoker 2000:476).

In the second stage of the analysis, we are interested in identifying whether information transferred via social networks has an impact on individuals' behavior, above and beyond pre-existing preferences. If social network ties alter preferences by systematically leading to different types of outcomes, it would provide evidence that social ties independently affected the interpretation of information, through mechanisms of trust or influence, and were not simply funnels of information.

DATA

Our data comes from the 4,725 recorded voyages of the English East India Company (Farrington 1999). It includes the ship, captain, ports, and travel dates of each listed voyage. Often several East Indiamen ships would be docked at the same port at the same time. We observe that exposure to other captains at port affects the decision of the focal captain about where to travel to next – i.e. information is transmitted about past destinations that affects the direction of future travels. This ship-to-ship exchange at port is the focus of our study. This is an event-based approach to information diffusion, most closely related to works that consider the effects of meetings in specific settings for the creation of ties (e.g., Sorenson and Stuart 2008) and the exchange of strategic information during event co-participation (e.g., Wang and Soule 2012).

Our dataset has several key features that are still rare in social network data. It is longitudinal, spanning over two centuries and encompassing several long periods of structural instability in the form of war between nations. The duration and eventfulness of the data facilitates the investigation of both global and individual level conditions of uncertainty. The continuous nature of the data allows for the observation of information conditions at the moment the decisions were made. Also, the captains had significant control over where their own ships traveled in the East, but no control over where other captains' ships traveled, building in a significant random component to both whom they encountered at port and what kinds of information those other individuals carried. Thus homophilous selection bias is less problematic in this data than in many other network datasets.

Additionally, network data rarely includes the contents of what is transmitted between nodes via relations; in this case we can infer the information carried from the prior travels of each ship, thus determining the relevant content of the social tie, i.e. information about ports. Diffusion studies often focus on the diffusion of one innovation or piece of information; in this case we are able to track the diffusion of information about many different ports, thus allowing for the comparison of the characteristics of the objects of diffusion, i.e. the relative amount of traffic at the different ports. Finally an additional advantage of our data is that whereas information travels by many different routes in our era of information technologies, in this period most of the information was condensed along the passage of the ships themselves. In some cases it was possible for commercial information to travel over land, but in the great majority of cases useful and timely information would arrive at sea ports via other ships.

Variables:

As outlined above, we are interested in whether repeated or one-shot exchange systematically affects behavior, indicating a relationship between the affective content of a tie and the outcomes it produces. We are further interested in disentangling the effect of uncertainty and social network use under conditions of uncertainty in order to understand the meaning of a social tie in the context of the early-modern English commercial world. As such, the unit of analysis is the decision of a captain regarding the next port they will travel to during the course of a longer voyage in the East Indies. We use both negative binomial as well as conditional logit regressions to consider the outcomes of the decisions and decision processes themselves.

Current traffic is the count of ships that visited the port within the five years prior to the time at which the focal captain's ship arrives at that port. This is a key outcome of interest for our analysis. We are interested in whether social networks channel individuals to more or less homogenous outcomes in conditions of uncertainty and stability. We operationalize homogeneity through port traffic. Choosing to travel to a port with high rates of traffic means that an individual is choosing to travel to the same place as a large number of other individuals, thus increasing the homogeneity of choice across the entire system. In this context, clustering is produced if more individuals end up at a heavily trafficked port. If captains choose to go to a port with low traffic rates, this increases the diversity of choice for the system and leads to more heterogeneity as more people are spread out over a larger number of ports.

We use a five-year time frame since smaller period do not capture representative variation between ports, particularly in the early years when traffic was lower; however the same models using two- and three-year periods produced substantively similar results. Thus the variable *current traffic* has one value for each port in each year and is the same across all captains traveling to that port or considering traveling to it.

The concept of uncertainty is measured along two dimensions: war and experience. We operationalize them in the dummy variables *war* and *first voyage* as well as the variable *voyage count*. There were several wars between European powers during the period of the East India Companies, as well as wars with Asian powers. The dummy variable we use, *War*, indicates whether Britain was at war with France, Holland, or both and excludes confrontations with Asian powers, which were confined to land battles and therefore had less impact on the passage of ships. The data was gathered from the Great Powers Wars dataset (Levy 1989). This form of uncertainty operates at the system level, as all those engaged in trade are subject to the vagaries of war. Hence, the variable *war* has one value in any given year and is the same across all captains and ports.

We capture inexperience by tracking the number of voyages captains had previously commanded to the East. This uncertainty operates at the level of the individual, and individuals with different levels of experience are working within the same system concurrently. *First voyage* is a binary variable that captures the first command voyage of the focal captain to the East Indies. While a cumulative measure of experience does not capture the more significant difference between first voyage as captain and subsequent increases in experience, we also present the models using *voyage count*, the sequential number of the current voyage in the career of the focal captain. Thus both experience variables have one value for each captain in each year and are constant across ports.

The variable *social network* is a decision- and port-specific variable indicating whether a particular captain had information about another port via other ships when making the decision about which port to travel to next. That is, when the focal captain k in port i is considering the set of alternative next ports J, we define the dummy variable $social\ network_{ijk}$ for each $j \in J$ to be one if the captain k had in port i encountered another ship who had earlier on the same voyage visited port j and zero otherwise. If the captain had information about a particular port from multiple other ships, we still give the variable the value one.

As an example, consider the hypothetical voyages of three ships, the *Britannia*, *Lord Hawkesbury*, and the *Airly Castle*. Once in the East Indies, the *Britannia* arrived in Madras then traveled to Whampoa, and returned to Madras. The *Airly Castle* arrived in Benkulen, and traveled to Manna and Pring before arriving in Malacca and finally returning to England. The *Hawkesbury* traveled also arrived in Madras, well after the departure of the *Britannia*, then traveled from Penang to Malacca to Pring, and finally to Whampoa, then returned to England. The *Airly Castl*e and the *Hawkesbury* were docked at Malacca at the same time. The *Britannia* and *Hawkesbury* were docked at Whampoa (harbor to Canton) at the same time. Thus the *Airly Castle* was exposed to recent information about Penang at Malacca. The *Hawkesbury* was exposed to recent information about Benkulen, Manna, and Pring at Malacca and then exposed to recent information about Madras at Whampoa. The *Britannia* was exposed to information about Penang, Malacca, and Pring at Whampoa. The only time the social network was activated was when the *Hawkesbury* traveled from Malacca to Pring.

Because information about ports was valuable, some captains may have hoarded information. Perhaps this did occur on occasion; however captains that had just traveled to a port would have less to gain from withholding timely information from others about a port that they were unlikely to return to on the same voyage. The captain that was potentially transmitting information was no longer among the pool of competitors attempting to reach a port before others, in order to get the best price on goods. The captain who held and could transmit information would therefore be more likely to consider the advantage to be gained from the future transfer of information from others – via reciprocated gestures of communication. In any case, our regression models present an empirical test of whether or not the information gathered by other captains impacted the travel path of those exposed.

The data systematically reports only arrival dates, so the exact overlap is unknown in most cases. The total number of completed trips over the history of the organization was 14,065. In 1,012 voyages additional notes in the data recorded the departure date of ships from one or more of the ports visited in the East Indies.[3] Out of a sample of 200 of these voyages, 72 trips had complete information. We used this information to estimate the time it took to travel between ports and the average stay in ports, which became the basis for our calculation of departure times.

Additionally we had to consider that factories could also serve as repositories of information for ships since factors and other merchants and administrators employed by the East India Company held semi-permanents residences at these stations. These actors could hold and transmit information between ships, even when port stays did not actually overlap—although the information would still have to be timely to be useful. We estimated that information stayed in ports for four months after the departure of a ship. The model results are robust to variations of this estimate. There was almost no change in

[3] Port departure often replaced port arrival information.

results based on three and five month storage periods (additional models available on request from authors). A small number of voyages originated in Asia. In these cases we estimated that they gathered in the port four months prior to departure to make preparations.

There are aspects of communication that are not captured by this measure. Most significantly, we can only infer the transfer of positive information about ports, whereas it is likely that positive and negative information about ports was communicated between interested parties. When positive information is transmitted, we can observe whether it had an influence by observing the decision to travel to a port; however each time one port is chosen as a destination, multiple ports are not chosen. This inevitability makes it much more difficult to properly identify negative effects from exposure to information. Although we are observing a process in which, in all likelihood, negative and positive information about ports are transferred between captains, we capture only the net positive impact of social networks. The interpretation of the results also should be limited to reflecting on the positive influence of social networks – persuasion rather than dissuasion.

Information may have also flowed through networks outside of the auspices of the East India Company. There is not systematic data on other merchants' travels, so we cannot include this information in our models. In any case, mechanisms for contact with other merchants are much less clear than in the case of employees of the English East India Company, who either housed together, dined together, or participated in the same social events. Additionally, antagonisms existed across cultural groups, increasing the likelihood that traders within one Company would exchange information with each other, and not across organizational and national boundaries. Finally, the private trade carried on by servants of the English Company was composed of similar goods, which were also different from country trading concerns of merchants confined to the East. English captains generally traded in mechanical trinkets, looking glass, magnifying lenses, and spirits, on their own account. It follows that market information from other captains engaging in a similar trade would be particularly useful. If any peer networks were used in directing the paths of the East India Company ships, it is likely to have been intra-organizational networks of communication between ships; however our results do not extend to other types of peer communication.

We further break down the process of information transfer through social networks by considering strong and weak ties separately. We consider a social network tie between the focal captain and another ship to be activated if the focal captain goes to a port about which he received information from that ship. We then define *strong tie*$_{ijk}$ as we do *social network*$_{ijk}$ but only consider information from another ship if the focal captain had previously activated the tie with that ship. That is, when the focal captain k in port i is considering the set of alternative next ports J, we define the dummy variable *strong tie*$_{ijk}$ for each $j \in J$ to be one if the captain k had in port i encountered another ship who had earlier on the same voyage visited port j and the captain k had earlier acted on the information provided by that other ship. Again, if the captain had information about a particular other port from multiple ships, we still give the variable the value one.

Similarly, we define *weak* tie_{ijk} by considering only other ships if the focal captain had never acted on information carried by them. If the focal captain received information about another port *j* through both strong and weak ties, then both *strong* tie_{ijk} and *weak* tie_{ijk} would get the value one.

An alternative operationalization of strong ties would be measuring captain dyad's total overlap across different ports, i.e., the amount of time they had previously spent together at different ports. Repeated exchange is more strongly linked to the social exchange literature (Emerson 1972) as well as the literature on negative effects of strong ties in organizational theory (Mizruchi and Stearns 2001; Sorenson and Waguespack 2006). Thus we believe capturing past instances in which information was both transmitted and acted upon is the appropriate measurement strategy.

Control Variables: One concern is that instead of strong or weak ties, alter status could be driving the results. Previous research has demonstrated that individuals are more likely to adopt the actions of high status alters (e.g., DiMaggio and Powell 1983). We thus define *alter* $status_{ijk}$ as we do *social* $network_{ijk}$ but consider the status of the other captains from which the information was received. We measured the status of a captain as the number of voyages he had been on (including the current one). Experience and knowledge were extremely valuable in overseas voyages. Mere survival demonstrated aptitude and expertise, thus we expect the count of voyages to be associated with status among captains. When the focal captain *k* in port *i* is considering the set of alternative next ports *J*, we define the variable *alter* $status_{ijk}$ for each $j \in J$ to be the average voyage count of the other captains whom the focal captain encountered in port *i* and whom had been to port *j* previously.[4]

Although captains had a great deal of autonomy once at sea, they were issued orders to visit certain ports on each voyage. We use the dummy variable *formal destination* to capture these ports. We also expect that *personal experience* would have an independent effect on captain's decisions. Captains would both gain information about ports on prior visits, and also form potentially useful commercial relationships. We therefore control for *personal experience*, which is a dummy variable and captures whether the focal captain had traveled to a given port in his past voyages. An additional concern is the level of common knowledge about the ports. We controlled for it using *prior traffic*, defined as the average number of ships per 5 years that had visited the port in the 20 years prior to the current 5-year period.[5] Since the level of activity of the Company varied substantially over the two centuries during which the East India Company was commercially active, we included the control variable *ships at sea*, defined as the count of the number of ships that had left England in the prior five years. We also control for the $distance_{ij}$ between the current port *i* and the destination port *j*. Tables 1a and 1b present summary statistics for all the variables.

----

[4] We also measured alter status as the highest voyage count of the other captains, rather than the average. The results were substantively the same.

[5] Thus, if the current year is 1800, *current traffic* counts the number of visits in the years 1795-1799. *Prior traffic* counts the number of visits in the years 1775-1794 and divides it by four to get the average number over 5-year periods. We varied the window of *prior traffic* between 10 and 50 years. The results were very similar.

Tables 1a & 1b about here

Count Models:

We first consider whether the use of network information under conditions of uncertainty led to more homogenous outcomes. In order to do so, we compare the choices captains made with and without network information across different conditions of uncertainty using a negative binomial regression. This model includes only trips that were taken, so the central question is whether acting on the information they received about ports via their peer network systematically led captains to more or less trafficked ports, i.e. more or less clustered outcomes, under different conditions. If network exchange information led captains to more heavily trafficked ports, we have evidence that network use does indeed produce homogenous outcomes. Thus, the dependent variable is the rate of traffic at those ports chosen as destinations. The unit of analysis is the decision of a captain to travel from port i to port j, and we compare the outcome, namely the rate of traffic at port j, across decisions made at different times. Each observation is a trip from one port to another.

The dependent variable *current traffic* counts the number of recent ships at a port over the past five years, indicating that a count model is appropriate. Both the standard models for count data, the negative binomial and Poisson, have the attractive feature that the conditional expectation of the outcome variable is equal to:

$$E(y_i|\mathbf{x}_i) = e^{\mathbf{x}_i \boldsymbol{\beta}}$$

where y_i is the ith observation of the dependent variable, $\mathbf{x}_i$ is the ith vector of explanatory variables, and $\boldsymbol{\beta}$ is the vector of coefficients. However, while the Poisson distribution implies that the conditional variance is equal to the conditional mean, the negative binomial distribution allows the conditional variance to be larger:

$$Var(y_i|\mathbf{x}_i) = e^{\mathbf{x}_i\boldsymbol{\beta}}(1 + \alpha e^{\mathbf{x}_i\boldsymbol{\beta}})$$

where $\alpha > 0$ is the dispersion parameter. Thus, when the data in question is over dispersed, when $\alpha > 0$ and thus the conditional variance is larger than the conditional mean, the negative binomial model is the appropriate one. We used the negative binomial distribution as the data showed evidence of over dispersion—although the results of these models were substantively very similar.

The probability function of the negative binomial distribution is:

$$P(y_i|\mathbf{x}_i) = \frac{\Gamma(y_i + k)}{\Gamma(k)\Gamma(y_i + 1)}\left(\frac{k}{\mu_i + k}\right)^k \left(1 - \frac{k}{\mu_i + k}\right)^{y_i}$$

where Γ is the gamma function, $k = \alpha^{-1}$, and $\mu_i = e^{\mathbf{x}_i\boldsymbol{\beta}}$. The estimation then proceeds by maximizing the likelihood function:

$$L(y_i|\mathbf{x}_i) = \prod_{i=1}^{N} P(y_i|\mathbf{x}_i)$$

The models include a dummy for each captain to control for the different trade patterns and period effects that each captain encountered. These dummies address the concern that estimates may be biased by some captains having systematically visited more or less heavily trafficked ports based on innate preferences, commercial interests, or simply the time period when they were active. We also added a dummy for the prior port, port i, to control for the range of options available from that port. Otherwise the estimates could be biased if some ports *i* were systematically linked with more frequently trafficked destination ports than some other ports.

Table 2 about here

Table 2 presents the results. Model 1 presents the baseline regression with the control variables. Model 2 introduces our first individual-level measure of uncertainty, *first voyage*, and Model 3 introduces the second individual-level measure of uncertainty, *voyage count*. In this case, as *voyage count* increases, uncertainty is reduced. Model 4 introduces the group-level measure of uncertainty, *war*. *First voyag*e and *voyage count* cannot be included in the same model, so Models 5 and 6 display the results for each combined with the group-level measure of uncertainty.

The tables present clear evidence that the use of social network ties led actors to different outcomes. The coefficient for *social networks* is consistently positive across all models, suggesting that the use of network information led captains to concentrate on more heavily trafficked ports than the baseline of no information. Individual-level uncertainty in and of itself increases the likelihood of choosing a more heavily trafficked port (*first voyage*), whereas increasing experience (*voyage count*), or decreasing uncertainty, increases the likelihood of choosing a less-frequented port. *War* has a different direct effect, increasing the likelihood of going to less heavily trafficked ports – suggesting that captains were avoiding some larger ports in order to reduce risk. This tendency makes substantive sense as major ports were also frequent targets. The interaction between *war* and *social networks* is significant and positive. Thus information transmitted via social network under wartime conditions seems to be leading captains to the remaining viable high-traffic ports. The coefficients for the interactions of *war* on one hand and either *first voyage* or *voyage count* on the other change only slightly when they are added into the same regression. This result suggests that the uncertainty arising at the individual level operates independently from the uncertainty arising at the group level. Together the results support previous findings that using social networks in conditions of uncertainty tends to produce homogenous outcomes and clustering.

Table 3 about here

Table 3 breaks down the social network variable into strong and weak ties, and includes the control variable alter status. The models follow the same structure as in Table 2. The central finding of interest is -- contrary to the expectations of current network theory – there is no tendency for strong ties to be more closely associated with homogenous outcomes than weak ties. In the simplest model both strong and weak ties lead to more homogenous outcomes; however it is weak ties that have a stronger effect. Once a measure of uncertainty is added to the model, strong ties lose their significance.

We are centrally concerned however not with the direct effect of social exchange, but how individuals use social ties in conditions of uncertainty. Individual and group-level uncertainty operate differently in this regard. We first consider individual-level uncertainty, captured by *first voyage* and *voyage count*. *First voyage* is associated with clustered behavior, gravitating towards more heavily-trafficked ports, whereas individuals with increasing experience, i.e. reduced uncertainty, prefer less heavily trafficked ports. The interaction between strong ties and both *first voyage* and *voyage count* is insignificant, whereas the interaction between weak ties and *first voyage* is significant and positive and the interaction between weak ties and *voyage count* is significant and negative. These results suggest that individuals are both using weak ties differently than strong ties and using weak ties differently depending on the degree of experience they have. Rather than rely on strong ties, captains appear to rely on weak ties in uncertainty, but use them to travel to more heavily trafficked ports.

The different types of network ties also interact significantly with the group-level uncertainty, *war*. Both strong and weak ties are associated with homogenous outcomes, which is the opposite of the direct effect of *war*, with weak ties having a larger effect. This finding reinforces the results from Table 2, where social network use in group-uncertainty is used to navigate to the remaining safe havens. Alter status however is associated with less homogenous outcomes, indicating that in times of war, captains are willing to follow experienced captains to a more diverse range of ports.

The count models establish an association between network use and clustered outcomes under conditions of uncertainty. Contrary to expectation, in this time period, they show that it is not repeated exchange that drives this association, but instead one-shot exchange indicating that tie strength is not associated with an increase in the effect of social exchange on behavior, measured via travel to different types of ports. There is no evidence that social exchange leads to more diverse outcomes for captains.

Choice Models

In this section we model the decision-process of captains in order to identify the mechanisms producing the association between one-shot exchange and homogenous outcomes since this association is not explained by existing theory on strong and weak ties. One explanation is the tendency for individuals to focus in on more familiar options when making decisions under conditions of uncertainty. In other words, the evaluation of the alternatives could be directly affected by uncertainty and simply manifested in the choice of alternatives presented via social exchange. This analysis allows us to consider whether the decision-process is affected by the transmission of information via strong or weak ties, thus illuminating the valence of these different types of exchange. Our interpretation is that if ties alter the interpretation of information at the decision-level, this indicates that they have meaning for individuals independent of the information carried by them as vehicles of trust or influence as well as information. We explore this possibility with a conditional logit discrete-choice model.

In the conditional logit we look at the factors that lead captains to make a particular choice. Instead of comparing across decision moments at different points in time as we did previously, the conditional logit centers its comparison on the decision made versus the possible alternative decisions that could have been made at that time. In this case, the model compares the port to which the captain chose to travel against the set of ports that were not chosen.

The conditional logit is the most effective way to model decision processes, thereby capturing effects such as the tendency to choose popular outcomes from a range of choices. There are disadvantages however. The first is that the outcome variable is the decision whether or not to travel to a given port. This means that in order to capture our main theoretical concern, which is the relationship between uncertainty, network exchange, and the traffic rate at different ports, we must rely on three-way interactions. Thus the interaction terms included in the model will be of central interest to our analysis. Interaction terms are informative, but retain some indeterminacy in terms of the source of the effect and are thus difficult to interpret.

In the conditional logit model we are analyzing which of a set of potential alternatives was chosen. McFadden originally proposed this approach (1974). The model conditions on the characteristics that are common across all choices and only alternative-specific variables directly enter the regression. Variables that are common across choices include in particular those related to the time period, the current port *i*, and the captain. Hence, for instance the main effects of *ships at sea, war*, *first voyage*, and *voyage count* do not enter into the regressions. To assess how these variables might have influenced the evaluation of alternatives, we use interactions of these variables with the alternative-specific variables. That is, to see if *war* influenced the evaluation of distance from the current port *i* to the alternative port *j*, the product $distance_{ij}$ x *war* is used.

The conditional logit model requires the specification of the choice set, i.e., a list of all the alternative ports the captain could have gone to instead of the chosen port. We use two criteria in constructing the choice set. First, ports enter the choice set five years before the first visit to that port from any other port and exit it five years after the last visit to the port. These are the ports that are considered to be active at the time. Second, we exclude from each choice set any ports that were never visited from the current port.

The conditional logit has a relatively straightforward structure. Given a set of *M* alternatives, a vector $\mathbf{x}_{ij}$ of variables related to the *j*th alternative in the *i*th decision moment, and a vector $\boldsymbol{\beta}$ of coefficients, the probability of choosing alternative *j* is:

$$p_{ij} = \frac{e^{\mathbf{x}_{ij}\boldsymbol{\beta}}}{\sum_{l=1}^{M} e^{\mathbf{x}_{il}\boldsymbol{\beta}}}$$

The estimation then is by maximum likelihood, i.e., choosing the vector of coefficients to maximize the probability of the observed choices.

Table 4 about here

Table 4 presents the results. Model 1 gives the baseline. Model 2 adds the two-way interactions between the network variables and *current traffic*. Models 3 through 5 add the three-way interactions between network variables, port traffic, and uncertainty, as well as the remaining two-way interactions.

The first relevant finding is that social network ties, strong and weak, have a consistently positive and highly significant effect, suggesting that information collected via social ties positively affected a captain's decision to travel to a port. This reinforces the importance of understanding how network ties are used in this context as they did have an impact on the conduct of trade. The difference in the values of the coefficients between strong and weak ties suggests that strong ties in particular were important in guiding the choices of captains. The interaction between both social network variables and *current traffic*, however, is both negative and significant. The coefficient is small, as are all the interactions between social ties, uncertainty, and port traffic. Our interpretation of these coefficients is not intended to motivate how ports were chosen, but instead how social network ties were mobilized in the process of choosing a port – with the understanding that network use only explains a portion of travel to specific ports. Thus we are interested in the direction and significance of the coefficients more than the size of the effect.

The coefficients for the interaction between strong and weak ties and current port traffic are negative, indicating a reduced likelihood of traveling to a port. Whereas the negative binomial model results presented in Table 2 indicate that when presented with information via social network ties individuals were more likely to travel to more heavily trafficked ports—compared to when they had no information. The results from the conditional logit suggest that given the information and range of possible options available to them at one port at one point in time, individuals did not prefer to use network information to travel to more heavily trafficked ports. A more nuanced picture emerges when we consider the remaining interactions.

The significant and positive interaction between *current traffic* and *first voyage* in Model 3 indicates that inexperienced captains were more likely to choose heavily-trafficked ports. The results also suggest that inexperienced captains were more likely to use the information of high-status alters (the interaction of *alter status* and *first voyage* is positive and significant). However, inexperience did not alter the relationship of port traffic and either type of social network ties – the interaction between *first voyage*, *current traffic*, and both strong and weak ties is insignificant. Thus there is no evidence that social network ties altered inexperienced captains existing preferences for more heavily trafficked ports.

Model 4 considers the impact of group-level uncertainty, *war*, on captains' decisions. Under conditions of wartime, only weak ties had a positive influence on the likelihood of traveling to a port – this seems to indicate that information about viable ports was more likely to flow through weak ties. However, the interactions between group-level uncertainty, measured through *war*, *current traffic,* and both strong and weak ties are not significant. Again, the models provide no evidence that information transmitted via networks changed captains behavior by leading to more or less heterogeneous outcomes under conditions of uncertainty, though there is evidence that captain's preferences for more or less heterogeneous outcomes changed under conditions of uncertainty.

Information Environments

The decisions made by captains were also likely to have been affected by the overall distribution of information available to them. In this last stage of analysis, we consider the distribution of information flowing through the network. Specifically we are interested in how the distribution of information available to actors may systematically differ under conditions of uncertainty versus certainty and therefore be confounded with the decisions of the actors themselves.

The effects of the information context are not effectively captured by the conditional logit. The conditional logit evaluates decisions based on the range of information available, but not how the range of choices itself can change under different circumstances. In this case, the overall flow of information across all ports may have changed across conditions of certainty and uncertainty or, additionally, since more or less heavily frequented ports produce different information contexts for individuals, they may choose the make decisions in different contexts under conditions of uncertainty. For example, it may be that individuals choose to act on information from social networks at ports that present a larger range of options when faced with uncertain circumstances.

Figure 1 about here

The data allows for an examination of the information about ports as it flows across the network. We first consider whether the total information differs across conditions of war and peace. Figure 1 presents a box plot of the average rate of traffic of ports for the previous five years. This average is of the ports that captains are exposed to via social networks – meaning while they are at port with captains who have recently traveled to these other ports. The box plot compares 0,1 conditions, where 0 indicates peace and 1 indicates war for roughly three 80 year periods, meaning it captures 1600 to 1680, 1680 to 1760, and 1760 to 1833, at which time outbound commercial voyages of the Company ended. The plot makes evident during war, particularly in the first and last eighty-year periods, captains were exposed to different ranges of information about ports during war. The distribution of traffic rates is higher in conditions of war, with the exception of the second eighty-year period. This period, in fact, was one of extended stability, during which much less time was spent in war than in the first and last periods. The plot indicates that the information flowing through the network during times of war was systematically skewed toward more heavily trafficked ports. This makes substantive sense because war encouraged greater concentration on a smaller number of ports, both because ports under enemy control fell out of the list of viable options and because the use of convoys increased clustering.

Figure 2 about here

Figure two uses the same method to evaluate changes in the overall distribution of information across different levels of captains' experience. Although inexperienced captains are always at sea with more experienced captains, and therefore the overall network conditions could not vary across populations, if inexperienced captains travel to more heavily trafficked ports – or some other set of ports defined or associated with a certain traffic rate – this could produce systematic variation in the information to which they are exposed. The distribution captures average traffic rates of ports to which captains are exposed via social networks. The three clusters, labeled PI, P2, and P3, refer to the same three eighty-year periods used above. Within clusters the plots are divided across the experience level of the captain measured by the number of the current voyage. There is no consistent trend within clusters other than an increase in port traffic across the periods, as expected given the increase in the number of ships out. Inexperienced captains, however, are not given on average more information about more heavily-trafficked ports; indeed, if anything the opposite holds true: more experienced captains are exposed more often to information about ports with heavier traffic. Thus the total distribution of information across the network cannot account for the relationship between inexperience, social networks use, and homogenous outcomes; although it can help explain the relationship between war, social networks, and clustered outcomes.

Figures 1 and 2 considered the information distribution across all ports without taking in to account whether captains activated their social networks at those ports or not. Figure 3 considers if there is a systematic difference in the type of information environment in which captains activated social networks, meaning they acted on information transmitted to them via other ships when exposed to information about a range of different types of ports. For example, inexperienced captains may have only activated their networks when the information contained news of the most heavily trafficked ports. The information content under consideration is still the distribution of the average rate of traffic at ports over the past five years. As before, the bins capture the average rate of traffic of the total ports captains were exposed to at each decision moment. The distribution is composed of the average at different decision moments. The comparison of interest is across pairs of bins. The light bin captures the information distribution at moments when captains did not activate social networks by accessing information held by other captains at the same port. The dark bin captures the information distribution at moments when captains did activate social networks. There is a pair of light and dark bins for each level of experience attained by captains, again measured by the number of voyages taken.

Figure 3 about here

Although the difference is small, in all cases except the first voyage, captains activate networks when the average rate of traffic is lower at the ports to which they have been exposed to information. That is, captains with more experience are more likely to use information transmitted across social ties when they hear about relatively less traveled ports. However, the opposite is true of captains on their first voyage. These captains have a unique tendency to activate their social networks when they are getting information that is skewed towards more heavily trafficked ports.

Discussion:

Putting the three sets of findings together across the different types of analyses gives us a much clearer idea of the mechanisms behind the relationship between uncertainty, clustering, and social exchange. Up to this point the literature in social networks on the effects of uncertainty has hypothesized that uncertainty produces homogenous outcomes because individuals rely upon strong ties in uncertain circumstances; the strong ties lead to closure and clustering in the structure of the network which leads in turn to feedback loops and redundancy, thus reducing the overall diversity of information circulating through that portion of the network. Although there is evidence that network exchange produces clustered outcomes, we find very little evidence that repeated exchange played an important role in producing those outcomes. There is also little evidence that social exchange build in enough trust or influence to push individuals to explore more diverse options.

The results of the conditional logit present evidence of individuals turning to strong ties for information, but their use is not associated with more or less homogenous outcomes. The only time we find any significant association between clustering and strong ties use is in a model that excludes any measure of group-level uncertainty (*war*). Indeed in the conditional logit, the negative interaction between *current traffic* and *strong ties* indicates that given the range of options available to them, strong ties (as well as weak ties) were less likely to lead individuals to more homogenous outcomes, i.e. more frequented ports.

In this data individuals have less strong than weak ties, thus the information diversity carried by weak ties will be greater than that carried by strong ties; however the range of information across strong and weak ties appears to be enough to allow individuals to pick out more diverse or more homogenous options from both under the right conditions. This condition is likely to hold in at least a significant proportion of possible empirical settings, such as, for example, an individual polling friends for new restaurant recommendations.

If we consider how uncertainty moderates the use of social ties, we do see that the sign of coefficients are the often reverse of what occurs under conditions of stability; however these results again do not support current theory extrapolated from the structural role of weak ties in transmitting novel information. Given current theory, we should expect individuals faced with uncertainty to turn to trusted social ties – i.e. strong ties – particularly those ties that they have used or activated before in the past. Given that these strong ties present them with a smaller range of information than weak ties, we should expect more clustered outcomes. What we observe is that individuals use social ties differently under conditions of uncertainty, but this seems to manifest a pre-existing preference which is a blanket response to uncertainty rather than a predilection for certain types of ties.

Linking back to the findings, we consider individual level uncertainty (*first voyage* and *voyage count*) first. As expected from current theory, uncertainty leads to more homogenous outcomes and greater experience (or knowledge) leads to more diverse outcomes, however this change has little to do with the alternating use of strong and weak ties. Instead the results indicate that weak ties are used differently under conditions of uncertainty and experience. At the level of the decision process, comparing across possible trips in the conditional logit, there is no significant interaction between uncertainty, network ties (strong or weak), and the traffic rate at destination ports, indicating that receiving information from social interactions does not change the way individuals act on information. Instead, there is evidence that inexperienced captains simply prefer more popular ports – consistent with the implications of prospect theory and the cognitive evaluation of options. The results suggest that this bias operates with or without the presence of social ties. This pre-existing bias perhaps also explains the slight difference observed in patterns of tie activation in the section on information context, where the plots indicate that only captains on their first voyage are likely to activate ties when exposed information about ports with higher average traffic. Thus there is little evidence that ties function independently to change behavior. Instead they seem to serve as vehicles for information that allow individuals to manifest pre-existing preferences for certain types of outcomes (by using the information presented to them in that context).

Similar results, relative to our central questions, hold for group-level uncertainty (*war*). Again, uncertainty is associated with more homogenous outcomes when we compare across the trips taken by captains. And again, this result is not related to an alternation between preferences for strong and weak ties. Instead both strong and weak ties are associated with more homogeneous outcomes. At the level of the decision-process, given the range of options available to captains, there are no significant interactions between war, information transferred via social ties (strong or weak), and traffic rates at destination ports. War is associated, however, with a preference for avoiding more heavily trafficked ports. Therefore it is somewhat puzzling what could produce the reversal of sign when individuals use social network ties to travel to more frequented ports, a significant relationship in the negative binomial. The plots of the kinds of information traveling across social ties under wartime conditions offer the only plausible explanation in the absence of network effects. The distribution of information flowing across social ties was systematically skewed towards more heavily trafficked ports in war, thus affected the range of information available to individuals about possible options. Again, these results indicate that it was not the interpretation of information transmitted via social ties that shifted under conditions of uncertainty, but instead the information itself.

CONCLUSION

This research explores how early modern actors used information gathered through social ties by identifying the extent to which exposure to information via social interactions influenced subsequent behavior in conditions of greater and lesser uncertainty. We considered whether repeated exchange and one-shot exchange systematically affected behavior by driving individuals to more or less heavily-frequented ports and weak ties use associated with diverse outcomes. We then built a model of the decision-process and considered the flow of information through the system under different conditions to further investigate the mechanisms behind the association between uncertainty, social exchange and clustering that we observed in the data.

The evidence is consistent in indicating that a preference for repeated exchange is *not* the strongest force driving the clustering that occurs under uncertainty in the trade network. Instead, weak ties, or one-shot exchanges, are more strongly associated with clustered outcomes. Indicating that the affective content of a tie, i.e. a relationship of trust or influence embedded in strong ties, is not driving behavior the way we would expect based on current network theory. We investigated the decision process in order to identify whether individuals were using the information transmitted through social ties differently under conditions of uncertainty. We found no evidence that social network transmission was affecting how information was used. Instead, the clustering we observed in one case appeared to derive mainly from an unmediated reaction to uncertainty in which individuals simply preferred more homogenous outcomes. In the other case of group-level uncertainty, individuals skewed towards more heavily trafficked ports, but this was the result of a system level change in the distribution of information that traveled through both one-shot and repeated types of exchange. Both results are consistent in suggesting that networks functioned as conduits of information, not vehicles of trust or influence with the ability to alter behavioral patterns.

The analysis we undertook therefore illuminates both the meaning and function of social exchange in the early-modern world of overseas trade and indicates limits to the generalizability of the theory of weak ties. Consistent with research that ascribes less emotional content to social ties in the pre-modern world and a more strategic orientation to relations (McLean 2007; Silver 1989 1990), we find evidence that ties in this context are better interpreted as tools for the transmission of information rather than transformative vessels affecting the judgment of individuals. This finding is particularly interesting as the English East India Company was one of the first organizations to take on the company form as the societies of England and Europe were reorganizing from systems of feudal patronage to formal organizational structures bound by rules and regulations rather than bonds of mutual obligation.

The English East India Company, however, is an interesting site for research not only because its records provide us with a systematic look into commercial practices prior to the Industrial Revolution, but also because the historical nature of the data provides an opportunity to test the generalizability of theories linking uncertainty and network dynamics. Considering how this association works in different historical periods and commercial contexts is one way to explore whether key mechanisms remains the same over different historical, cultural, and institutional circumstances. If the same mechanisms are operational, we have greater reason to believe they will hold true in the future. If it does not hold, we are closer to understanding what types of contextual factors play a role in producing the mechanism we have observed in the recent past. Thus, analysis of historical data contributes to cross-cultural comparisons of trust and social exchange processes (Barr, Ensminger, and Johnson 2009).

Finally, by incorporating the idea of cognitive processes and decision-making into our model of network processes we contribute to a long-standing effort to incorporate micro-level mechanisms and psychological research into the study of network processes (Carley 1989; Casciaro and Lobo 2008; DiMaggio 1997; Strang and Macy 2001) and a newer emphasis on exploring how micro-level processes produce collective outcomes (Hedström 2005; Hedström and Bearman 2009; Demeulenaere 2011).

REFERENCES

Adams, Julia. 1996. “Principals and Agents, Colonialists and Company Men: The Decay of Colonial Control in the Dutch East Indies” *American Sociological Review*:12-28.

Adams, Julia. 2005. *The Familial State: Ruling Families and Merchant Capitalism in Early Modern Europe*. Ithaca: Cornell University Press.

Aral, Sinan, and Marshall Van Alstyne. 2011. "The Diversity-Bandwidth Trade-off." *American Journal of Sociology* 117(1):90-171.

Barabasi, Albert-Laszlo, and Eric Bonabeau. 2003. "Scale-Free Networks." *Scientific American* 288(5):60-69.

Barr, Abigail, Jean Ensminger, and Jeffrey C. Johnson. “Social Networks and Trust in Cross-Cultural Economic Experiments” in Whom Can We Trust? How Groups, Networks, and Institutions Make Trust Possible; New York: Russell Sage Foundation.

Bearman, Peter S. 1993. *Relations into Rhetorics: Local Elite Social Structure in Norfolk, England, 1540-1640*. New Brunswick, N.J.: Rutgers University Press.

Bowen, H.V. 2007. "Privilege and Profit: Commanders of East Indiamen as Private Traders, Entrepreneurs, and Smugglers." *International Journal of Maritime History* XIX(2):43-88.

Brass, Daniel J., Joseph Galaskiewicz, Henrich R. Greve, and Wenpin Tsai. 2004. "Taking Stock of Networks and Organizations: A Multilevel Perspective." *The Academy of Management Journal* 47(6):795-817.

Burt, Ronald S. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, Mass.: Harvard University Press.

Buskens, Vincent. 2002. *Social Networks and Trust*. Vol 30. Kluwer Academic.

Carley, Kathleen. 1989. “The Value of Cognitive foundations for Dynamic Social Theory.” *Journal of Mathematical Sociology*, 14.2-3:171-208.

Carruthers, Bruce G. "Homo Economicus and Homo Politicus: Non-Economic Rationality in the Early 18th century London Stock Market." *Acta Sociologica* 37.2 (1994):165-194.

Casciaro, Tiziana and Miguel Sousa Lobo. 2008. “When Competence is Irrelevant: The Role of Interpersonal Affect in Task-Related Ties” *Administrative Science Quarterly* 53(4):655-684.

Centola, Damon and Michael Macy. 2007. "Complex Contagions and the Weakness of Long Ties." *American Journal of Sociology* 113(3):702-734.

Chaudhuri, K.N. 1978. *The Trading World of Asia and the English East India Company, 1660-1760*. Cambridge, New York: Cambridge University Press.

Coleman, James S. 1990. *Foundations of Social Theory*. Cambridge and London: Belknap Press.

Demeulenaere, Pierre. 2011. *Analytical Sociology and Social Mechanisms*. Cambridge University Press.

DiMaggio, Paul. 1987. "Classification in Art." *American Sociological Review* 52(4):440-55.

DiMaggio, Paul. 1997. "Culture and Cognition." *Annual Review of Sociology* 23:263-87.

DiMaggio, Paul and Hugh Louch. 1998. "Socially Embedded Consumer Transactions: For What Kinds of Purchases do People Most Often Use Networks?" *American Sociological Review*:619-637.

DiMaggio, Paul J., and Walter W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." *American Sociological Review* 48(2):147-60.

Erickson, Bonnie H. 1996. "Culture, Class, and Connections." *American Journal of Sociology* 102(1):217-51.

Gibson, David R. 2008. "How the Outside Gets in: Modeling Conversational Permeation." *Annual Review of Sociology* 34:359-84.

Goldberg, Jessica. 2012. *Trade and Institutions in the Medieval Mediterranean: The Geniza Merchants and their Business World*, Cambridge, UK: Cambridge University Press.

Goldstein, Daniel G., and Gerd Gigerenzer. "Models of Ecological Rationality: The Recognition Heuristic." *Psychological Review* 109.1 (2002):75.

Granovetter, Mark S. 1978. "Threshold Models of Collective Behavior." *American Journal of Sociology* 83(6):1420-43.

Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78(6):1360-80.

Granovetter, Mark S. 1974. *Getting a Job*. Chicago: University of Chicago Press.

Granovetter, Mark. 1983. "The Strength of Weak Ties: A Network Theory Revisited." *Sociological Theory* 1:201-33.

Grassby, Richard. 1995. *The business community of seventeenth-century England*. Cambridge England; New York: Cambridge University Press.

Greif, Avner. 1989. "Reputation and Coalitions in Medieval Trade - Evidence on the Maghribi Traders." *Journal of Economic History* 49(4):857-82.

Greif, Avner. 2006. *Institutions and the Path the Modern Economy: Lessons from Medieval Trade*, Cambridge, UK: Cambridge University Press.

Hedström, Peter. 2005. *Dissecting the Social: On the Principles of Analytical Sociology*. Cambridge, UK; New York: Cambridge University Press.

Hedström, Peter, and Peter Bearman. 2009. *The Oxford Handbook of Analytical Sociology*. Oxford; New York: Oxford University Press.

Kollock, Peter. 1994. "The Emergence of Exchange Structures: An Experimental Study of Uncertainty, Commitment, and Trust." *American Journal of Sociology* 100(2): 313-45.

Lawler, Edward J., and Jeongkoo Yoon. 1996. "Commitment in Exchange Relations: Test of a Theory of Relational Cohesion." American Sociological Review 61(1):89-108.

Levi, Margaret and Laura Stoker. 2000. "Political Trust and Trustworthiness" *Annual Review of Political Science* 3:475-507.

Lin, Nan. 2001. *Social Capital: A Theory of Social Structure and Action.* Cambridge, UK; New York: Cambridge University Press.

Lizardo, Omar. 2006. "How Cultural Tastes Shape Personal Networks." *American Sociological Review* 71(5):778-807.

Macy, Michael W. 1991. "Chains of Cooperation: Threshold Effects in Collective Action." *American Sociological Review* 56(6):730-47.

McFadden, D. L. 1974. "Conditional Logit Analysis of Qualitative Choice Analysis." In *Frontiers in Econometrics*, ed. P. Zarembka. New York: Academic Press:105-142.

McLean, Paul. 1998. "A Frame Analysis of Favor Seeking in the Renaissance: Agency, Networks, and Political Culture." *American Journal of Sociology* 104(1):51-91.

—. 2007. *The Art of the Network: Strategic Interaction and Patronage in Renaissance Florence*. Raleigh, North Carolina: Duke University Press.

Merton, Robert K. 1968. "The Matthew Effect in Science." *Science* 159(3810):56-63.

Mizruchi, Mark S., and Linda Brewster Stearns. 2001. "Getting Deals Done: The Use of Social Networks in Bank Decision-Making." *American Sociological Review* 66(5):647-71.

Molm, Linda D., Nobuyuki Takahashi, and Gretchen Peterson. 2000. "Risk and Trust in Social Exchange: An Experimental Test of a Classical Proposition." *American Journal of Sociology* 105(5):1396-427.

Molm, Linda D., Monica M. Whitham, and David Melamed. 2012. "Forms of Exchange and Integrative Bonds: Effects of History and Embeddedness" *American Sociological Review*, 77 (1):141-165.

Padgett, John F. 2012. "Country as Global Market: Netherlands, Calvinism, and the Joint-Stock Company"." Pp. 208-34 in *The Emergence of Organizations and Markets*, edited by John F. and Walter W. Powell Padgett. Princeton & Oxford: Princeton University Press.

Podolny, Joel M. 1994. "Market Uncertainty and the Social Character of Economic Exchange." Administrative Science Quarterly 39(3):458-83.

Schelling, Thomas C. 1960. *The Strategy of Conflict.* Cambridge, MA: Harvard University Press.

Silver, Allan. 1989. "Friendship and Trust as Moral Ideals: An Historical Approach" *European Journal of Sociology*, 30:274-297.

Silver, Allan. 1990. "Friendship in Commercial Society: Eighteenth-Century Social Theory and Modern Sociology." *American Journal of Sociology* 95(6):1474-504.

Smith, Edward Bishop, Tanya Menon, and Leigh Thompson. 2011. "Status Differences in the Cognitive Activation of Social Networks." *Organizational Science* Articles in Advance:1-16.

Sood, Gagan. 2007. "'Correspondence is Equal to Half a Meeting': The Composition and Comprehension of Letters in Eighteenth-Century Islamic Eurasia" *Journal of the Social and Economic History of the Orient*, 50 (2-3):172-214.

Sorenson, Olav, and Toby E. Stuart. 2008. "Bringing the Context Back In: Settings and the Search for Syndicate Partners in Venture Capital Investment Networks." *Administrative Science Quarterly 53*(2):266–294.

Sorenson, Olav, and David M. Waguespack. 2006. "Social Structure and Exchange: Self-Confirming Dynamics in Hollywood." *Administrative Science Quarterly* 51(4):560-89.

Stuart, Toby E., and Olav Sorenson. 2003. "The geography of opportunity: Spatial heterogeneity in founding rates and the performance of biotechnology firms." *Research Policy* 32(2):229-53.

Sutton, Jean. 1981. *Lords of the East: The East India Company and its Ships*. London: Conway Maritime Press.

Sutton, Jean. 2010. *The East India Company's Maritime Service, 1746-1834: Masters of the Eastern Seas*; Suffolk, UK: Boydell Press.

Uzzi, Brian. 1999. "Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing" *American Sociological Review*:481-505.

Watts, Duncan J. 1999. "Networks, Dynamics, and the Small-World Phenomenon." *American Journal of Sociology* 105(2):493-527.

White, Douglas R., and Michael Houseman. 2002. "The navigability of strong ties: Small worlds, tie strength, and network topology." *Complexity* 8 (1):72-81.

Yamagishi, Toshio, Karen S. Cook, and Motoki Watabe. 1998. "Uncertainty, Trust, and Commitment Formation in the United States and Japan." *American Journal of Sociology* 104(1):165-94.

Table 1a: Summary statistics for count models

	Mean	S.D.	Min	Max
Ships at Sea	130.06	77.34	1.00	272.00
Distance	1642.13	1865.60	3.25	12404.25
Current Traffic	33.85	31.87	0.00	157.00
Prior Traffic	25.50	25.66	0.00	119.75
Formal Orders	0.30	0.46	0	1
Personal Experience	0.28	0.45	0	1
Social Networks	0.28	0.45	0	1
Strong Tie	0.09	0.28	0	1
Weak Tie	0.23	0.42	0	1
Alter Status	1.87	5.28	0	66
First Voyage	0.44	0.50	0	1
Voyage Count	2.25	1.56	1	11
War	0.56	0.50	0	1

Table 1b: Summary statistics for choice models

	Mean	S.D.	Min	Max
Distance	2659.10	2096.90	3.25	12404.25
Current Traffic	11.42	20.01	0.00	157.00
Prior Traffic	9.80	16.49	0.00	119.75
Formal Orders	0.05	0.21	0	1
Personal Experience	0.09	0.29	0	1
Social Networks	0.15	0.35	0	1
Strong Tie	0.03	0.17	0	1
Weak Tie	0.13	0.33	0	1
Alter Status	0.89	3.65	0	82
First Voyage	0.42	0.49	0	1
Voyage Count	2.27	1.53	1	11
War	0.57	0.49	0	1

Table 2: Negative binomial regression of current rate of traffic at chosen port

	(1)	(2)	(3)	(4)	(5)	(6)
Ships at Sea	0.00231**	0.00275**	0.00289**	0.00255**	0.00303**	0.00314**
	(5.72)	(6.76)	(6.87)	(6.56)	(7.85)	(7.86)
Distance (log)	0.00347	0.00508	0.00397	0.00280	0.00455	0.00336
	(0.43)	(0.63)	(0.50)	(0.35)	(0.57)	(0.42)
Prior Traffic	0.0245**	0.0245**	0.0247**	0.0245**	0.0245**	0.0246**
	(36.34)	(36.24)	(36.68)	(36.53)	(36.40)	(36.89)
Formal Destination	0.339**	0.328**	0.325**	0.340**	0.328**	0.325**
	(15.10)	(14.65)	(14.44)	(15.10)	(14.63)	(14.41)
Personal Experience	0.221**	0.291**	0.285**	0.216**	0.290**	0.281**
	(12.18)	(13.70)	(12.73)	(12.10)	(13.72)	(12.74)
Social Networks	0.268**	0.226**	0.331**	0.168**	0.138**	0.229**
	(17.08)	(11.77)	(11.85)	(6.85)	(5.22)	(7.03)
First Voyage		0.126**			0.139**	
		(5.09)			(5.74)	
Social Networks x First Voyage		0.0934**			0.0789**	
		(3.27)			(2.77)	
Voyage Count			-0.0403**			-0.0420**
			(-4.64)			(-5.01)
Social Networks x Voyage Count			-0.0292**			-0.0266**
			(-2.89)			(-2.71)
War				-0.164**	-0.174**	-0.166**
				(-6.72)	(-7.17)	(-6.90)
Social Networks x War				0.164**	0.155**	0.159**
				(5.25)	(4.94)	(5.08)
Log-likelihood	-54044.3	-54002.3	-54005.4	-54006.1	-53961.0	-53966.5
Captains	1562	1562	1562	1562	1562	1562
Observations	13668	13668	13668	13668	13668	13668

Constant, captain dummies, and previous port dummies included but not reported. Robust standard errors clustered by captain. *t*-statistics in parentheses. * $p < 0.05$, ** $p < 0.01$

Table 3: Negative binomial regression of current rate of traffic at chosen port

	(1)	(2)	(3)	(4)	(5)	(6)
Ships at Sea	0.00227**	0.00269**	0.00284**	0.00249**	0.00296**	0.00307**
	(5.64)	(6.66)	(6.74)	(6.42)	(7.69)	(7.66)
Distance (log)	0.00280	0.00428	0.00314	0.00281	0.00436	0.00322
	(0.35)	(0.54)	(0.40)	(0.35)	(0.55)	(0.41)
Prior Traffic	0.0244**	0.0244**	0.0245**	0.0245**	0.0245**	0.0246**
	(35.89)	(35.83)	(36.27)	(36.23)	(36.14)	(36.63)
Formal Destination	0.341**	0.331**	0.328**	0.338**	0.327**	0.325**
	(15.15)	(14.73)	(14.51)	(15.04)	(14.59)	(14.38)
Personal Experience	0.222**	0.289**	0.283**	0.216**	0.288**	0.278**
	(12.16)	(13.65)	(12.61)	(12.08)	(13.69)	(12.60)
Strong Tie	0.167**	0.176**	0.131**	0.0403	0.0432	0.00456
	(7.59)	(6.16)	(3.30)	(1.01)	(0.99)	(0.09)
Weak Tie	0.222**	0.168**	0.308**	0.0458	0.00585	0.131**
	(12.58)	(7.91)	(9.34)	(1.52)	(0.19)	(3.17)
Alter Status	0.00221	0.00273	0.000248	0.0238**	0.0244**	0.0212**
	(1.42)	(1.49)	(0.09)	(4.65)	(4.75)	(3.91)
First Voyage		0.126**			0.140**	
		(5.10)			(5.80)	
Strong Tie x First Voyage		-0.0292			-0.0268	
		(-0.63)			(-0.59)	
Weak Tie x First Voyage		0.121**			0.105**	
		(3.69)			(3.22)	
Alter Status x First Voyage		-0.00165			-0.00130	
		(-0.57)			(-0.48)	
Voyage Count			-0.0401**			-0.0422**
			(-4.68)			(-5.12)
Strong Tie x Voyage Count			0.0151			0.0138
			(1.03)			(0.95)
Weak Tie x Voyage Count			-0.0393**			-0.0361**
			(-3.29)			(-3.06)
Alter Status x Voyage Count			0.000753			0.000896
			(0.91)			(1.12)
War				-0.151**	-0.162**	-0.154**
				(-6.21)	(-6.71)	(-6.40)
Strong Tie x War				0.158**	0.163**	0.161**
				(3.26)	(3.37)	(3.31)
Weak Tie x War				0.247**	0.238**	0.239**
				(6.74)	(6.53)	(6.59)
Alter Status x War				-0.0250**	-0.0251**	-0.0246**
				(-4.65)	(-4.73)	(-4.54)
Log-likelihood	-54042.9	-54000.3	-54003.4	-53997.0	-53950.7	-53957.2
Captains	1562	1562	1562	1562	1562	1562

Observations	13668	13668	13668	13668	13668	13668

Constant, captain dummies, and previous port dummies included but not reported. Robust standard errors clustered by captain. *t*-statistics in parentheses. * $p < 0.05$, ** $p < 0.01$

Table 4. Conditional Logit Regression of Decisions to Travel to a Port

	(1)	(2)	(3)	(4)	(5)
Distance (log)	-0.437**	-0.437**	-0.438**	-0.437**	-0.438**
	(-71.41)	(-71.54)	(-71.34)	(-70.40)	(-70.16)
Current Traffic	0.0252**	0.0304**	0.0274**	0.0323**	0.0295**
	(36.83)	(40.17)	(31.77)	(32.29)	(27.74)
Prior Traffic	0.00420**	0.00284**	0.00276**	0.00265**	0.00255*
	(4.28)	(2.88)	(2.81)	(2.66)	(2.56)
Formal Orders	1.317**	1.264**	1.255**	1.268**	1.258**
	(44.79)	(42.94)	(42.64)	(43.20)	(42.85)
Personal Experience	0.665**	0.639**	0.742**	0.636**	0.740**
	(15.66)	(15.25)	(16.46)	(15.12)	(16.37)
Strong Tie	0.787**	1.071**	1.133**	1.230**	1.264**
	(14.40)	(16.35)	(12.66)	(10.86)	(10.08)
Weak Tie	0.213**	0.561**	0.494**	0.324**	0.274**
	(5.97)	(11.88)	(7.42)	(3.79)	(2.82)
Alter Status	-0.0438**	-0.0120	-0.0257**	0.0436**	0.0318*
	(-13.81)	(-1.57)	(-2.61)	(2.97)	(1.96)
Strong Tie x Current Traffic		-0.00933**	-0.00993**	-0.0125**	-0.0126**
		(-7.11)	(-5.84)	(-3.84)	(-3.71)
Weak Tie x Current Traffic		-0.0125**	-0.0116**	-0.00924**	-0.00853**
		(-13.56)	(-10.09)	(-4.80)	(-4.13)
Alter Status x Current Traffic		-0.000221+	-0.0000959	-0.00186**	-0.00176**
		(-1.93)	(-0.67)	(-5.60)	(-5.08)
First Voyage x Current Traffic			0.00713**		0.00730**
			(6.79)		(6.91)
Strong Tie x First Voyage			-0.145		-0.0970
			(-1.10)		(-0.74)
Weak Tie x First Voyage			0.115		0.0989
			(1.22)		(1.05)
Strong Tie x First Voyage x Current Traffic			0.000624		0.000103
			(0.23)		(0.04)
Weak Tie x First Voyage x Current Traffic			-0.00166		-0.00166
			(-0.93)		(-0.94)
Alter Status x First Voyage			0.0328*		0.0322*
			(2.18)		(2.25)
Alter Status x First Voyage x Current Traffic			-0.000281		-0.000274
			(-1.23)		(-1.30)
War x Current Traffic				-0.00306**	-0.00345**
				(-2.98)	(-3.44)

Strong Tie x War				-0.307*	-0.303*
				(-2.14)	(-2.11)
Weak Tie x War				0.320**	0.302**
				(3.12)	(2.94)
Strong Tie x War x Current Traffic				0.00512	0.00490
				(1.42)	(1.36)
Weak Tie x War x Current Traffic				-0.00293	-0.00269
				(-1.33)	(-1.24)
Alter Status x War				-0.0588**	-0.0612**
				(-3.52)	(-3.67)
Alter Status x War x Current Traffic				0.00175**	0.00177**
				(4.97)	(5.03)
Log-likelihood	-31045.4	-30826.4	-30776.4	-30780.2	-30730.4
Captains	1561	1561	1561	1561	1561
Observations	335841	335841	335841	335841	335841

Robust standard errors clustered by captain. *t*-statistics in parentheses. * $p < 0.05$, ** $p < 0.01$

Figures.

Figure 1. Box plot of the average rate of traffic of ports across war

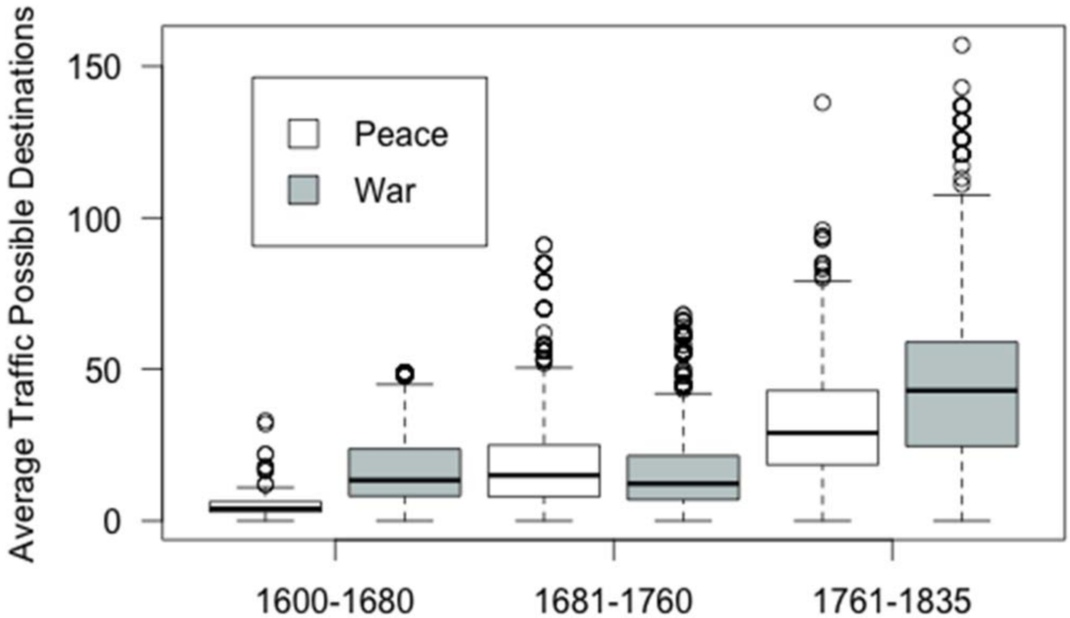

Figure 2. Box Plots of the Average Rate of Traffic across Experience Levels

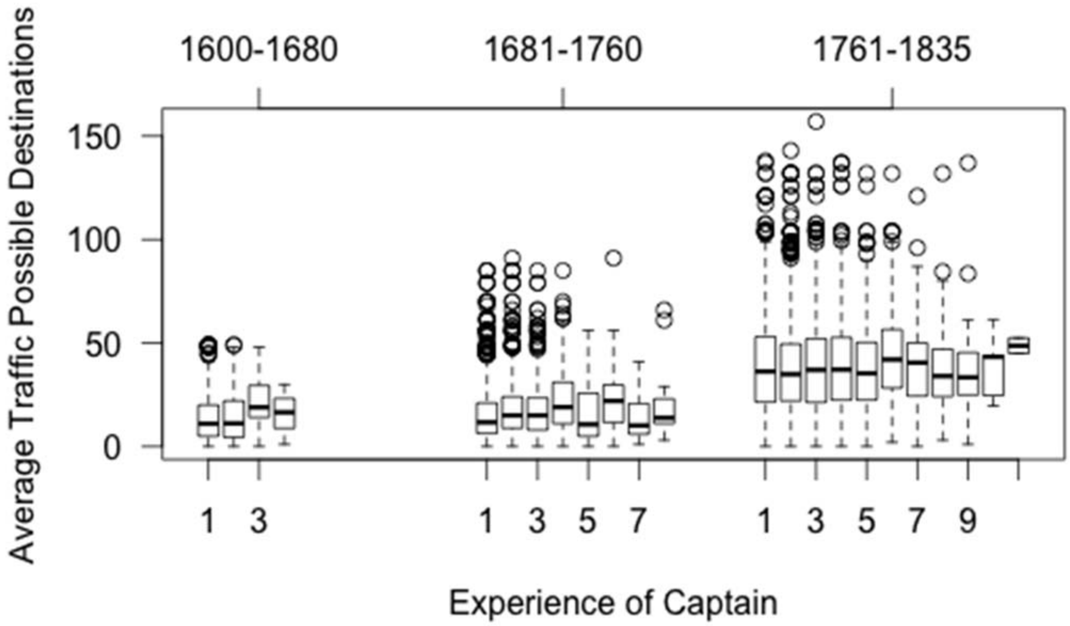

Figure 3. Box Plots of Traffic across Experience and Activation