INTERNATIONAL ECONOMIC REVIEW
Vol. 64, No. 1, February 2023 DOI: 10.1111/iere.12600

MEDIEVAL MATCHING MARKETS*

By Lars Boerner and Daniel Quint

Martin-Luther University Halle-Wittenberg, Germany; Halle Institute for Economic Research, Germany; DAFM, King's College London, UK.; University of Wisconsin-Madison, U.S.A.

We study the regulation of brokerage in wholesale markets in premodern Central Western Europe. Examining 1,804 sets of rules from 82 cities, we find brokerage was primarily a centralized matchmaking mechanism. Brokerage was more common in towns with larger populations, better access to sea ports and trade routes, and greater political autonomy. Brokers' fee structures varied systematically: price-based fees were more common for highly heterogeneous goods, quantity-based fees for more homogeneous goods. We show theoretically that this was broadly consistent with total surplus maximization, and that brokerage was more valuable in markets with unequal numbers of buyers and sellers.

1. INTRODUCTION

Going back to Adam Smith, economists have often thought of markets as self-organizing, with Smith's "invisible hand," Hayek's "spontaneous order" (Hayek, 1960) or Coase's "smoothly operating pricing system" (Coase, 1960) inexorably guiding traders to the efficient allocation. More recent work, however, has highlighted the sensitivity of market performance to more granular details of how trade is organized and carried out in a market and thus the importance of markets being carefully designed. Roth (2007) explains: "Traditional economics views markets as simply the confluence of supply and demand. A new field of economics, known as 'market design,' recognizes that well-functioning markets depend on detailed rules." Milgrom (2019) offers the example of a trading platform: "Successful trading platforms need to be designed to meet the needs of market participants… Market operators need to structure their trading platforms so that participants can be matched with the right partners, trust and quality can be assured, payments can be facilitated, and prices can be protected against manipulators…."

However, while the tools that modern market designers have at their disposal—game theory, lab experimentation, and computational simulation—may be relatively new, people have been regulating markets and trying to improve their performance for many hundreds of years. Roth (2016) writes, "The design of markets, via marketplaces, is an ancient human activity, older than agriculture." Challenges to market design today—informational asymmetries,

*Manuscript received April 2019; revised June 2022.
The authors thank Chris Turansick for excellent RA work and Ran Abramitzky, Paul David, Oscar Gelderblom, Yadira Gonzalez de Lara, Avner Greif, John Hatfield, Randolph Head, Scott Kominers, Ramon Marimon, Muriel Niederle, Albrecht Ritschl, Battista Severgnini, and Hermann van der Wee for encouraging discussions and comments. We have benefited from the comments of participants at conferences at the All-UC Economic History meeting at UC San Diego, the European Economic Association Meeting at Bocconi University, the Economic History Society Annual Conference at the University of Reading, and seminars at the European University Institute, Humboldt Universitat zu Berlin, Freie Universitat Berlin, London School of Economics, Stanford University, and University of Utrecht. Lars Boerner thanks the Department of Economics at Stanford University for the hospitality during several visits while this article was being written. Finally we would like to to thank the anonymous referees and the editor for their encouraging advices and comments. Please address correspondence to: Lars Boerner, Martin-Luther University Halle-Wittenberg, Germany. E-mail: *lars.boerner@wiwi.uni-halle.de*.

strategic behavior, market thinness, or congestion problems—are often problems that were present in earlier times as well.

The design of a market—the specific rules and allocation mechanism implemented—determines who trades what, how much surplus is generated, and how it is divided among the players in the market. This eventually has an impact on the development and economic growth of societies. Thus, understanding early market design can help to relate intentional rational action to long-run economic development. The importance of the formation of market institutions for the economic development of societies has been recognized in the literature (North (1981, 1990); Lin and Nugent 1995; Acemoglu et al. (2005b); Greif (2006); Rodrick 2008). However, the evolution of market mechanisms has traditionally been seen as an act of spontaneous order or a manifestation of the power of the invisible hand. This is perhaps surprising; Rodrick (2000) outlined the potential use of mechanism design to better understand the various forms of market institutions related to economic development in different countries.

The existing literature has considered the formation of market institutions mainly in a larger institutional context. Scholars looking into institutional mechanisms have focused on conditions that enable a smooth working of the price mechanism, such as equal access to markets, enforcement of market contracts, and secure property rights in general. Seminal work has been done by in particular scholars working on the long-run institutional transformation of premodern Europe from a comparative perspective to better understand the unique European path of economic development that might have led to the economic divergence between the Western societies and other parts of the world and to investigate more recent institutional transformations using Western development as a benchmark case. (Important examples are North (1990), North et al. (2009), Greif (1993), Greif (1994), and Greif (2006), and Acemoglu et al. (2005) and Acemoglu and Robinson (2012).)

While these approaches inform us about the formation of institutions guaranteeing equal access and enforcement of impersonal market exchange, very little has been said about the institutional detail of exactly how trade was actually achieved: how the aggregation of information worked, if the search and matching led to the right pairing of buyers to sellers, and how the observed market organizations affected the welfare gains of market participants and society overall. Historical investigations indeed show that the allocation of products was a concern (Heckscher, 1935; Hibbert, 1963); information asymmetry, temporary product shortages, hoarding, and market forestalling were serious problems at the time. Such historical findings have also been taken up by the market design literature to motivate current market design problems (Roth and Xing, 1994).

This article aims to fill this gap by analyzing the formation of allocation mechanisms in premodern European towns from a market design perspective. We investigate how societies organized markets and whether their market policies were well designed to have a positive effect on welfare. We look at one important type of regulated allocation process, the organization of intermediation in the form of brokerage, primarily in wholesale markets. Regulated intermediation first appeared in European towns during the second half of the 13th century. Early regulations can particularly be found in Italy and the Lower Countries (van Houtte, 1936; Rezzara, 1903). However, a comprehensive quantitative study on the origin, spread and development of the brokerage institution is missing so far. Origins of brokerage have been linked to the urbanization process of the 13th century (van Houtte, 1936); whether it can be related to preceding medieval Arabic merchant institutions or Roman law is an open debate (van Houtte, 1936; Lieber, 1968).

We study 231 cities in Central and Western Europe, roughly in the area of the Holy Roman Empire north of the Alps, during the period from 1200 to 1700. This area and period are particularly appealing for empirical investigation because local municipalities were typically economically and politically autonomous. Thus, each city could implement its own types of regulations and allocation mechanisms, leading to potentially rich variation in detail.

We identify cities with (and without) brokerage regulations and find in cities with regulations a dominant brokerage design with specific combinations of rules. The dominant design was a sort of centralized matchmaking mechanism: a few licensed brokers specializing in a particular product were given the exclusive right to offer a service pairing mainly foreign merchants with local buyers, and their behavior was strictly regulated. Brokers were not allowed to do any business on their own behalf and were restricted in what information they could disclose. The brokerage service was open to everybody, to the rich and poor, and to foreign and local merchants. Brokers received a predefined fee based on the transactions they generated—most commonly either a fixed fee per unit traded or a fixed fraction of the sales price.

We introduce a simple theoretical model to understand the effects of these rules by analyzing the incentives faced by the broker. In our model, we find that the efficiency of the allocation reached depends on the interaction between the type of fees earned by the broker and the nature of the product being traded. Specifically, price-based fees lead to a greater surplus (for both buyers and sellers) when products have a large variation in quality, whereas unit-based fees lead to greater surplus when products are more homogeneous and sellers are therefore differentiated primarily by their costs. We also find that the use of the appropriate type of fees encourages greater use of the broker by both buyers and sellers. Finally, we find that the pairings created by brokers tend to be more efficient than random matching when the market is unbalanced—either buyers significantly outnumber sellers or vice versa; we also find that the "appropriate" type of fees (unit fees for more homogeneous goods, price-based fees for more heterogeneous goods) are the only ones that perform well in both types of unbalanced markets.

Empirically, based on our investigation of 1,804 sets of brokerage regulations, we find that the choice of fee structure largely matched the efficient one—price-based fees were more common for products with greater heterogeneity; unit fees, more common for more homogeneous products. This gives suggestive evidence that town officials were acting deliberately and rationally in their design of brokerage rules. More broadly, we find that towns that implemented brokerage (compared to towns without) can be characterized by stronger economic activity, political economic interest, administrative capacity, and neighboring effects based on other towns that had already implemented brokerage (perhaps based on competition, learning, and imitation effects). In addition, sudden changes to the economic environment, such as the shock of the Black Death, were associated with a greater likelihood of brokerage implementation in the subsequent period.

Our insights closely complement the findings of the existing literature. North et al. (2009) have identified a process of institutional transition, which started during premodern times, from a natural state based on personalized power relations to a society with impersonal open access order institutions. Similarly, Acemoglu and Robinson (2012) have found the formation of so-called inclusive institutions. Key in these approaches is the impersonal and equal access to institutions and the existence of these institutions independent of the current carrier. Our findings indeed identify such institutions in the form of official intermediaries who guarantee equal access not only to the market but also explicitly to an allocation mechanism deliberately designed by the city–state. The institution is also detached from the person, since a broker was sworn in for some years and then replaced or could be dismissed if he or she did not comply with the rules. In addition, the implemented brokerage mechanism gave the broker an impersonal monetary incentive (based on the quality and price of the product, not the identities of the traders) to improve the market allocation.[1] The formation and implementation of such a mechanism can be seen as a novelty at the time but also as an early point on the timeline

[1] Similarly, Greif (2006) focuses on information flows during the Middle Ages and elaborates on the transformation of personal reputation-based enforcement mechanisms to an impersonal mechanism in the exchange of merchant transactions.

of the formation of open access order institutions discussed by other scholars. Thus, it can be seen as an early trial of the fundamental institutional change suggested in the literature.

In addition, our article relates to a seminal but controversial finding of Heckscher (1935) on the origins and early formation of mercantilism. Looking into premodern market policy, in particular market taxation and the organization of staple markets, he concludes that towns implemented market regulations in the interest of the town society but also incorporated the interests of foreign merchants, since towns had to rely on the inflow of consumption goods and raw inputs for production. In this way, Heckscher identifies early forms of mercantilism as both protective and liberal but strongly with the goal of supporting market transactions and trade flows. However, his claims of an intentional-acting town or a state organizing and channeling market transactions in the interest of society had been rather critically received or even disputed by scholars working on related questions in social science, such as Marc Bloch or Thomas H. Marshall (Magnusson 1994). His study was based on only a few historical case studies, his analysis of the details of the allocation process was rather limited, and finally, his descriptive theory was seen as rather complicated and difficult to fully understand. Our findings, based on systematically collected market regulations and analysis of market mechanisms and policy through the lens of market design, indeed support such intentional welfare-improving policy supporting both local and foreign interests.

Our article relates to the analysis of market design from a long-run perspective. The recent literature on market design focuses on modern problems (Milgrom, 2004; Roth, 2008). By extending this line of research to a long-run historical analysis, we are able to shed light on the identification and persistent use of specific market clearing techniques in important historical contexts and begin to shed some light on a neglected institutional dimension: the long-run evolution of the active design of market mechanisms. Such a line of research is only now in the process of arising. For instance, Boerner and Hatfield (2017) study the evolution of financial clearing mechanisms for nontradeable financial instruments in an environment with limited legal enforcement; Donna and Espín-Sánchez (2015) study the use of auction mechanisms to allocate water; and van Bochove et al. (2017) study the use of two-stage auction mechanisms to clear markets for heterogeneous financial securities.

Our results also characterize the environment in which this type of intermediation mechanism more often appeared. Economic policy-friendly governments (DeLong and Shleifer 1993, Stasavage (2014)), university institutions that support the education and literacy of the town administration (Cantoni and Yuchtmann, 2014), and trade-geographic advantages (Acemoglu et al., 2005; Bosker et al., 2013) have been linked to prosperous premodern European economic development. Based on our findings, these characteristics are also associated with a higher likelihood of implementing market allocation regulations. Such an empirical analysis into the connection between deliberately designed markets and their environment from such a long-run perspective is, to the best of our knowledge, new to the literature.

Our article also contributes to an established literature on intermediation (Biglaiser, 1993; Caillaud and Jullien, 2003; Gehrig, 1993; Neeman and Vulkan, 2010; Rubinstein and Wolinsky, 1987; Rust and Hall, 2003; Spulber, 1996; Yavaş, 1992, 1994, for example). Much of this literature argues that intermediaries improve the welfare of consumers and suppliers by reducing or eliminating the uncertainty associated with searching for a satisfactory match. Transactions with recognized centralized intermediaries can supplant decentralized search and bargaining so that customers and suppliers avoid the costs of decentralized search. This literature typically studies the decentralized evolution of different forms of intermediation, for example, endogenizing the number of intermediaries, the form they take (matchmakers or middlemen), and/or the prices they charge. Our article complements these studies by instead analyzing a "top–down" implementation of brokers as centralized matchmakers and evaluating this implementation's performance, focusing on brokers' behavior when they are constrained by regulation instead of competition or the threat of entry.

Finally, our study contributes to a better understanding of medieval and early modern markets in general and of brokerage in particular. Recent studies in economic history have mainly focused on market access and monopolistic structures in merchant cities (see, e.g., Richardson, 2004). A formal institutional analysis and empirical quantification of brokerage is missing so far. The historical investigation of brokerage institutions has been analyzed rather from a descriptive, holistic perspective, putting it into the wider historical context (for instance, see Murray 2005, Gelderblom (2013), and Demont et al. (2018)). In a companion paper to this one, Boerner (2016) relates to this historical literature and studies in detail the multifunctionality of brokerage, where he finds certification and tax collection as the main obligations of brokers in addition to matching; in addition, he relates brokerage to other forms of market mechanisms.[2]

Our article is structured as follows: Section 2 discusses the historical economic environment and describes the evolution and some common characteristics of the identified brokerage regulations based on a case study of Frankfurt. Section 3 explicitly models broker incentives in a simple theoretical framework and gives results about the value of brokerage and conditions favoring one or another type of broker compensation. Section 4 presents the data set, identifies specific brokerage rules implemented, and empirically examines patterns in the adoption of brokerage regulations, focusing on the questions of whether or not to implement brokerage and which type of brokerage fees to use. Section 5 further discusses the theoretical model in relation to the existing literature; Section 6 concludes. A separate Online Appendix contains further examples, empirical results, theoretical proofs, simulation results, and a complete list of archival sources used.

2. CITY GROWTH, TRADE, AND BROKERAGE

Starting in the late Middle Ages, Western Europe was characterized by economic expansion and related demographic and institutional changes (Bairoch, 1988; Lopez, 1976). Driven mainly by interregional trade with merchants traveling to foreign cities, towns started to grow; complementary to this growth, trade institutions evolved, which supported the exchange of products (Dijkmann, 2011; Greif, 2006; Gelderblom, 2013; Postan, 1987; Verlinden, 1963). In addition to the well-researched development of institutions enabling enforcement of merchant contracts (Greif, 2006), a number of less systematically studied institutions evolved to support the key elements of trade, such as information aggregation and the matching between buyers and sellers. In particular, product-specific spot markets and warehouses for wholesale products and regulated intermediation in the form of brokerage can be frequently documented. Other institutional forms supporting information flow and allocation processes only developed gradually during this period and only appeared more regularly during the early modern period. (These would include more permanent partnerships in the form of the first companies, with partners located in geographically separated business offices (de Roover (1963), p. 70 ff.; Hunt and Murray (1999), Boerner and Ritschl (2009)); weekly public market price lists (McCusker and Gravesteijn, 1991); and centralized market clearing mechanisms, such as sophisticated auction formats (van Bochove et al., 2017).

To better understand the form, purpose, and significance of the implementation of brokerage regulations, we first examine the case of Frankfurt. Frankfurt is an interesting case to study, since it was one of the most important cities—both economically and politically—during the period and area of our investigation (Dietz, 1910; Holtfrerich, 1999; Rothmann, 1998). A historical source study not only reveals information on the form and function of brokerage but also on the larger historical context and institutional change outlined in the introduction.

Brokerage regulations can be regularly documented in Frankfurt from the middle of the 14th century until the end of the 17th century (the endpoint of this investigation) and beyond (Schubert, 1962). This is typical throughout the area of investigation—brokerage and brokerage regulations persist throughout the 18th century in flourishing towns. The specific

[2] A more extensive discussion of the related historical research can be found there.

regulations and underlying intermediation mechanisms we can document are very detailed and differentiated. The smooth functioning of the allocation process must have been a concern of the town officials of Frankfurt, and they likely established strong expertise due to their commercial interests. This can be inferred, for instance, from the organization of brokerage and communication of the regulations to different foreign merchant groups during fair times (Rothmann, 1998, p. 122ff.). It is also reflected in communication from 1613, when the increasingly important city of Leipzig asked Frankfurt officials for advice on how to design their own brokerage rules. Frankfurt sent their regulations, also referring to other towns, such as Cologne, Hamburg, and Nuremberg (Moltke, 1939, p. 15f.). The brokerage regulations of these towns might have worked as role models for other cities and are fairly representative of what we see in the whole sample (discussed later on).

Brokerage was implemented as a sort of centralized clearinghouse mechanism: a fixed number of licensed brokers had the exclusive right to match buyers and sellers. A broker was sworn in by the town and licensed for a specific product or product category. From the middle of the 14th century, we find brokers for wine, meat, horses, and herring (Dietz, 1910, p. 379f., Schmitz, 1968, p. 28ff). By the end of the 14th and beginning of the 15th century, brokers for other products can be observed: for wool, silk, skins, and fur used as inputs by the cloth and textile industry and then for spices, metals and ironware, cattle, property, rents, and bills of exchange.

The regulations restricted the intermediation activities of the brokers to matching buyers and sellers and prohibited brokers from any private business, such as buying and selling for themselves or partnering with others who did.[3] For a successful match, they received predetermined fees either per unit[4] or based on the final price.[5] The fee structure was specified separately for each product and was quite low compared to the selling price.[6] This fee could not be changed and was typically split equally between the buyer and the seller.[7] Regulations for some product categories required brokers to work in groups and share their fees (Schubert, 1962, p. 45f.).[8] The use of a broker was typically not mandatory: only in very few cases over the whole period we study do we find evidence that a broker had to be used.[9] Most of the common rules, as well as the common combinations of rules, appeared throughout the sample.

Brokers were normally citizens, typically local merchants or producers. During fair times, some foreign merchant groups were allowed to bring their own (product-specific) brokers, who followed the same regulations as the permanent local brokers (Schubert, 1962, p. 37f.).

The brokerage regulations from Frankfurt also reveal a long catalog of penalties for not following the rules—in particular, penalties for violating the private business constraint, asking for higher fees, or for performing brokerage without being an officially sworn-in broker. In earlier regulations during the 14th century, the punishment was banishment from the city for one year and losing one's job.[10] Later regulations from the 15th century on mainly imposed

[3] See, for instance, the broker oath from 1465 (Buecher, 1915, 213f.).

[4] For example, they received three *Schillinge* for one *Fuder* of wine in 1373 (Buecher, 1915, p. 325); three *Heller* for one cow or swine in 1373 (Buecher, 1915, p. 221); or two *Groschen* for one ton of herring in 1415 (Buecher, 1915, p. 241).

[5] For example, they received four *Heller* at an outdoor market (six *Heller* during a fair) for each pound in the price of a horse in 1360 (Buecher, 1915, p. 237); one *Groschen* for each 100 guilders for bills of exchange around 1450 (Buecher, 1915, p. 250).

[6] For a general discussion of brokerage fees relative to good prices, see Gelderblom (2013).

[7] However, some regulations (particularly early ones) indicated that for some products, the seller had to pay the fee: for instance, the seller paid the entire brokerage fee for horses and more than half the fee for pigs.

[8] For example, in the wine brokerage fees mentioned above from 1373, wine brokers had to share profits. In addition, clauses related to information sharing among brokers and "no competition among brokers" can be found in many town regulations (see Boerner, 2016).

[9] This seems to only regularly have been the case for small retailers (called "Hoecker" ("sitters")) who bought foodstuff products, such as eggs, milk, and cheese, for daily reselling on the streets of Frankfurt during the second half of the 14th century—for example, from 1377, see Buecher (1915, p. 227). For single observations for a few other products, see Schubert (1962, p. 57).

[10] For example, in 1357 (Wolf (1969), p. 11ff.) or 1360 (Buecher (1915), p. 211f.).

fines.[11] We have no detailed source material on the application of these punishments, but detailed evidence of the application of similar punishment mechanisms for brokers can be extensively documented in the city of Cologne during the same period of time (see Boerner, 2016).

These regulations also inform us about the political motivation of town officials in implementing these orders (Schubert (1962), p. 69ff.). We find two main types of motivation. During the 14th century, regulations state that these brokerage regulations were implemented in the interest of the town and its citizens. (For an example from 1350, see Buecher, 1915, p. 325.) In addition but particularly later on in the data, the regulations state that the broker should treat all his customers in an equal way independent of whether they are rich or poor or whether local or foreign.[12],[13] In some regulations, related statements of equal treatment are explained in more detail when they talk about information sharing between the broker and traders on either side of the market: the broker was not allowed to inform the buyer if the seller was in a hurry to sell his goods nor to tell the seller if the potential buyer was rich or poor.[14] The broker could also not reveal incorrect estimates of the value of a product (too high or too low) to one side of the market.

From these sources, we can clearly infer concerns about information asymmetries between traders, which went beyond knowledge of who was selling or buying which types of products into product valuations and price preferences of market participants. (If a seller learned from a broker that a buyer could afford to pay a high price, he would have a stronger incentive to demand a high price; if a buyer learned about past prices or that the seller needed to sell his goods quickly, he could understate his own willingness to pay.[15]) Thus, the broker was a powerful intermediary who had information that could influence trade and price formation or give him an advantage in doing private business. Regulations and punishment for such behavior indeed show the fear of this abuse and the importance of this intermediary function in improving the allocation process.[16] Consequently, the role of brokerage was to support the matching of buyers to sellers and to solve the information asymmetry problems between the two sides of the market in a "fair way."

Finally, we should discuss product characteristics in premodern markets, which could lead to informational asymmetry and the need for matching institutions. Differences in product quality can be observed for a large number of different products, but the degree of variation depended on the product. At one extreme were basic foodstuff and input products, which were rather homogenous:[17] in Frankfurt, there was a large market for wine, grain, fish, and

[11] For example from 1406, see Buecher (1915, p. 214f.), and from 1466, see Wolf (1969, p. 356).

[12] This later incorporation of equal and fair treatment relative to the primacy of the local interest is a general pattern that can be observed when we examine regulations from the full sample of towns. The average year of a regulation demanding "fair treatment" is 1536 (330 observations); the average year mentioning the "interest of the town" is 1393 (131 observations), and "for their citizens," is 1406 (33 observations). This supports the idea of a shaping of brokerage into a more inclusive or impersonal institution over time. Another indication of such a process is the early diffusion of inclusive policy statements along the Rhine–Main–Meuse–Scheldt area—see Figure 1, right panel.

[13] See Buecher (1915) for examples from 1360 (p. 211), from ca. 1450 (p. 249), and from 1460 (p. 224).

[14] Such statements can be found, for instance, in brokerage rules from Frankfurt in 1406 and 1465 (Buecher (1915), p. 211ff. and 213ff.) and in 1685 (Beyerbach (1818), p. 700ff.).

[15] Brokerage regulations from the Alsatian merchant town of Schlettstadt in the early 16th century gave exactly this second reason for ordering the broker not to reveal information to one side of the market (Gény (1902), pp. 988–89).

[16] The conscious implementation, self-reflection, and outside perception of these policies can also be seen in various source material from other important merchant towns, such as Cologne or Brugge. For instance, in one source from Cologne, an expert probably ordered by the city of Cologne evaluates different market making activities and regulations, including brokerage regulations. The report concludes that the brokerage regulations in use are good and should be kept (Stein II, 1893–95, p. 565f.). In a letter from the Hanseatic League to Brugge in 1438, merchants who had earlier left Brugge were negotiating over returning to Brugge to do business. Among other demands, they wrote that they would only return if the city could guarantee that brokers did no private business for themselves (Hoehlbaum (1876), Hansisches Urkundenbuch, VII n. 389 § 5).

[17] Only a small fraction of wine consumed was high-quality wine, where we might expect more variations in value—see Rose (2011) and Matheus (2004).

cattle, as well as markets for homogeneous raw inputs for garment production and construction materials, such as wood, bricks, and metals (Dietz, 1910). Variation in these markets was rather driven by cost differences: transportation costs (and tolls) varied depending on the importing region and trade routes (Henning, 1991; Pfeiffer, 1997), and prices varied based on seasonal fluctuations, particularly for agricultural products such as wine or grain (Schmitz, 1968). In Frankfurt, wine trade from different regions along the Main/Rhine and Mosel, Austria and Franken can be documented (Rothmann, 1998); grain came from the Baltics, Switzerland or north Germany, and cattle (Westermann, 1978) came from Hungary, Poland, Denmark, or Switzerland. At the other extreme, some products had much larger variation in product quality. Cloth, for example, was produced in a large variety of quality (Jenkins, 2003), and cloth from all major European producers could be found in Frankfurt (Rothmann, 1998). Financial instruments, for example, bills of exchange, were also very heterogeneous, as preferences for them depended very much on the participants and the place the bill was drawn on. The limited tradeability of bills of exchange made the valuation even more heterogeneous (Munro, 1994; North, 1981; van der Wee, 1963). In Frankfurt, the drawing and clearing of bills of exchange for locations and merchants from all over Europe can be documented (Rothmann, 1998). The quality of properties, houses, and leased land similarly varied substantially. Finally, the value of horses varied based on the function, that is, riding, for a cart, or for military purpose, or on the age and race of the horse; Frankfurt had one of the largest horse markets in Germany (Schubert, 1962). While we can also expect some variations in costs among these products, we can expect that the matching process was largely driven by the various product qualities on these markets. Interestingly, we can observe in Frankfurt that brokerage fees for homogenous products were typically calculated based on volume, whereas brokerage fees for products that varied more in quality were typically calculated as a percentage of the price. In the next section, we will investigate how the choice of brokerage fees had an impact on brokers' incentives and the allocation process.

3. THEORETICAL ANALYSIS

3.1. *Model.* Next, we introduce a simple theoretical model to study the incentives faced by the broker and the impact of brokerage on trade. We focus on two questions: when should we expect brokerage to be socially valuable, and which type of brokerage fees will lead to better outcomes? The model has been kept as simple as possible to make the forces at play transparent; the relationship between our model and the existing theory literature is discussed in a later section.

There is a set of sellers $s \in \mathcal{S} = \{1, 2, \dots, N_s\}$, each with a single good to sell, and a set of buyers $b \in \mathcal{B} = \{1, 2, \dots, N_b\}$, each seeking a single good to buy. Sellers vary in both the *quality* of their good q_s and their *cost* c_s, which we can think of either as the cost of supplying the good or the seller's value from keeping it (to consume or to sell later). More specifically, each seller has a *type* $t_s \in \mathbb{R}$, which determines both the quality of their good, $q_s = q(t_s)$, and their cost, $c_s = c(t_s)$, via two functions $q, c : \mathbb{R} \to \mathbb{R}^+$. Similarly, each buyer has a type $v_b \in \mathbb{R}$ influencing their valuation for each good. A buyer with type v who buys a good of quality q at price p receives payoff

$$U(v, q) - p$$

and a seller with cost c who sells his good at price p earns profit

$$p - \delta(p) - c,$$

where $\delta(p)$ is the commission paid to the broker, which may (or may not) depend on p. (Given our assumption below on price determination, who physically pays the broker's commission is immaterial to payoffs; we assume it is the seller.) We assume the following about the structure of payoffs:

ASSUMPTION 1. *Gross buyer surplus $U(v,q)$ is increasing and continuous in v, increasing and continuous in q, and supermodular; that is, for $q' > q$, $U(v,q') - U(v,q)$ is increasing in v.*

ASSUMPTION 2. *The functions $q(\cdot)$ and $c(\cdot)$ are both continuous and weakly increasing, and at least one of the two is strictly increasing.*

Beyond technical concerns such as continuity, these assumptions say several substantive things. First, all buyers agree on the quality ranking of different goods—differentiation is vertical, not horizontal. Second, a buyer who values one good more highly than another buyer also values a different good more highly than that other buyer. Third, a buyer who values one good more highly would also pay more for a given quality *upgrade*, that is, to switch from one good to a higher-quality good. Fourth, cost and quality increase together—that is, no seller is both higher-quality and cheaper than another seller.

Some of our results presented below (Theorems 3 and 4) will hold for every possible combination of buyers and sellers; others (Theorems 1, 2, and 5) will hold in expectation or in reference to probabilities in large markets. For the latter results, we assume that seller types t_s are independently drawn from a probability distribution F_s; buyer types v_b are independently drawn from a probability distribution F_b; and F_s and F_b are atomless distributions, each of which is strictly increasing on compact support.

Fixing the broker's fee schedule $\delta(p)$, we define a buyer b and seller s to be *compatible* if there is some price p such that $\min\{U(v_b, q_s) - p,\ p - \delta(p) - c_s\} > 0$, that is, if the buyer and seller can both earn strictly positive payoffs trading with each other net of the broker's fee. For our "small market" results, we assume that every trader is compatible with at least one trader on the other side of the market (or ignore traders who are not); for our "large market" results, we assume that every buyer is compatible with a positive measure of seller types and vice versa.

Motivated by our application, we consider two commission structures for the broker: the broker earns either a constant commission for each trade that occurs ("unit fees") or a fixed fraction of the price paid in each transaction ("percentage fees"). We consider a full-information environment where the broker knows the types of each buyer and each seller. (We will discuss later the incentives for traders to mislead the broker.) Once a buyer and seller have been paired up, assuming they are compatible, they trade at the Nash bargaining price, which is the solution to the problem

$$\max_{p} \left(U(v_b, q_s) - p\right)^{\phi} \left(p - \delta(p) - c_s\right)^{1-\phi}$$

with ϕ a fixed constant commonly interpreted as the "bargaining power" of each side.[18]

Under unit fees, a broker seeking to maximize commissions would naturally be indifferent among many different ways he or she could pair buyers to sellers, as long as they all led to the same number of trades. To resolve such indifferences, we additionally assume there is a small probability that a compatible buyer and seller would still fail to agree on a price and therefore

[18] This outcome with $\phi = 1/2$ was proposed by Nash (1950, 1953), who showed it uniquely follows from a particular set of axioms. Kalai and Smorodinsky (1975) offer a different axiomatization that gives the same outcome as in our setting. Binmore et al. (1986) discuss the use of this model as a "reduced form" for more complex dynamic bargaining games. In our setting, ϕ can be thought of as capturing factors excluded from our model, such as the relative number of buyers and sellers or the likely time until the arrival of other merchants selling similar goods. We show in the online appendix that Nash bargaining leads to trade at price $p = (1-\phi)U(v_b, q_s) + \phi c_s + \phi u$ under unit fees $\delta(p) = u$ and at price $p = (1-\phi)U(v_b, q_s) + \phi c_s/(1-f)$ under percentage fees $\delta(p) = f p$.

fail to trade. We assume this probability is decreasing in the gains from trade and consider the limit as it becomes both vanishingly small and highly convex. Specifically, we assume trade is successful with probability

$$1 - e^{-K(U(v_b, q_s) - c_s - \delta)}$$

and take the limit as $K \to \infty$.[19]

Taking the setup above (and the fee structure) as given, we assume the broker acts to maximize his commissions:

ASSUMPTION 3. *The broker matches buyers and sellers in whatever way maximizes his or her expected commissions, assuming that when a buyer b is paired with a compatible seller s, they trade at the Nash price with probability* $1 - e^{-K(U(v_b, q_s) - c_s - \delta)}$.

Note that in determining the Nash bargaining price, we assume each trader's outside option is a payoff of 0 (not trading) and do not consider the possibility they might find someone else to trade with. We imagine that while the eventual price to be negotiated is predictable, haggling is still a time-consuming process and that once a buyer and seller are paired up and begin to negotiate, neither will have time to find another trading partner in the event they fail to agree. Thus, each can either trade with this partner or not trade. Similarly, we do not constrain the broker to select a *stable matching*– -that is, to avoid matching a buyer b and a seller s to other partners when they would both prefer to trade with each other—but allow the broker to select any matching of buyers to sellers subject to the constraint that any buyer–seller pair must be compatible in order to trade. (We will consider stability later.) Informally, we imagine that if it were easy for buyers and sellers who wanted to trade with each other to find each other, there would be little need for the broker to begin with.

While our formulation allows sellers to differ in both quality and cost, we will focus on the two polar cases where one type of variation dominates the other in terms of buyer preferences:

DEFINITION 1. We will say that **variation in costs dominates** (or simply "costs dominate") if for every buyer b and any two sellers s and s',

$$c_s \quad < \quad c_{s'} \qquad \longrightarrow \qquad U(v_b, q_s) - c_s \quad > \quad U(v_b, q_{s'}) - c_{s'}.$$

Conversely, we will say that **variation in quality dominates** (or "quality dominates") if for every buyer b and any two sellers s and s',

$$q_s \quad > \quad q_{s'} \qquad \longrightarrow \qquad U(v_b, q_s) - c_s \quad > \quad U(v_b, q_{s'}) - c_{s'}.$$

Thus, costs dominate if every buyer would generate more surplus trading with the lower cost of two sellers—that is, if every buyer agrees that the lower-cost product, even though it is lower quality, is still a better value. Quality dominates if the reverse is true—even though the higher-quality product is higher cost, every buyer agrees it's a better value. (Equivalently, costs dominate if the match surplus $U(v_b, q(t_s)) - c(t_s)$ is decreasing in t_s for every v_b, and quality dominates if it is increasing for every v_b.) A natural, special case of costs-dominate is

[19] Under unit fees, minimizing the expected number of trades that will fail to occur, even when this probability is vanishingly small, serves as a "tiebreaker" in the broker's preferences. The exact functional form of the probability is not important; this is simply one that works. If we did not introduce this breakdown possibility and instead considered different rules for how a broker would choose among different buyer–seller matchings giving the same number of trades, Theorem 1 would still hold under any rule. The parts of Theorems 2, 3, 4, and 5 covering the costs-dominate case, however, would depend on the broker choosing the most efficient matching among those giving equal commissions, except in the case of uniform quality ($q_s = q$ for all s), in which case they would hold for any rule.

when all products are of identical quality, and a special case of quality dominates is when all sellers have identical costs.

3.2. *When Does Brokerage Increase Total Surplus?.* With our model defined, we first consider the question of when brokerage is likely to increase the total surplus. To address this question, we assume that in the absence of brokerage, buyers and sellers would pair up randomly and attempt to trade with whatever trading partner they found. If there were N_b buyers and $N_s < N_b$ sellers, then each seller would find a buyer, and each buyer would have a probability N_s/N_b of finding a seller; vice versa if there were more sellers than buyers.[20] Analogous to our assumptions about trade within brokerage, we assume that without brokerage, traders have only one opportunity to trade—they pair up with someone (or do not), and by the time they figure out whether they are compatible and attempt to work out a deal, no other opportunities exist for trade.

Note that compared to this benchmark of random matching, our model implicitly assumes that the broker has the *ability* but *not* necessarily the inclination to increase the total surplus. We have assumed the broker has both the information and the power needed to improve match quality; on the other hand, we have assumed he or she will act to maximize his or her commissions, not total surplus. As we will see below, in some settings, the distortion caused by the latter is the dominant effect, and the presence of the broker reduces the total surplus. On the other hand, in some settings, the broker's incentives are sufficiently aligned with the total surplus that the broker's presence predictably increases surplus.

More specifically, we find that in large markets, brokerage can always increase total surplus if the market is sufficiently *unbalanced*, that is, has highly unequal numbers of buyers and sellers. In some large, unbalanced markets, one type of commission (unit or percentage fees) leads to an increase in surplus, and the other does not; in some, either form of fees leads to increased surplus. Going further, in large and unbalanced markets, one type of fee—unit fees when costs dominate and percentage fees when quality dominates—leads with high likelihood to the first-best outcome (the particular matching of buyers to sellers that maximizes total surplus), whereas the other does not. In balanced markets, on the other hand, brokerage with either type of fee is not guaranteed to outperform random matching.

To formalize these results, we consider markets where the ratio N_b/N_s of buyers to sellers remains constant, whereas the number of buyers N_b and sellers N_s increases. We consider the ex ante expected surplus when buyer and seller types are *i.i.d.* draws from the probability distributions F_b and F_s and compare the matching chosen by a broker maximizing either unit or percentage fees to the expected surplus achieved under random matching.

THEOREM 1. *Fix the primitives of an environment—U, $q(\cdot)$, $c(\cdot)$, F_s, and F_b—and assume brokerage fees are small. There are cutoffs $k_* < 1$ and $k^* > 1$ such that:*

1. *If $N_b/N_s < k_*$ (many sellers per buyer), when the market is sufficiently large:*
   - *(a) if variation in costs dominates, brokerage with unit fees is more efficient than random matching;*
   - *(b) if variation in quality dominates, brokerage with either unit or percentage fees is more efficient than random matching;*
2. *If $N_b/N_s > k^*$ (many buyers per seller), then if either costs or quality dominates, brokerage with either unit or percentage fees is more efficient than random matching.*

Thus, brokerage with the appropriately chosen fee structure always outperforms random matching in large markets that are *sufficiently unbalanced* in either direction, and in many cases, brokerage with either type of fee will do so.

[20] A "noisier" matching function, where even traders on the short side of the market were not assured of finding a partner, or a cost of searching would of course make brokerage more appealing.

As noted above, we can show a much stronger result for a particular choice of fee structure—unit fees when costs dominate or percentage fees when quality dominates. In those cases, in sufficiently large and unbalanced markets, the broker almost always chooses the exact matching that maximizes the total surplus.

THEOREM 2. *Suppose that either $N_b/N_s > k^*$ or $N_b/N_s < k_*$ and brokerage fees are small.*

1. *If variation in costs dominates and unit fees are used, then as the market becomes large, the probability goes to 1 that the broker chooses the exact matching that maximizes total surplus.*
2. *If variation in quality dominates and percentage fees are used, then as the market becomes large, the probability goes to 1 that the broker chooses the exact matching that maximizes total surplus.*

Note that this is a limit result in the sense of holding as $(N_b, N_s) \to +\infty$, but it does not require the ratio N_b/N_s to go to $+\infty$ or 0; it holds for each fixed value of N_b/N_s either above k^* or below k_*. Note also that the opposite cases do not hold—for either large or small values of N_b/N_s, with percentage fees when costs dominate or unit fees when quality dominates, the probability the broker chooses the surplus-maximizing match goes to zero as the market becomes large.

For intuition, for Theorems 1 and 2, consider first the case of many buyers. Since high-value buyers create the greatest match surplus with any seller, every type of seller is compatible with the highest-value buyers. When N_b/N_s is sufficiently large, there are more "high-value buyers" than there are sellers; brokers maximize their commissions by pairing each seller with one of these buyers, and this maximizes total surplus as well. Whether costs or quality dominates, it is efficient to pair higher-type (hence higher-quality) sellers with higher-type (higher willingness-to-pay-for-quality) buyers. This is in the interest of brokers under percentage fees, since supermodularity of the match surplus function (and the determination of prices under Nash bargaining) means commissions are maximized under assortative matching. Under unit fees, on the other hand, the broker is most concerned with the "weakest" seller—the one generating the least surplus with trade and therefore most likely to fail to agree on a price—and will choose to pair him or her with the highest-value buyer. When costs dominate, the "weakest" seller is the highest-cost seller, which is also the highest-quality seller, and this is therefore efficient; when quality dominates, the "weakest" seller is the lowest-quality one, and unit fees lead to reverse-assortative matching, which is inefficient. In that case, the matching of all sellers to high-value buyers still increases the total surplus relative to random matching (Theorem 1, part 2), but the broker does not choose the surplus-maximizing matching.

Next, consider the case of many sellers. Now, the broker will find a seller for every buyer. When quality dominates, it is efficient to use only the highest-quality sellers, and this also maximizes commissions under percentage fees and minimizes the likelihood of a bargaining breakdown under unit fees. Furthermore, under percentage fees, the broker will match buyers to high-quality sellers assortatively (matching high-quality to high-willingness-to-pay-for-quality), giving part 2 of Theorem 2. Under unit fees, the broker will match weaker buyers to better sellers, leading to reverse-assortative matching and failing to achieve first best. When costs dominate, a broker under unit fees will pair each buyer to a low-cost seller, which is efficient, and will pair the "weakest" buyer with the strongest seller, who is also the lowest-quality, leading to the efficient assortative matching. A broker under percentage fees, however, will not use the cheapest sellers available but has incentives to pair each buyer with the highest-quality, highest-cost seller they are compatible with, which can easily lead to outcomes worse than random matching.

We should emphasize that regardless of the fee structure, brokerage need *not* outperform random matching in *balanced* markets. Examples 3 and 4 in the online appendix offer two illustrations (one where costs dominate and one where quality dominates) of large, balanced markets where brokerage significantly reduces the total surplus. We have also used numerical simulations to examine some arbitrary but reasonable-looking parameterizations of buyer and seller types based on uniform distributions. In these simulations, brokerage with either type of fee often produced lower total surplus than random matching in balanced markets, especially as the market became large. When $N_b/N_s \geq 2$ (at least two buyers per seller), brokerage with either type of fee substantially outperformed random matching and was fairly close to first best. When $N_b/N_s \leq 1/2$ (at least two sellers per buyer), brokerage with "appropriately-chosen" fees (unit fees when costs dominate and percentage fees when quality dominates) did similarly well, but brokerage with the "wrong" type of fee gave substantially lower surplus than random matching.[21] Explanation of the simulation setup and results are in the online appendix.

3.3. *Unit versus Percentage Fees: Efficiency and Stability.*

3.3.1. *Efficiency.* The results above suggest that brokerage is likely to be valuable at least in large, unbalanced markets. They also suggest that the fee structure may matter for efficiency and that the "right" choice of unit or percentage fees will depend on the details of the environment—in particular, whether the variation in costs or in quality is more important. Next, we show that this latter insight holds much more generally—not just in unbalanced markets, large markets, or in expectation but in every market and for every possible realization of buyer and seller types.

We focus on the generic case where no two traders have identical types.[22] We also assume that if a buyer b and seller s are compatible under one type of fee (unit or percentage), they are also compatible under the other type of fee. This is because we want to focus on the way the broker's incentives are shaped by the type of commission he or she receives, and this is easiest to see when we compare the broker's choice under the two fee structures when facing the same "choice set" (the same set of potential matchings); this assumption holds if brokerage fees are small.

THEOREM 3. *Fix the set of buyers and sellers and their types, and assume brokerage fees are small.*

1. *If variation in costs dominates, then unit fees always lead to a more efficient outcome than percentage fees.*
2. *If variation in quality dominates, then percentage fees always lead to a more efficient outcome than unit fees.*

The theorem is proved in the online appendix, but much of the intuition can be gained from two examples. For both examples, we assume that the buyer's gross surplus $U(v_b, q_s) = v_b q_s$, and that fees are small and $\phi = 1/2$, so that trade occurs at the midpoint between the buyer's valuation and the seller's cost.

EXAMPLE 1 (COSTS DOMINATE). There are two buyers, with types $(v_1, v_2) = (10, 6)$, and three sellers, with costs $(c_1, c_2, c_3) = (4, 7, 9)$ and identical quality $q_1 = q_2 = q_3 = 1$. Total surplus is maximized if the highest-value buyer buys from the lowest-cost seller and nobody else trades, giving surplus of $10 - 4 = 6$. A broker maximizing unit fees would pair buyer 1 with seller 2 and buyer 2 with seller 1 to earn commission from two trades instead of one; this would generate a surplus of $(10 - 7) + (6 - 4) = 5$. A broker maximizing percentage fees would further

[21] Per Theorem 1, part 1(b), in large markets, brokerage with unit fees will still outperform random matching when quality dominates and N_b/N_s is sufficiently low; the simulations suggest that unlike the other results, this one may only hold in markets that are *extremely* imbalanced.

[22] Thus, $v_b \neq v_{b'}$ for any two buyers $b' \neq b$, and $(q_s, c_s) \neq (q_{s'}, c_{s'})$ for any two sellers $s' \neq s$. Given our other assumptions, this ensures a unique matching of buyers to sellers that maximizes total surplus and a unique matching that maximizes expected commissions under either unit or percentage fees.

inflate his commission by pairing buyer 1 with seller 3 instead of seller 2, leading to a total surplus of $(10-9)+(6-4)=3$.

In this example, either type of fee leads to more than the efficient number of trades, but percentage fees lead to a further inefficiency: the broker increases his or her commission by pairing buyer 1 with a high-cost seller when a lower-cost seller is available, leading the buyer to pay a higher price. In fact, the features of Example 1 generalize. The proof of Theorem 3, part 1 is based on two facts that hold whenever variation in costs dominates: (i) unit and percentage fees always lead to the same number of trades, and (ii) unit fees always lead the broker to select the most efficient matching with this number of trades, whereas percentage fees may not.

Next, we consider an example where all sellers have identical costs, and thus, quality dominates. Here, there is a potential for a different type of inefficiency—a mismatch between seller quality and buyer willingness-to-pay-for-quality—which is more severe under unit fees.

EXAMPLE 2 (QUALITY DOMINATES). There are four buyers, with types $(v_1, v_2, v_3, v_4) = (8, 5, 3, 2)$, and four sellers, with quality $(q_1, q_2, q_3, q_4) = (6, 4, 3, 2)$ and identical costs $c_1 = c_2 = c_3 = c_4 = 10$.

In this environment, total surplus is maximized if buyer 1 buys the highest-quality object, buyer 2 buys the second-highest quality object, and the other two objects are not traded; this generates surplus of $(8\times 6-10)+(5\times 4-10)=48$.

Percentage fees are maximized if buyer 1 buys the highest-quality object, buyer 2 buys the *third*-highest quality object, and buyer 3 buys the second-highest-quality object. (This generates a third transaction and prices of 29, 12.5 and 11 instead of 29 and 15; therefore, the broker earns a commission on 8.5 more in sales.) The total surplus is lower, however, at $(48-10)+(15-10)+(12-10)=45$. (Selling good 3 to buyer 2 and good 2 to buyer 3 generates higher commissions than just selling good 2 to buyer 2 but generates less surplus.)

Unit fees are maximized if all four objects trade; this is only possible if buyer 1 buys good 4, buyer 2 buys good 3, buyer 3 buys good 2, and buyer 4 buys good 1. This is hugely inefficient: the higher-quality goods are largely "wasted" by going to lower-value buyers, and the total surplus is just $(16-10)+(15-10)+(12-10)+(12-10)=15$.

To prove Theorem 3, part 2, we show in general that when quality dominates, percentage fees may lead to more than the efficient number of trades but always lead to the most efficient matching with that many trades; however, unit fees may lead to even more trades, and may not lead to the most efficient matching with that many trades.

Overall, then, the result is quite sharp: when sellers offer similar-quality products and differ mostly in their costs, unit fees lead to a more efficient outcome; when sellers instead offer products with widely-varying quality but have similar costs, percentage fees lead to a more efficient outcome. Note also that these results hold for *every* realization of buyer and seller types, not just in expectation over certain probability distributions of types.

3.3.2. *Stability.* As we noted earlier, there were rare instances in which the use of a broker was mandatory, but this was the exception rather than the rule; for the most part, merchants could choose whether to trade through a broker or on their own. Thus, we want to consider the incentives for traders to elect to trade through the broker. Of course, if the broker's fees are large, traders have an incentive to search on their own even if they would be perfectly happy with the broker-selected match, purely to avoid paying the commission. We abstract away from this by assuming the fee is small and instead focus on traders' incentives to search on their own in the hope of improving their match relative to the partner the broker would pair them with.

We do this by considering the *stability* of the matching selected by the broker.[23] We can represent a matching as a mapping M from the set of traders to itself, where $M(b) = s$ and $M(s) = b$ if buyer b and seller s are paired together (and by convention a trader who does not trade is mapped to himself). If we let $\mu(b, s)$ be the payoff buyer b receives from buying from seller s at the Nash price and $\nu(s, b)$ the payoff seller s receives from selling to buyer b, a matching M is defined to be *stable* if there is no pair of traders (b, s) such that

$$\mu(b, s) \; > \; \mu(b, M(b)) \qquad \text{and} \qquad \nu(s, b) \; > \; \nu(s, M(s)),$$

that is, if there is buyer–seller pair who are not matched to each other, who would both happily abandon their partner under M to instead trade with each other. If a broker's incentives led him or her to select a stable matching, this would mean that even with full information and no frictions, no group of traders could all benefit from abandoning the broker to trade among themselves. We can interpret this as meaning participation in brokerage would likely be high.[24]

Stability in our setting is generally not guaranteed.[25] In the examples above and those in the online appendix referenced above, the matching chosen by the broker under either fee structure is not stable. Thus, stability of the chosen match is too high a bar for us to use. However, we can also consider *how close* to stable is the outcome each fee structure leads to. For a given value $\varepsilon \geq 0$, a matching M is called ε-*stable* if there is no buyer–seller pair (b, s) such that

$$\mu(b, s) \; > \; \mu(b, M(b)) + \varepsilon \qquad \text{and} \qquad \nu(s, b) \; > \; \nu(s, M(s)) + \varepsilon,$$

that is, if no buyer and seller could both gain *more than* ε by instead trading with each other. (We can therefore think of ε as the cost of private search that would suffice to make all traders trade through the broker or more vaguely as a measure of how strong an incentive traders face to try to trade without the broker.) We will define a matching M' to be (weakly) *more stable* than another matching M if for any value of ε, if M is ε-stable, then M' is ε-stable as well. We find results on ε-stability that mirror our results on efficiency:

THEOREM 4. *Fix the set of buyers and sellers, and assume brokerage fees are small.*

1. *If variation in costs dominates, then unit fees always lead to a more stable outcome than percentage fees.*
2. *If variation in quality dominates, then percentage fees always lead to a more stable outcome than unit fees.*

The two examples from earlier can again be used to build intuition for these results. In Example 1 (costs dominate), under the matching chosen by a broker under unit or percentage fees, the highest-value buyer and lowest-cost seller are not paired with each other and face the largest incentive to avoid the broker and trade directly. Trading with each other would lead them to a Nash price of 7 and surplus of 3 each. In the matching chosen under unit fees, they are earning surpluses of 1.5 and 1, respectively, by trading with other traders; they would therefore gain 1.5 and 2 from such a change. This means the matching chosen under unit fees is ε-stable for $\varepsilon \geq 1.5$. In the matching chosen under percentage fees, the low-cost seller is

[23] There is an enormous literature considering stability in matching markets. See Roth and Sotomayor (1990) for a review of the early literature and Abdulkadiroğlu and Sönmez (2013) for a more recent survey.

[24] Games where each trader chooses whether to trade through the broker or on his or her own always have multiple equilibria, since if all the buyers seek to trade through the broker, all the sellers will want to as well, and if all the buyers search on their own, all the sellers will want to. Stability can be thought of as meaning that everyone trading through the broker would still be *an* equilibrium and stable even to group deviations, even if traders had full information about each others' types and no frictions in finding each other.

[25] In contrast, Bloch and Ryder (2000) in a similar model assume the broker is constrained to choose a stable matching. We discuss their paper's relation to ours in a later section.

again earning a surplus of 1, but the high-value buyer earns a surplus of only 0.5; therefore, both traders would gain at least 2 from bypassing the broker to trade with each other, and the broker-selected matching is only ε-stable for $\varepsilon \geq 2$. Thus, unit fees lead to a matching that is more stable.

In Example 2 (quality dominates), under unit fees, the highest-value buyer and highest-quality seller are not matched with each other and face an enormous incentive to bypass the broker and trade with each other: the buyer would go from a surplus of 3 to a surplus of 19, and the seller would go from a surplus of 1 to a surplus of 19. The matching under unit fees is therefore ε-stable for $\varepsilon \geq 16$. Under percentage fees, the highest-value buyer and highest-quality seller are already matched together; the second-highest-value buyer and second-highest-quality seller face the strongest incentive to bypass the broker and trade with each other, but they gain only 2.5 and 4 from doing so; therefore, the matching under percentage fees is ε-stable for $\varepsilon \geq 2.5$.

If unit fees (when costs dominate) or percentage fees (when quality dominates) lead to a more stable matching, this suggests the broker should attract more traders, as traders have less incentive to bypass the broker if there's a cost to searching and trading on their own. Thus, our results on stability seem to reinforce our results on efficiency. When costs dominate, unit fees lead to a more efficient outcome than percentage fees for a given set of traders trading through the broker *and* give more of an incentive for traders to use the broker; when quality dominates, percentage fees lead to both a more efficient outcome and greater incentives to trade through the broker.[26]

3.4. *Trader Heterogeneity and the Desirability of Brokerage.* We can also consider the effect that the characteristics of the distributions F_b and F_s of trader types have on the desirability of brokerage. One might guess that as either buyers or sellers become more heterogeneous, there is more to be gained by pairing them up correctly and therefore more surplus to be gained from brokerage. This intuition is correct, at least in the cases where the broker is likely to select the surplus-maximizing matching—in large, unbalanced markets with the "appropriate" type of fee (Theorem 2).

To state our results, we first need to define what it means for traders on either side of the market to become "more heterogeneous." Roughly, we will say buyers are more heterogeneous when the match surplus a given seller would create with a randomly-chosen buyer becomes more spread out but not consistently higher or lower, and vice versa for sellers. To state this more formally, we first define two standard ways to compare probability distributions. If random variables X and Y have probability distributions F and G, respectively, then

- X *first-order stochastically dominates* Y if for any a, $F(a) \leq G(a)$; that is, X is less likely than Y to be below any value a
- X is *more dispersed than* Y if for any $a < b$, $F^{-1}(b) - F^{-1}(a) \geq G^{-1}(b) - G^{-1}(a)$; that is, the distribution of X has more distance between any two quantiles than the distribution of Y

Let $V(v_b, t_s) = U(v_b, q(t_s)) - c(t_s)$ be the surplus created when a buyer of type v_b buys from a seller of type t_s, which may be positive or negative. Let V_b denote a random buyer type drawn from the distribution F_b, and T_s a random seller type drawn from F_s.

DEFINITION 2. A change in F_b makes buyers **more heterogeneous** if for every t_s, the probability distribution of $V(V_b, t_s)$ becomes more dispersed but does not shift either up or down via first-order stochastic dominance.

[26] Note, however, that the stability results do not automatically strengthen the efficiency results. For example, when quality dominates, if the highest-value buyer and highest-quality seller opt out of brokerage to trade directly with each other instead of matching with other traders through the broker, this increases total surplus provided the cost to them of finding each other is not too high.

Similarly, a change in F_s makes sellers more heterogeneous if for every v_b, the distribution of $V(v_b, T_s)$ becomes more dispersed but does not shift up or down via first-order stochastic dominance.

Define the "social value of brokerage" as the difference in expected total surplus between the matching chosen by the broker and the outcome under random matching. What we find is that in large markets that are sufficiently unbalanced, an increase in heterogeneity on the "long" side of the market (the side with more traders) always increases the social value of brokerage.

THEOREM 5. *If either (a) costs dominate and unit fees are used or (b) quality dominates and percentage fees are used, then*

1. *In large markets with N_b/N_s sufficiently high (many more buyers than sellers), the social value of brokerage increases as buyers become more heterogeneous.*
2. *In large markets with N_b/N_s sufficiently low (many more sellers than buyers), the social value of brokerage increases as sellers become more heterogeneous.*

Similarly to Theorems 1 and 2, however, these results on heterogeneity need not hold in balanced markets. Example 5 in the online appendix illustrates a balanced market in which increasing trader heterogeneity reduces the value of brokerage.

We defer a discussion of the related theoretical literature until later so that we can move on quickly to our empirical analysis in light of our theoretical findings. After that, we will discuss how our model relates to the existing theory literature on intermediation—particularly why many of the complications considered in the existing literature are not needed in our setting. For now, we will quickly discuss one key point. Town officials were concerned that brokerage should benefit both local citizens and foreign merchants (see, for example, the policy statements discussed above). Our theoretical results therefore focus on efficiency—maximizing total surplus—instead of on the surplus earned by buyers. Brokerage can be thought of as a two-sided platform, and trade could only occur if the platform offered sellers sufficient profits to attract merchants to the town. The need to attract sellers to a town could easily be part of why brokerage was appealing—instead of simply passing regulations to allow buyers to buy on increasingly more favorable terms at the expense of sellers, town officials could have considered that well-designed brokerage could potentially increase the gains to both sides of the market, encouraging sellers to come while still preserving the surplus of the local buyers. Under our assumption of Nash bargaining (common to much of the above literature as well), buyers and sellers split the total gains from trade in a fixed ratio, so maximizing surplus (by matching the right buyers to the right sellers) would maximize the payoff to both sides of the market. However, even without this assumption, town officials could not maximize their citizens' long-term gains from trade without ensuring that foreign sellers could earn sufficient profits, making total surplus a reasonable objective function to focus on.

4. BROKERAGE REGULATIONS

Having established some theoretical results about the efficiency properties of brokerage, we now turn to a more systematic examination of a larger sample of brokerage rules. Our study covers towns in the area of Central Western Europe, basically the outline of the Holy Roman Empire north of the Alps at its largest, as well as eastern neighboring cities in the kingdoms of Poland and Hungary. Following Bairoch (1988), our investigation covers the years 1200 to 1700 and includes all cities in this area that had at least 5,000 inhabitants at some point during this period. This means 231 towns were considered; brokerage was identified in 91 of them, and detailed regulations found in 82. Figure 2 shows all towns considered and distinguishes those in which brokerage regulations were found from the others.

The data are compiled from edited and nonedited sources based on several thousand pages of source material, which have been translated and analyzed by us from different mainly medieval Germanic dialects. We analyzed all edited sources available for the area and period of investigation, as well as complementary archival material mentioned in the edited documents or secondary literature. In addition, we checked for documented archival material in all cities in the area of investigation mentioned in Bairoch (1988). The composition of our sample of brokerage regulations thus reflects the random survival and accessibility of the sources, not a conscious biased selection on other bases. (A complete list of all sources can be found in the online appendix.)

4.1. *Existence of Brokerage Regulations.* We begin by investigating which cities instituted brokerage at all and how they compare to the cities that did not. As an indicator for whether brokerage was in use in a town at a particular point in time, we divide our period of investigation (1200–700) into 50-year intervals, creating 10 time windows for each of the 231 cities and therefore 2,310 potential "observations." We create a binary variable whose value is 1 if we find brokerage regulations for that city mentioned at least once during that time period and 0 otherwise. For a time period in which a particular city had no population size information (typically because the town was too small to be captured in the Barioch city population statistics), we drop the observation for most regressions, leaving us with 1,823 city/time-period combinations in which to examine whether brokerage was used.[27] Of these 1,823 city/half-century pairs, 307, or about 17%, contained an observation of brokerage rules (or 13% when considering all 2,310 city/half-century pairs).[28]

We then examine how the presence of brokerage relates to certain demographic, political, and trade-geographic variables that scholars have used in the past to determine economic activity and development. Explanatory variables are defined in detail in the online appendix. Table 1 shows the descriptive statistics of these explanatory variables. For each binary variable, it also includes the fraction of observations where brokerage was found when this variable is equal to 1, and for the other variables, the average of the variable in the observations where brokerage was found. Thus, Table 1 shows that brokerage was found in 42% of observations of cities containing a university, much higher than the overall sample (13%); in addition, it shows that the average population in observations where brokerage was found (17,190) was almost double the average population in the overall sample (8,820).

To understand the relationship between these variables and brokerage, we run probit and linear probability regressions, using the existence of brokerage as the dependent variable and this set of explanatory variables. Table 2 shows the output of these regressions. Column (1) shows the marginal effects from a probit regression incorporating all variables. Column (2) shows coefficients from a linear probability regression. Columns (3)–(8) replace all city- and time-invariant variables with city and century fixed effects. Column (3) incorporates time-varying institutional effects, such as a bishop, free imperial cities, and university towns; column (4) adds log population; column (5) adds time-specific events, such as the period after the Black Death or during the Thirty Years War; column (6) adds the number of neighboring towns with brokerage; column (7) replaces the institutional effects with a one lagged period variable of the bishop, free imperial cities, and university characteristics; and column (8) replaces log population with population quintiles. (Tables 6 and 7 in the online appendix give additional specifications, including some on a smaller balanced sample.)

[27] In the online appendix, we also analyze two balanced samples: one using only cities for which we have population size data for the whole period and one where we replace missing population observations with an arbitrary small population size of 500 (for such an approach see Cantoni, 2015). Both balanced samples deliver very similar results to the unbalanced sample in our primary specification.

[28] The source investigation resulted in a total of 1,804 observed sets of brokerage rules distributed among 307 city/half-century pairs in 82 towns. This 82 is slightly smaller than the number of towns in which we know brokerage existed, 91, since we do not have any detailed regulations for a few of them. A detailed analysis of the regulations follows in the next section.

Table 1
SUMMARY STATISTICS—EXISTENCE OF BROKERAGE

Variable	Mean	Std Dev	Min	Max	% with Brokerage	Mean with Brokerage
		Dependent Variable				
Existence of Brokerage	0.13	0.34	0	1		
		Explanatory Variables				
Free Imperial City	0.17	0.38	0	1	29%	
Bishop	0.19	0.39	0	1	25%	
University	0.05	0.22	0	1	42%	
Hanseatic League	0.17	0.38	0	1	12%	
Roman City	0.13	0.34	0	1	28%	
Water (any port)	0.51	0.50	0	1	23%	
Sea port	0.13	0.33	0	1	28%	
Number of major trade routes	3.2	2.2	1	9		4.30
Number of neighbouring cities with brokerage	1.75	2.20	0	11		2.52
Population (thousands)	8.82	9.93	1	127		17.19
Post Black Death	0.10	0.30	0	1	16%	
Thirty Years War	0.05	0.22	0	1	10%	
		Other Control Variables				
Year	1425	144	1200	1650		1471
Longitude	9.65	5.18	2.88	52.52		8.35
Latitude	50.55	2.07	36.64	54.78		50.37

Note: The total number of observations is 2,310 or 1,823. Institutional variables change over time (with the exception of the Hanseatic League & Roman City); geographic and trade-geographic variables do not.

As the regression results show, we find clear positive relationships between the existence of brokerage regulations and several key variables established in prior literature as being indicative of the level of economic activity. First, we find a positive, statistically significant relationship between brokerage and the population of a city. Population size has been identified as a good proxy variable for economic growth and development in premodern European towns (DeLong and Shleifer 1993, Acemoglu et al. (2005)). Recall that our model finds brokerage to be welfare-increasing in markets that are sufficiently large and unbalanced. In premodern times, we would expect frequent volatility and unbalanced distributions between the buyer and seller sides to be the rule instead of the exception, and we would expect this to be especially true during periods of economic change and growth. One example of such a time was the period after the plague of the Black Death, roughly between 1350 and 1400. Following Epstein (2000), after the death of a large share of the population and a sudden increase of welfare per capita, there was a particular need to economically reconnect different towns and regions by trade. Indeed, this period had a higher likelihood of brokerage. Conversely, during times of war, such as the Thirty Years' War, significantly less economic activity would be expected, and brokerage was indeed less likely to be found in cities that were directly affected by the Thirty Years' War, although the result is not statistically significant when fixed effects are included.

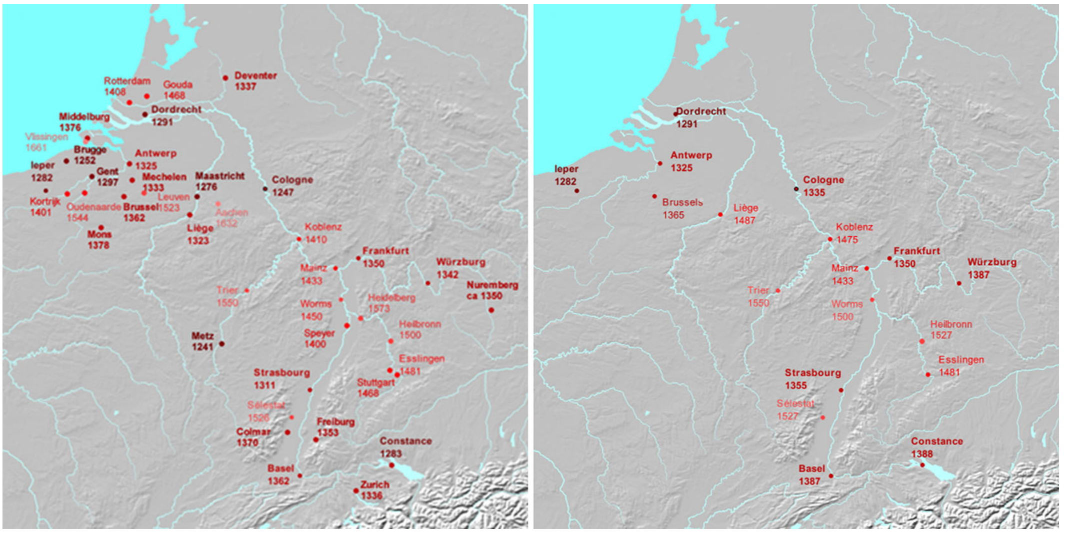
A general time trend cannot be observed. This might be related to the fact brokerage seemed to appear and disappear based on regional economic activity and only stayed permanently once implemented in persisting trade hubs.[29] The earliest brokerage regulations can be observed mainly during the second half of the 13th century in the economic prosperous areas of Belgium, Lower Rhine, and Southern Germany (see Figure 1, left panel), with the first observations in the 1240s.

[29] As a robustness check, we also investigate if the relationship between the institutional variables (as discussed in the next paragraph) and the implementation of brokerage changed over time; the results are consistent when we examine the pre-1500 and post-1500 samples separately; see Table 11 in the online appendix.

TABLE 2
REGRESSION RESULTS: EXISTENCE OF BROKERAGE REGULATIONS, 1200–700

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable:	……………… Existence of Brokerage ………………							
Regression Type:	Probit	……………… Linear Probability Model ………………						
Sample:	……………… Unbalanced ………………							
Fixed Effects:	None	None	……………… City and Century ………………					
Free imperial city	0.09*	0.10*	0.19***	0.26***	0.26***	0.23***	0.33***	0.23***
	[0.04]	[0.04]	[0.05]	[0.05]	[0.05]	[0.07]	[0.12]	[0.07]
Bishop	−0.04	−0.02	−0.19**	−0.20***	−0.20***	−0.24***	−0.21**	−0.24**
	[0.04]	[0.06]	[0.08]	[0.08]	[0.08]	[0.09]	[0.08]	[0.09]
University	0.12***	0.13*	0.10	0.07	0.07	0.04	0.05	0.05
	[0.06]	[0.06]	[0.07]	[0.07]	[0.07]	[0.07]	[0.08]	[0.08]
Hanseatic	−0.06*	−0.06						
	[0.03]	[0.04]						
Roman city	0.09	0.07						
	[0.05]	[0.05]						
Log (Population)	0.13***	0.18***		0.15***	0.15***	0.14***	0.14***	
	[0.02]	[0.03]		[0.03]	[0.03]	[0.03]	[0.04]	
Population quintile 2								0.02
								[0.02]
Population quintile 3								0.04**
								[0.02]
Population quintile 4								0.07*
								[0.04]
Population quintile 5								0.14***
								[0.05]
Water (any port)	0.01	0.00						
	[0.03]	[0.03]						
Sea port	0.22***	0.20**						
	[0.07]	[0.05]						
Number trade routes	0.02***	0.02*						
	[0.01]	[0.01]						
Neighbours w brokerage	0.05**	0.05				0.05**	0.05**	0.06**
(log, within 100 km)	[0.02]	[0.03]				[0.03]	[0.02]	[0.03]
Post Black Death	0.06***	0.06**			0.08**	0.06*	0.07**	0.06*
	[0.02]	[0.02]			[0.03]	[0.03]	[0.03]	[0.03]
Thirty Years War	−0.05***	−0.05**			−0.04	−0.04	−0.04	−0.04
	[0.01]	[0.01]			[0.03]	[0.03]	[0.03]	[0.03]
Year	0.00	−0.00	0.00**	0.00	−0.00	−0.00	−0.00	−0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Longitude	0.00	−0.00						
	[0.00]	[0.00]						
Latitude	−0.01	0.01						
	[0.01]	[0.01]						
Observations	1697	1823	2310	1823	1823	1697	1697	1697
No. of city clusters	225	225	225	225	225	225	225	225
No. of century clusters	5	5	.	.	.	.	.	.
R^2	0.29	0.26	0.48	0.50	0.50	0.54	0.53	053

NOTE: Column (1) gives the marginal effects from the probit regression, column (2) linear probability model estimates, and columns (3)–(8) various linear probability specifications with city and century fixed effects. Robust standard errors are in brackets, clustered by city in all columns and also by century in columns (1) and (2). All results use an unbalanced panel; similar analysis on a smaller balanced panel is in the online appendix. Columns (1) and (2) include all variables; columns (3)–(8) incorporate groups of variables not captured by fixed effects. Column (3) uses time-varying institutional effects only; column (4) adds population size; column (5) adds historical effects; column (6) adds the effect of neighboring cities. Column (7) replaces the time-varying institutional effects with their one-period lag; column (8) replaces population size with the corresponding population quintiles. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.



NOTES: Left map shows the first year brokerage rules were observed in various towns in the Rhine–Maine–Meuse–Scheldt region. Right map shows the first year an "inclusive policy statement" was found. Darker shades of red indicate earlier dates; lighter reds, later dates. In both cases, note the slight spread from North to South in major trade cities from the late 13th into the 14th century, followed by further regional penetration during the 15th and early 16th century.

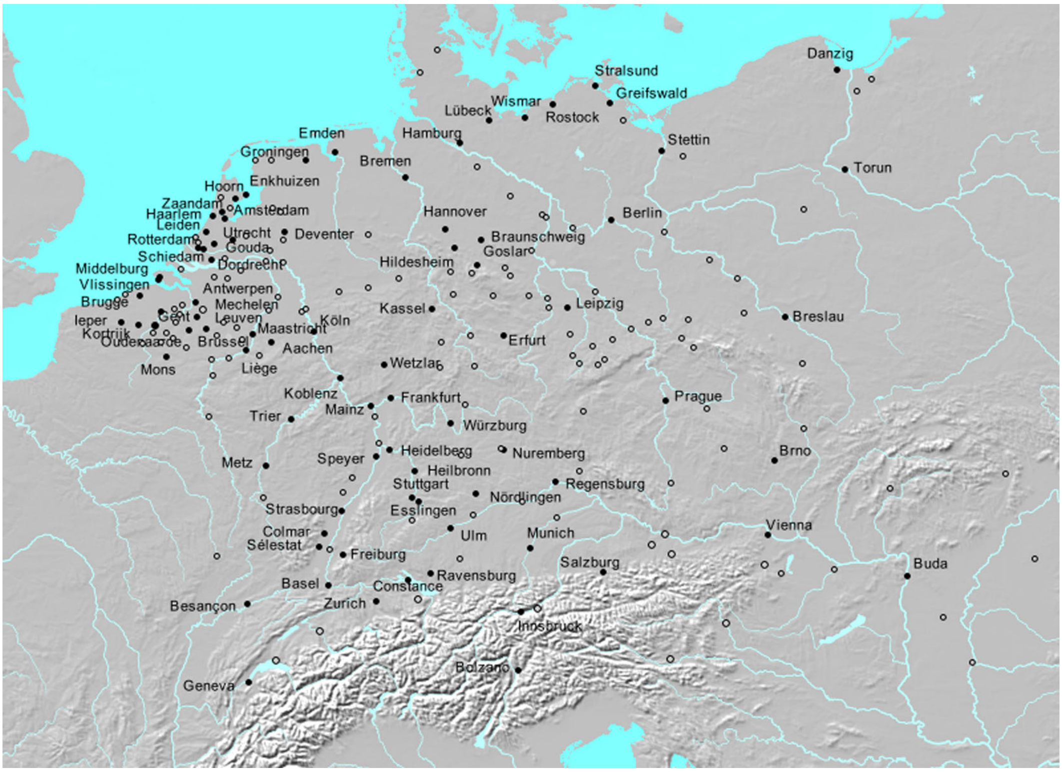
FIGURE 1

DIFFUSION OF IDEAS OVER TIME

Brokerage was also correlated with the trade-geographic location of a town. Cities with access to the sea had a greater likelihood of implementing brokerage regulations; cities with more trade routes reaching the town were also more likely to have brokerage rules. The importance of trade geography for economic development has been identified, for example, by Bosker et al. (2013), and the importance of proximity to the seacoast, particularly the Atlantic coast, by Bairoch (1988) and Acemoglu et al. (2005).

Next, we find a significant relationship between the implementation of brokerage regulations and the political organization of a town. Autonomous cities, such as free and imperial cities, were more likely to implement brokerage regulations than were so-called territorial cities, which were governed by a duke, or bishop towns, which were ruled by an ecclesiastic ruler. This is in line with previous scholars (DeLong and Shleifer 1993, Acemoglu et al. 2005 b, Bosker et al. 2013, Stasavage 2014), who have argued that autonomous cities were particularly active economically due to their need to support local production and trade but also due to the incentives of the local participative governments, which were at least partly represented by local craftsmen and merchants. Thus, the improvement of the allocation process as predicted by the model was a concern of these cities. In contrast, cities ruled top–down by either dukes or bishops could rely on other income streams (rents and taxes) and had less incentive to promote local trade activities. (Cities classified as neither "free imperial" nor "bishop" were ruled by a territorial duke who lived outside the town; the dummy variable for territorial cities is excluded from the regressions, so coefficients on the other city types can be thought of as relative to the baseline of a territorial city.)

Furthermore, we find that the existence of a university in a town is positively correlated with the implementation of brokerage regulations, though the effect is smaller and not statistically significant when fixed effects are included. This is in line with Cantoni and Yuchtmann (2014), who argue that universities produced administrative experts who were able to read



NOTES: Dots depict all towns under investigation, that is, all towns with a population of at least 5,000 at some point during the period of investigation (1200–700). Towns with brokerage regulations are marked with dots and labeled; other towns (without brokerage) are marked with circles. Source: Based on own source material.

FIGURE 2

THE EXISTENCE OF BROKERAGE IN CENTRAL/WESTERN EUROPE BETWEEN 1200 AND 1700

and write and in this way could be instrumental for the town in implementing market regulations.[30]

We also find a significant positive relationship between the existence of brokerage and the number of other cities having brokerage regulations in a radius of 100 km in the previous period of observation. This could indicate imitation or competition effects, as discussed earlier and as illustrated by communications between towns regarding the use of brokerage. This is also in line with the heavy use of brokerage along the Rhine, one of the most important trade routes in our period of investigation, or along the coastline of the North and Baltic Sea (see Figure 2).

We do not find that belonging to the Hanseatic League had a differential effect on a city's likelihood of instituting brokerage. This might seem surprising at first, since we would expect that cities who organize their trade political interests abroad would also organize the markets inside the town walls. However, scholars of the Hansa (Dollinger, 1966; Friedland, 1991) argue that cities belonging to the Hanseatic League were rather heterogeneous and that not all of them were so actively involved; thus, membership was not such a strong indicator of trade activities per se.

Our results also suggest that we are not simply seeing the effects of a selected sample of surviving source material based on the size of a city. We find a large number of significant effects

[30] A direct link between brokerage rules and the historical roots of legal codification based on a Roman heritage cannot be supported. Controlling for a town's Roman origin does not affect the results, and the variable itself is not statistically significant.

TABLE 3
SUMMARY STATISTICS—BROKERAGE RULES

Rule or Rules	Observations	Distinct Towns	Min Year	Max Year	Mean Year
Individual Rules					
Only licensed brokers (a)	956	63	1252	1699	1474
Private business constraint (b)	561	45	1252	1699	1466
Fixed fees (c)	808	65	1252	1699	1480
Unit fees (d)	497	52	1252	1692	1469
Value fees (e)	269	42	1252	1699	1504
Forced brokerage (f)	94	19	1282	1682	1448
Combinations of Rules					
Matchmaking (a+b+c)	420	40	1252	1699	1466
Matchmaking with unit fees (a+b+d)	272	31	1252	1692	1456
Matchmaking with value fees (a+b+e)	143	27	1252	1699	1505
Matchmaking without private business constraint (a+c)	172	30	1322	1674	1520
Matchmaking without fixed fees (a+b)	33	18	1284	1699	1465
Forced matchmaking (a+b+c+f)	47	8	1282	1682	1426

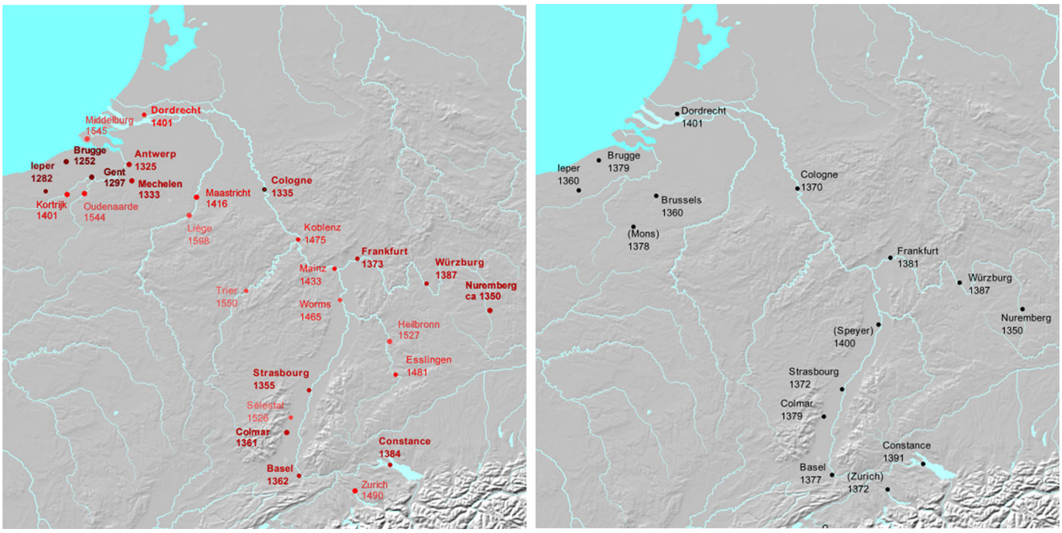
beyond city size, which are related to other institutional and geographical characteristics. For example, brokerage regulations were more frequently found in free and imperial cities than in bishop-led cities, despite the fact that they were smaller on average and that towns with an ecclesiastical institution and leader typically archived materials over a longer period of time. Finally, a large set of robustness checks have been done which can be found in the online appendix.

4.2. *Specific Regulations Implemented.* Next, we return to our sample of 1,804 sets of brokerage regulations found in 82 cities and examine the details of how brokerage was organized. Table 3 shows the number of times and in how many distinct towns a particular regulation was observed, as well as frequently-found combinations of regulations.

The most commonly used rule gave licensed brokers the exclusive right to match buyers and sellers (*only licensed brokers*); this was found in 956 observations from 63 towns.[31] Brokers were often prohibited from conducting private business (*private business constraint*)—this prohibition was found in 561 observations in 45 towns. This constrained the brokers from making profits, acting as a private buyer, being in open or silent partnership with others, or working on commission for nonpresent merchants. In some cases, brokers were also forbidden from being a host for their customers. Brokers typically earned a predefined brokerage fee (*fixed fees*), which came out of the price paid in the transaction and was only paid after the proposed sale was agreed to by the merchants and the transaction was completed. This was found in 808 observations in 65 towns. The most common form of predefined fee was a fixed fee per unit of goods traded (*unit fees*). Common also were fees that depended on the price paid. These were most commonly a simple percentage of the transaction price but were sometimes nonlinear or step functions; we code all of these as *value fees*.[32] Use of a broker was typ-

[31] Other forms of intermediation were generally not allowed. Some early sources documented brokers sharing this privilege with innkeepers—this was seen particularly in the area of the Netherlands and Belgium (see also Boerner, 2016), for example, in Brugge (Gilliodts-Van Severen, 1881; Gelderblom, 2013). Furthermore, there is evidence that during the 17th century in fast-growing cities, such as Amsterdam (Noordkerk (1748), vol. 2, p. 1060–63), Hamburg (Beukemann (1912), p. 545–61), Leipzig (Moltke (1939), p. 14f.), and Nuremberg (Roth (1802), p. 338), private intermediaries who acted as matchmakers were temporarily tolerated and then forbidden again.

[32] The number of observations of fixed fees do not exactly equal the sum of unit and value fees, since a few sources reveal information on the existence of fixed fees but do not inform us of their exact nature and in some cases, we find both types of fees in one observation.



NOTES: The left panel shows towns that implemented the "matchmaking" combination of rules and indicates the first year such regulations were found. The right panel shows the towns that implemented the "matchmaking" regulations for wine, ca. 1350–400. Cities shown in parentheses had wine brokerage but without the full matchmaking design. Source: Based on own source material.

FIGURE 3

MATCHMAKING MECHANISMS ALONG THE RHINE–MAIN–MEUSE–SCHELDT AREA

ically optional; the obligation to use a broker (*forced brokerage*) was only found in 94 observations in 19 towns. Such an obligation was typically only temporary and for selected goods.[33]

When we investigate combinations of rules found together in a single observation, we observe a pattern similar to what we discussed earlier for Frankfurt. In 420 sets of regulations from 40 towns, the town limited brokerage to a few licensed brokers, imposed the private business constraint, and set a predetermined fixed fee (either unit or value-based). Since the broker could not trade on his own but could only facilitate the matching of buyers to sellers, we can think of their role as that of a centralized clearinghouse and matchmaking mechanism. We refer to this combination of rules as *matchmaking* and more specifically as *matchmaking with unit fees* or *matchmaking with value fees*.[34] The prevalence of this particular matchmaking mechanism can be further documented when looking at one of the most important trade routes of the area and period of investigation, the Rhine–Main–Meuse–Scheldt area (Irsliger, 2010). Figure 3 shows in the left panel the diffusion of the matchmaking mechanism in towns along this trade route and shows in the right panel its use specifically for wine brokerage in these towns from 1350 to 1400 to highlight its use for a single important product market along this trade route at a specific point in time.

In a smaller number of observations (172 regulations in 30 towns), brokers were not prohibited from conducting private business on their own behalf, but the other regulations were the same—brokerage was limited to a small number of licensed brokers, merchants could choose whether to use a broker, and brokers received fixed unit or value fees when the trade had taken place. We refer to this combination of rules as *matchmaking without private business constraint*. While this combination of rules has a flavor of intermediaries who act as market makers (i.e., brokers could have acted as resellers on a permanent basis), no such activity of

[33] A permanent obligation for foreigners to use a broker as an intermediary can be only documented in Brugge (see Gilliodts-Van Severen, 1881).

[34] Again, the numbers in Table 3 for the matchmaking mechanisms with different fees do not exactly aggregate up to the category *matchmaking*, since in some observations, we are only informed about the fixed fees but not about the specific form.

official brokers can explicitly be documented from the sources. Interestingly, this set of rules occurs later, on average, than the more frequently observed matchmaking design, with the first such observation occurring only in the early 14th century. This observation, together with the above-mentioned temporary acceptance of private intermediaries during the 17th century in some cities, could be interpreted as the roots of a development that allowed official brokers in some towns during the 18th century to act as market makers (see van Bochove (2013) and Santarosa (2013)). However, no significant "year" coefficients can be estimated when comparing these two designs.[35] In another less common combination of rules found earlier in the sample, merchants were *required* to use a broker, whereas the other regulations (only licensed brokers, no private business, and fixed unit or value fees) remained the same; we refer to these as *forced matchmaking*. Even less common were regulations that did not specify a fixed level of fees (*matchmaking without fixed fees*) but where the other dominant rules remained the same.

4.3. *Product Categories and Brokerage Fee Basis.* One important variable in the regulation of brokerage was the choice between unit and value fees. Since private business was prohibited, brokerage fees were the direct income streams for the brokers and consequently determined the incentives they faced; as we demonstrated in the theory section, the fee structure can have a large effect on the broker's behavior and therefore on the outcomes achieved.

As exemplified in the case of Frankfurt, brokerage regulations were for particular products or product categories. The products covered were basic foodstuffs, such as fish, grain, wine and beer, cattle and meat, and oil and fat; finished cloths or input goods for the textile "industry," such as raw textiles (wool, linen, fustian, etc.) or fur, skins, and leather; spices and similar products (in particular coloring products); construction material; metals; financial products (including gold and silver); and property (land and houses). All of these categories could be found through the whole period of investigation, typically in towns along trade routes for these products (for example, as shown in Figure 3 for wine brokerage in towns along the Rhine–Main trade route). A few products—financial products, property, and construction material—can be more frequently documented later on; this can be explained by the development of financial markets and increasing urbanization with the related demand for construction material.[36]

Table 4 gives some descriptive statistics for each product category. Columns one and two show how many times and in how many distinct towns brokerage rules were observed for each product category. The third column shows the mean of the year for each product. The last four columns relate to the choice of unit versus value-based brokerage fees. Column four shows how many sets of regulations for a product category specified either unit or value fees (fixed fees with information on the fee type)[37]; column five shows the fraction of these observations that specified unit fees. Column six shows how many observations for a product category specified fixed fees in combination with the other regulations in the dominant combination of regulations we labeled matchmaking (brokers having the exclusive right to act as intermediaries and being barred from private business and brokerage not being mandatory); column seven shows the fraction of these observations that specified unit fees. Thus, for example, brokerage rules for financial products were observed 113 times and in 31 towns. In 49 of these observations, fixed fees were specified as the fee type, and in only 6% of these 49 observations were the fixed fees unit fees. In 25 observations, the matchmaking combination was used with specified fixed fees, and in just 8% of these observations were they unit fees. Thus, while unit

[35] See Table 12 in the online appendix.

[36] A debate on wood scarcity from the 16th century onward has also been established in the literature (von Below and Breit, 1998).

[37] In very few observations, both types of fees are mentioned. In this case, we assign the observation to value fees.

TABLE 4
SUMMARY STATISTICS — PRODUCT CATEGORIES AND UNIT VERSUS VALUE FEES

Product	Observations	Towns	Mean Year	Fixed Fees	% Unit Fees	Matchmaking w Fixed Fees	% Unit Fees
Finance	113	31	1511	49	6%	25	8%
Property	50	19	1523	27	7%	15	0%
Horses	91	27	1450	36	8%	22	0%
Wine and beer	151	42	1469	70	96%	39	97%
Grain	84	29	1473	41	78%	23	87%
Fish	102	25	1492	40	95%	22	95%
Cattle and meat	57	19	1460	23	87%	10	90%
Oil and fat	68	25	1464	55	96%	25	96%
Construction material	88	24	1518	58	81%	28	96%
Metal	65	22	1449	41	78%	22	77%
Spices	96	33	1473	61	69%	29	69%
Raw textile	125	35	1469	67	46%	38	42%
Fur, skin, and leather	87	26	1446	49	67%	26	62%
Cloth	144	42	1449	62	37%	33	21%
Total	1,307	75	1475	683	61%	362	60%

fees were slightly more common than value fees in the overall sample, financial products were much more commonly traded with value fees.[38]

Table 5 gives regression results to establish whether these patterns in the relationship between product category and fee type are statistically significant and persist when we control for city size, time, geography, political institutions, and trade geography, as in the earlier regressions. Columns (1)–(4) use the 683 observations of fixed fees (where we have information on the type of fees), with the dependent variable being a dummy for whether unit fees (as opposed to value fees) were used. Column (1) gives the marginal effects from a probit regression with all covariates, column (2) the results from a linear probability regression with all covariates, and (3)–(4) give linear probability regressions with city and century fixed effects, controlling for different sets of covariates. Columns (5)–(8) show analogous results for the subsample of observations where either unit or value fees were found in combination with the other "matchmaking" combination of rules, where we have 362 observations with a known fee structure. A positive coefficient indicates that unit fees were more common for a given product, and a negative coefficient indicates that value fees were more common. Error terms are again clustered by city and (for columns (1)–(2) and (5)–(6)) by century. (Tables 8 and 9 in the online appendix show results for additional specifications.)

Looking at the product categories in Tables 4 and 5, we find broad agreement between the type of fees more commonly used for a given product and the type of fees predicted by our theory model to be more efficient. Three products were traded much more frequently via brokerage with value fees: horses, property, and financial products. (These have small percentages in columns 5 and 7 of Table 4 and statistically significant negative coefficients in Table 5.) All these products can be thought of as having highly heterogeneous quality and likely heterogeneous tastes among buyers. On the other hand, basic consumption goods, such as grain, wine and beer, fish, cattle and meat, oil and fat, and raw input and construction materials, such as wood, bricks, and metals, were all rather homogeneous, and all were mainly traded via unit fees.

On the other hand, there were some products that were commonly traded using both unit and value fees. Spices and similar goods such as coloring products fit this description, as do products for the clothing manufacturing "industry": raw textile inputs, such as wool, linen, or

[38] Note that the number of observations of fixed fees or of matchmaking with fixed fees in the "total" row does not match the sum of the product categories. This is because no product category was specified in a few observed regulations, and in rare cases, a product was mentioned that did not fit into one of the listed categories.

TABLE 5
REGRESSION RESULTS—DETERMINANTS OF FEE STRUCTURE, 1200–700

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable:	. . . . 1 if unit fees, 0 if value fees							
Regression Type:	Probit	. Linear Probability Model .			Probit	. Linear Probability Model .		
Sample:	. . . Brokerage Rules with Fixed Fees . . .				. . . Smaller "Matchmaking" Sample . . .			
Fixed Effects:	None	None	City and Century		None	None	City and Century	
Finance	−0.47***	−0.47***	−0.43***	−0.43***	−0.71***	−0.46**	−0.44***	−0.41***
	[0.17]	[0.09]	[0.07]	[0.07]	[0.21]	[0.10]	[0.13]	[0.13]
Property	−0.37	−0.40**	−0.32***	−0.33***	.	−0.45*	−0.44***	−0.42***
	[0.29]	[0.14]	[0.07]	[0.07]	.	[0.18]	[0.13]	[0.13]
Horses	−0.49**	−0.52**	−0.54***	−0.54***	.	−0.63**	−0.63***	−0.64***
	[0.22]	[0.14]	[0.10]	[0.10]	.	[0.14]	[0.14]	[0.15]
Wine and Beer	0.39***	0.32**	0.35***	0.35***	0.25***	0.30**	0.29**	0.30***
	[0.05]	[0.10]	[0.07]	[0.07]	[0.03]	[0.08]	[0.11]	[0.11]
Grain	0.32***	0.24	0.24**	0.24**	0.19***	0.27	0.27**	0.28**
	[0.07]	[0.12]	[0.10]	[0.10]	[0.02]	[0.15]	[0.13]	[0.13]
Fish	0.37***	0.33*	0.32***	0.32***	0.22***	0.31	0.31**	0.32***
	[0.05]	[0.14]	[0.09]	[0.09]	[0.03]	[0.17]	[0.15]	[0.15]
Cattle and meat	0.30***	0.22	0.24**	0.29***	0.06	0.15	0.14	0.16
	[0.07]	[0.12]	[0.11]	[0.11]	[0.09]	[0.15]	[0.16]	[0.15]
Oil and fat	0.40***	0.34**	0.34***	0.34***	0.22***	0.33*	0.29**	0.29**
	[0.05]	[0.12]	[0.06]	[0.06]	[0.03]	[0.13]	[0.12]	[0.12]
Construction material	0.33***	0.24	0.24**	0.23**	0.23***	0.37**	0.33**	0.34**
	[0.07]	[0.12]	[0.10]	[0.10]	[0.03]	[0.15]	[0.14]	[0.15]
Metal	0.28***	0.13	0.09	0.09	0.15**	0.14	0.09	0.10
	[0.06]	[0.12]	[0.10]	[0.10]	[0.06]	[0.15]	[0.14]	[0.14]
Spices	0.22***	0.04	0.02	0.02	0.10*	0.02	0.00	0.00
	[0.04]	[0.06]	[0.08]	[0.07]	[0.06]	[0.10]	[0.12]	[0.12]
Raw textile	0.01	−0.19	−0.20**	−0.20*	−0.17	−0.24	−0.28	−0.28
	[0.17]	[0.12]	[0.11]	[0.07]	[0.34]	[0.21]	[0.21]	[0.21]
Fur, skin and leather	0.22***	0.08	0.04	0.03	0.08	0.01	−0.04	−0.03
	[0.08]	[0.08]	[0.10]	[0.10]	[0.13]	[0.13]	[0.15]	[0.15]
Cloth	−0.11	−0.28*	−0.28**	−0.29**	−0.53*	−0.45*	−0.50***	−0.49***
	[0.21]	[0.11]	[0.11]	[0.11]	[0.30]	[0.18]	[0.17]	[0.17]

(*Continued*)

TABLE 5
(CONTINUED)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable:	. . . . 1 if unit fees, 0 if value fees							
Regression Type:	Probit	. Linear Probability Model .			Probit	. Linear Probability Model .		
Sample:	. . . Brokerage Rules with Fixed Fees . . .				. . . Smaller "Matchmaking" Sample . . .			
Fixed Effects:	None	None	City and Century		None	None	City and Century	
Time and (geography)	YES	YES	YES	YES	YES	YES	YES	YES
Institutions	YES	YES		YES	YES	YES		YES
Population	YES	YES		YES	YES	YES		YES
Trade geography	YES	YES			YES	YES		
Observations	680	680	683	680	325	362	362	361
City clusters	57	57	57	57	38	38	38	26
Century clusters	5	5	.	.	5	5	.	.
(Pseudo) R^2	0.39	0.41	0.53	0.53	0.54	0.33	0.63	0.64

NOTE: Robust standard errors clustered by city code (and by century for columns (1), (2), (5), and (6)) are in brackets. Column (1) gives marginal results for the probit regression, column (2) gives linear probability regression results, and columns (3)–(4) give linear probability results with city and century fixed effects for unit (as opposed to value) fees for all products. Columns (1) and (2) control for all variables, (3)–(4) control for time, the remaining time-varying institutional variables, and population in the fixed effects specifications. Columns (5)–(8) repeat the same four specifications on the smaller sample of regulations with the "matchmaking" combination of rules and fixed fees. In column (5), (probit regression on the smaller sample), two categories are omitted because all observations of these products used value fees. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

fustian, (semifinished) cloth, and also furs, skins, and leather products. This might be surprising for some products based on the pattern we have observed so far: some of these products differed widely in value and quality, and we would expect that buyers had fairly heterogeneous preferences for them. However, it appears that towns followed two different strategies, which explains this observed use of both fee structures. For example, for the product category of spices, when unit fees were used, we find long detailed lists of different spices, with a different unit fee assigned for each one. (One example is brokerage rules from Frankfurt in 1373—see Buecher, 1915, p. 250.) This reduced the heterogeneity within the category. On the other hand, when value fees were used, only a general expression for spices was mentioned, with a fixed percentage applying to all of them. (An example is denoted by the rules from Ofen in 1403—see Michney and Lichner 1845, p. 74; from Bruinswick in 1320, see Hänselmann and Mack 1900, vol. 2, p. 516–7.) A similar pattern can be observed for cloth, where many specific types of cloths were listed separately with unit fees or else a single level of percentage fees was used for many different types of cloth.[39,40]

Thus, our empirical findings on the variation in the fee basis both with and without the other regulations in the "matchmaking" design broadly agree with the fee structure our theoretical model suggests would have been more efficient.

Most other covariates do not show any significant effect when comparing fee structures in the larger sample. In the smaller sample of matchmaking, we find a bit of correlation between the use of value instead of unit fees and the variables previously related to stronger overall economic activity. Finally, product categories have no impact on other details of the brokerage design.[41]

5. DISCUSSION OF OUR MODEL AND THE HISTORICAL CONTEXT

Having deferred this discussion earlier, we now discuss our theoretical model with the existing literature on intermediation, with a focus on the modeling choices we made that seemed most appropriate given the historical context.

Bloch and Ryder (2000) study a model similar to ours but where the broker is constrained to choose a (typically unique) stable matching and the incentive for traders to instead search on their own is to avoid paying the broker's fee. Yavaş (1994) studies a similar model but where traders endogenously choose how hard to search as well. (These models often feature multiple equilibria, and which traders use the broker can depend on the form of fees.) Since brokers' fees were low in our historical context (Gelderblom, 2013) and set by the town, we instead allow the broker to choose any individually rational matching and assume he chooses the one that maximizes commissions, then examine the effect this has on welfare and traders' incentives to use the broker.

Several papers focus on middlemen, such as retailers who hold an inventory of many products. Some (Johri and Leach, 2002; Shevchenko, 2004) focus on a middleman's role in improving match quality in a setting with heterogeneous goods and idiosyncratic preferences. Others

[39] In some cities, particularly during the 17th century, we find a combination of both systems at work: long lists of products with unit fees plus a group of products with percentage fees. For Amsterdam, see Noordkerk (1748), p.1060–63; for Hamburg, see Beukemann (1912), p. 542–61. In cases where we found both types of fees in one observation, we coded this as value fees in the empirical analysis.

[40] Harder to explain is the frequent use of value fees for raw textiles, as these products are rather homogeneous. Indeed, when these products are traded by unit fees, we rarely find longer lists of products with different fees as in the case of spices: we find one unit fee for a sack of wool (Cologne 1406, in Stein II, 1893–95, p. 113f.) or a bale of fustian (Middleburg 1405, in Pols 1888, p. 597). Nevertheless, we also frequently observe regulations specifying value fees. In the case of regulations from Bruinswick, we find a switch from unit fees (in 1320) to value fees (in 1433).

[41] The full regression output can be found in Table 12 in the online appendix. In addition, a comparison between the matching design and the second most frequent design (matching without a private business constraint) can be found there. Introducing a private business constraint into the brokerage regulations is strongly predicted by the political variables: towns with strong governments, such as a bishop seat or a local parliament (free and imperial cities), were more likely to implement such a regulation. Both can be explained by a stronger legislature and enforcement of these market regulations. This is in line with what we found before related to the general implementation of brokerage regulations.

(Biglaiser 1993, Biglaiser and Friedman 1994, Li 1998) focus on a middleman's role in implicitly guaranteeing quality, thereby mitigating a moral-hazard problem in settings where buyers cannot judge quality for themselves. While our focus is on a different form of intermediation, this role of quality certification can be sometimes documented as a complementary role of the premodern broker (Boerner, 2016), but we focus in this article on the broker's role as matchmaker. A number of papers endogenize the form of intermediary (matchmakers vs. market makers) or their number by modeling entry by potential intermediaries (Nosal et al., 2015; Rubinstein and Wolinsky, 1987; Rust and Hall, 2003; Yavaş, 1992). In our historical setting, the form of intermediation was chosen by the town and entry was restricted to approved brokers. Such models would be appropriate for later periods, when private intermediaries coexisted with official brokers. Official brokers in the form of matchmakers generally persisted throughout the 18th and 19th centuries, but private intermediaries such as officially permitted marketmakers became increasingly important in larger markets.

Finally, a number of papers (Caillaud and Jullien, 2003; Hossain et al., 2011) study competing matchmakers in the form of market platform competition. In our historical context, competition between brokers within a town was specifically ruled out. However, the spread of brokerage—and its role in the competition between towns to attract foreign merchants—bears further historical study, especially in light of our initial findings on the "neighbor town effect" in our data. Such competition along trade routes and the resulting brokerage institutions might be identified as one institutional basis for market integration and price adjustment between towns: brokerage might have reduced price distortion and frictions in marketplaces and supported price equalization between towns. In this way, the findings of this study relate to the market integration literature in economic history (for instance, see Bateman (2011); Federico (2012); Chilosi et al. (2013)).

Most (though not all) of the literature cited above use multiperiod models, in which a buyer or seller who failed to trade today could return to the market in the future and try again, and focus on steady states where the entry of new traders balances the exit of successful traders. For our application, this seemed unnecessary; traveling sellers were typically in a town for a short amount of time, so modeling this as a single opportunity to trade seemed more natural than an infinite-horizon model. As discussed earlier, our results focus on efficiency—maximizing total surplus—instead of on maximizing the surplus of the buyer side (or of the intermediary), due to the town's need to attract sellers. Finally, like some but not all of the literature discussed above, we simplified our analysis by assuming full information—that the broker knows both buyers' and sellers' preferences and does not have to concern himself with learning them.[42] If buyers and sellers had private information about their types, they might well have incentives to misrepresent them to the broker in order to be matched to a different trader or to trade at a more favorable price. This incentive is always present, but we would expect it to be smallest when "good" traders are rewarded with "good" matches, which tends to happen more with percentage fees, especially in the quality-dominates case. Private information would also be another important reason for the private business constraint—traders would presumably be much more willing to reveal their true type when the broker was only going to use it to match them to a trading partner as opposed to being a middleman who was seeking to buy from them (or sell to them) at the most advantageous price.

6. CONCLUSION

This article studies the implementation of allocation mechanisms in pre-industrial economies. We examine brokerage as a market clearing institution implemented by town officials in late medieval and early modern merchant cities. We show that cities implemented brokerage in environments associated with stronger economic activity. In addition, we show

[42] In a different model in earlier versions of this article, we assumed the broker knew buyers' preferences but needed to elicit sellers', and we obtained qualitatively fairly similar results.

that the specific brokerage mechanisms chosen were sensitive to the product markets where they were applied and that the patterns in product-specific choices are broadly consistent with the welfare-maximizing ones.

To achieve these results, based on an investigation of 231 cities, we created a comprehensive source analysis covering brokerage statutes from 82 towns north of the Alps in Central and Western Europe from the middle of the 13th century until the end of the 17th century. We identified brokerage as a centralized matchmaking institution implemented by towns to promote and support trade, to create welfare for the town and their citizens, and to give equal opportunities to the citizens and foreign merchants.

We introduced a theoretical matching model and showed that the optimal form of brokerage fees—price-based fees when products are more heterogeneous in quality and volume-based fees when products are more homogeneous—generates more surplus and a greater incentive for traders to use the broker, and that brokerage creates more surplus than random matching in large unbalanced markets if the appropriate form of fees are used. We showed that the implementation of brokerage regulations correlates with variables related to economic activity identified in the literature and that variations in the fees used are largely consistent with the welfare-maximizing ones.

These results show the important role of market design for economic development. Our findings highlight the active role of merchant cities in pre-industrial Europe in creating markets and solving incentive and allocation problems. They support the argument of an institutional change starting during this period that created large benefits for society. In particular, we identify centralized allocation mechanisms as open access order institutions (North et al., 2009) and as market policy instruments that have an impact on the welfare of both sides of the market (Heckscher, 1935).

These results open up new questions for a future research agenda. This article covers one specific market clearing mechanism out of a larger set of medieval market rules. Other rules covered market location and the timing of buying and selling goods. It would be of considerable interest to examine the interplay of brokerage and other market mechanisms. Another question relates to a more detailed understanding of the evolution, adaptation, and learning behavior of market rules over time. Finally, it would be interesting to link market making activities more explicitly to city growth to understand causation, with the ultimate goal of understanding the divergence in growth paths in different cities and regions.

ACKNOWLEDGEMENT

Open Access funding enabled and organized by Projekt DEAL.

Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table 15: Baseline specification, sellers outnumber buyers
Table 16: Different specifications of costs-dominate case (qs = 1 for every seller)
Table 17: Different specifications of quality-dominates case (vb U[5, 10], qs U[5, 10])

REFERENCES

ABDULKADIROĞLU, A., and T. SÖNMEZ, "Matching Markets: Theory and Practice," *Advances in Economics and Econometrics* 1 (2013), 3–47.

ACEMOGLU, D., and J. ROBINSON, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* (New York: Crown Publishing Group, 2012).

———, S. JOHNSON, and J. ROBINSON, "The Rise of Europe: Atlantic Trade, Institutional Change and Growth," *American Economic Review* 95(3) (2005), 546–79.

———, ———, and ———, "Institutions as a Fundamental Cause of Long-Run Growth," in P. Aghion and S. N. Durlauf, eds., *Handbook of Economic Growth*, Volume 1, Part A (Amsterdam: Elsevier, 2005b), 385–472.

BAIROCH, P., *Cities and Economic Development, from the Dawn of History to the Present* (Chicago: Chicago University Press, 1988).

———, J. BATOU, and P. CHEVRE, *La Population des villes Europeennes, banque des donnees et analyse sommaire des resultats: 800–1850* (Geneva: Droz, 1988).

BATEMAN, V. N., "The Evolution of Markets in Early Modern Europe, 1350-1800: A Study of Wheat Prices," *Economic History Review* 64(2) (2011), 1–25.

BEUKEMANN, F., *Die Geschichte des Hamburger Mäklerrechts* (Heidelberg: Carl Beyer, 1912).

BEYERBACH, J. C., *Sammlung der Verordnungen der Reichsstadt Frankfurt* (Frankfurt a. M., 1818).

BIGLAISER, G., "Middlemen as Experts," *RAND Journal of Economics* 24(2) (1993), 212–23.

———, and J. FRIEDMAN, "Middlemen as Guarantors of Quality," *International Journal of Industrial Organization* 12 (1994), 509–31.

BINMORE, K., A. RUBINSTEIN, and A. WOLINSKY, "The Nash Bargaining Solution in Economic Modelling," *RAND Journal of Economics* 17(2) (1986), 176–88.

BLOCH, F., and H. RYDER, "Two-Sided Search, Marriages, and Matchmakers," *International Economic Review* 41(1) (2000), 93–115.

BOERNER, L., "Medieval Market Making: Brokerage Regulations in Late Medieval and Early Modern Central/Western Europe," LSE Economic History Working Paper, 2016.

———, and J. W. HATFIELD, "The Design of Debt Clearing Markets: Clearinghouse Mechanisms in Pre-Industrial Europe," *Journal of Political Economy* 125(6) (2017), 1991–2037.

———, and A. RITSCHL, "The Economic History of Sovereignty: Communal Responsibility, the Extended Family, and the Firm," *Journal of Institutional and Theoretical Economics* 165(1) (2009), 99–112.

BOSKER, M., E. BURINGH, and J. L.VAN ZANDEN, "From Baghdad to London: Unraveling Urban Development in Europe, the Middle East, and North Africa, 800-1800," *Review of Economics and Statistics* 95(4) (2013), 1418–37.

BUECHER, K.,ed.,*Frankfurter Amts- und Zunfturkunden bis zum Jahre 1612* (Frankfurt a. M.: Baer, 1915).

CAILLAUD, B., and B. JULLIEN, "Chicken & Egg: Competition among Intermediation Service Providers," *RAND Journal of Economics* 34(2) (2003), 309–28.

CANTONI, D., "The Economic Effects of the Protestant Reformation: Testing the Weber Hypothesis in the German Lands," *Journal of the European Economic Association* 13(4) (2015), 561–98.

———, and N. YUCHTMANN, "Medieval Universities, Legal Institutions, and the Commercial Revolution," *Quarterly Journal of Economics* 129 (2014), 823–87.

CHILOSI, D., T. E. MURPHY, R. STUDER, and A. C. TUNÇER, "Europe's Many Integrations: Geography and Grain Markets, 1620-1913," *Explorations in Economic History* 50(1) (2013), 46–68.

COASE, R., "The Problem of Social Cost," *Journal of Law and Economics* 3 (1960), 1–44.

DE ROOVER, R., "The Organization of Trade," in M. M. Postan, E. E. Rich, and E. Miller, eds., *The Cambridge Economic History of Europe from the Decline of the Roman Empire*, Volume 3 (Cambridge: Cambridge University Press, 1963), 42–118.

DEMONT, V., M. SCHERMAN, and A. W. SLEESWIJK,eds.,*Le pouvoir des courtiers. Univers marchandet acteurs du courtage en Europe (XIVe-XVIIIe siècle)* (Paris: Presses de l'École normale supérieure, 2018).

DIETZ, A., *Frankfurter Handelsgeschichte*, 5 Volumes (Frankfurt a. M.: Hermann Minjon, 1910–1925).

DIJKMANN, J., *Shaping Medieval Markets. The Organisation of Commodity Markets, C.1200–C.1450* (Leiden: Brill, 2011).

DOLLINGER, P., *Die Hanse* (Stuttgart: Alfred Kröner Verlag, 1966).

DONNA, J., and J.-A. ESPÍN-SÁNCHEZ, "The Illiquidity of Water Markets: Efficient Institutions for Water Allocation in Southeastern Spain," Working Paper, 2015.

Federico, G., "How Much Do We Know about Market Integration in Europe?," *Economic History Review* 65(2) (2012), 470–97.

Friedland, Klaus, *Die Hanse* (Stuttgart: Verlag W. Kohlhammer, 1991).

Gelderblom, O., *Cities of Commerce: The Institutional Foundation of International Trade in the Low Countries, 1250-1650* (Princeton: Princeton University Press, 2013).

Gehrig, T., "Intermediation in Search Markets," *Journal of Economics and Management Strategy* 2 (1993), 97–120.

Gény, Joseph, *Elsäsische Stadtrechte, I Schlettstadter Stadtrechte* (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1902).

Gilliodts-Van Severen, L., "Les Anciens Règlements de la Corporation de Courtiers de Bruges," *La Flandre, Revue des monuments d'histoire et d'antiquitiés* XII(1881), 121–48, 219–60.

Greif, A., "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition," *American Economic Review* 83(3) (1993), 525–48.

———, "Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies," *Journal of Political Economy* 102(5) (1994), 912–50.

———, *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade* (Cambridge: Cambridge University Press, 2006).

Hänselmann, L., and H. Mack, eds., *Urkundenbuch der Stadt Braunschweig II and III* (Braunschweig: Schwetschke, 1900).

Hayek, F. A., *The Constitution of Liberty* (Chicago: Chicago University Press, 1960).

Heckscher, E. F., *Mercantilism* (London: George Allen & Unwin Ltd., 1935).

Henning, W. F., *Handbuch der Wirtschafts- und Sozialgeschichte Deutschlands. Band 1: Deutsche Wirtschafts- und Sozialgeschichte im Mittelalter und in der frühen Neuzeit* (Paderbron: Ferdiand Schöningh, 1991).

Hibbert, A. B., "The Economic Policies of Towns," in M. M. Postan, E. E. Rich, and E. Miller, eds., *The Cambridge Economic History of Europe*, Volume III (Cambridge: Cambridge University, 1963), 157–230.

Hoehlbaum, K., K. Kunze, H. G. Van Rundstedt, and W. Stein, *Hanisches Urkundenbuch*, 11 Volumes (Halle: Verlag der Buchhandlung des Waisenahauses, 1876–1939).

Holtfrerich, C. L., *Frankfurt as a Financial Centre: From Medieval Trade Fair to European Banking Centre* (Munich: Verlag C.H. Beck, 1999).

Hossain, T., D. Minor, and J. Morgan, "Competing Matchmakers: An Experimental Analysis," *Management Science* 57(11) (2011), 1913–25.

Hunt, E. S., and J. M. Murray, *A History of Business in Medieval Europe, 1200-1550* (Cambridge: Cambridge University Press, 1999).

Irsliger, F., "Der Rhein als Handelsstrasse im späten Mittelalter," in F.J. Felten, ed., *Wirtschaft an Rhein und Mosel: Von den Römern bis ins 19. Jahrhundert* (Stuttgart: Franz Steiner Verlag, 2010)

Jenkins, D.,ed.,*The Cambridge History of Western Textiles* (Cambridge: Cambridge University Press, 2003).

Johri, A., and J. Leach, "Middlemen and the Allocation of Heterogeneous Goods," *International Economic Review* 43(2) (2002), 347–61.

Kalai, E., and M. Smorodinsky, "Other Solutions to Nash's Bargaining Problem," *Econometrica* 43(3) (1975), 513–18.

Li, Y., "Middlemen and Private Information," *Journal of Monetary Economics* 42 (1998), 131–59.

Lieber, A. E., "Eastern Business Practices and Medieval European Commerce," *Economic History Review* 21(2) (1968), 230–43.

Lopez, R. S., *The Commercial Revolution of the Middle Ages, 950-1350* (Cambridge: Cambridge University Press, 1976).

Matheus, M.,ed.,*Weinproduktion und Weinkonsum im Mittelalter* (Stuttgart: Steiner Verlag, 2004).

McCusker, J. J., and C. Gravesteijn, *The Beginnings of Commercial and Financial Journalism* (Amsterdam: NEHA, 1991).

Michney and Lichner, eds., *Das Ofener Stadrecht von 1244-1421* (Pressburg: Böhlau Verlag, 1845).

Milgrom, P., *Putting Auction Theory to Work* (Cambridge: Cambridge University Press, 2004).

———, "Auction Market Design: Recent Innovations," *Annual Reviews* 11 (2019), 383–405.

Moltke, S., *Die Geschichte der Leipziger Maklerschaft* (Leipzig: Deichert, 1939).

Munro, J., "The International Law Merchant and the Evolution of Negotiable Credit in Late-Medieval England and the Low Countries, " in J. Munro, ed., *Textiles, Towns, and Trade: Essays in the Economic History of Late Medieval England and the Low Countries* (Ashgate: Aldershot, 1994).

Nash, J., "The Bargaining Problem," *Econometrica* 18(2) (1950), 155–62.

———, "Two-Person Cooperative Games," *Econometrica* 21(1) (1953), 128–40.

Neeman, Z., and N. Vulkan, "Markets versus Negotiations: The Predominance of Centralized Markets," *B.E. Journal of Theoretical Economics* 10(1) (2010), 1–30.

NOORDKERK, H., *Handvesten van Amsterdam*, 3 Volumes (Amsterdam: Hendrik van Waeseberge, Salomon, and Petrus Schouten, 1748).

NORTH, D. C., *Structure and Change in Economic History* (New York: Norton, 1981).

———, *Institutions, Institutional Change, and Economic Performance* (Cambridge: Cambridge University Press, 1990).

———, J. J. WALLIS, and B. R. WEINGAST, *Violence and Social Orders: A Conceptual Framework for Interpreting Recorded Human History* (Cambridge: Cambridge University Press, 2009).

NOSAL, E., Y. Y. WONG, and R. WRIGHT, "More on Middlemen: Equilibrium Entry and Efficiency in Intermediated Markets," *Journal of Money, Credit and Banking* 47(2) (2015), 7–37.

PFEIFFER, F., *Rheinische Transitzölle im Mittelalter* (Berlin: Akademie Verlag, 1997).

POLS, M. S., *Westfriesche Stadtrechten* ('S Gravenhage: Martinus Nijhoff, 1888).

POSTAN, M. M., "The Trade of Medieval Europe," in E. E. Rich, C. Postan and M. M. Postan eds., *The Cambridge Economic History of Europe*, Volume 2 (Cambridge: Cambridge University Press, 1987), 168–305.

REZZARA, J., *Die Mediatori Del Contratto Di Mediazione: Studio Di diritto Commerciale* (Torino: Fratelli Bocca, 1903).

RICHARDSON, G., "Guilds, Laws, and Markets for Manufactured Merchandise in Late-Medieval England," *Explorations in Economic History* 41 (2004), 1–25.

ROSE, S., *Wine Trade in Medieval Europe, 1000-1500* (London: Continuum, 2011).

ROTH, A. E., "The Art of Designing Markets," *Harvard Business Review* 85(10) (October 2007), 118–26.

———, "What Have We Learned from Market Design?," *Economic Journal* 188 (2008), 285–310.

———, *Who Gets What and Why: The New Economics of Matchmaking and Market Design* (Boston: Mariner Books/Houghton Mifflin Harcourt, 2016).

———, and M. A. O. SOTOMAYOR, *Two-Sided Matching: A Study in Game-Theoretic Modeling and Analysis* (Cambridge: Cambridge University Press, 1990).

———, and X. XING, "Jumping the Gun: Imperfections and Institutions Related to the Timing of Market Transactions," *American Economic Review* 84(4) (1994), 992–1044.

ROTH, J. F., *Geschichte des Nürnbergischen Handels*, 4 volumes (Leipzig: Adam Friedrich Böhme, 1802).

ROTHMANN, M., *Die Frankfurter Messen im Mittelalter* (Stuttgart: Franz Steiner Verlag, 1998).

RUBINSTEIN, A., and A. WOLINSKY, "Middlemen," *Quarterly Journal of Economics* 102(3) (1987), 581–93.

RUST, J., and G. HALL, "Middlemen versus Market Makers: A Theory of Competitive Exchange," *Journal of Political Economy* 111 (2003), 353–403.

SANTAROSA, V. A., "Pre-Banking Financial Intermediaton: Evidence from a Brokerage Law Reform in 18th Century Marseille," Working Paper, University of Michigan, 2013.

SCHMITZ, H. J., *Faktoren der Preisbildung für Getreide und Wein in der Zeit von 800 bis 1350* (Stuttgart: Gustav Fischer Verlag, 1968).

SCHUBERT, H., *Unterkauf und Unterkäufer in Frankfurt am Main im Mittelalter* (Frankfurt, 1962).

SHEVCHENKO, A., "Middlemen," *International Economic Review* 45(1) (2004), 1–24.

SPULBER, D., "Market Microstructure and Intermediation," *Journal of Economic Perspectives* 10 (1996), 135–52.

STASAVAGE, D., "Was Weber Right? The Role of Urban Autonomy in Europe's Rise," *American Political Science Review* 108(2) (2014), 337–54.

Stein, W., ed., *Akten zur Geschichte der Verfassung und Verwaltung der Stadt Köln im 14. und 15. Jahrhundert*, 2 Voulmes (Bonn, 1893–1895).

VAN BOCHOVE, C., "Configuring Financial Markets in Pre-modern Europe," *Journal of Economic History* 73(1) (2013), 247–278.

———, L. Boerner, and D. Quint, "Anglo-Dutch Premium Auctions in 18th Century Amsterdam," Working Paper, University of Wisconsin, 2017.

VAN DER WEE, H., *The Growth of the Antwerp Market and the European Economy*, 3 volumes (Leuven: Den Haag, 1963).

VAN HOUTTE, J. A., "Les Courtiers au Moyen Age," *Revue Historique de Droit Francais et Etranger* 5 (1936), 105–41.

VERLINDEN, C., "Markets and Fairs," in M. M. Postan, E. E. Rich, E. Miller, *The Cambridge Economic History of Europe*, Volume 3 (Cambridge: Cambridge University Press, 1963), 119–56.

VON, BELOW, S., and S. BREIT, *Wald - von der Gottesgabe zum Privateigentum* (Stuttgart: Lucius & Lucius, 1998).

WESTERMANN, E.,ed.,*Internationaler Ochsenhandel (1350-1750)* (= Beiträge zur Wirtschaftsgeschichte 9. Akten des 7th International Economic History Congress Edinburgh 1978) (Stuttgart: Franz Steiner Verlag, 1979).

WOLF, A., *Die Gesetze der Stadt Frankfurt am Main im Mittelalter* (Frankfurt a. M., 1969).

YAVAŞ, A., "Marketmakers versus Matchmakers," *Journal of Financial Intermediation* 2(1) (1992), 33–58.

———, "Middlemen in Bilateral Search Markets," *Journal of Labor Economics* 12(3) (1994), 406–29.