

From bilateral exchange to market organization

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Abstract

Markets do not emerge naturally; they require deliberate investment to come into being. This paper studies the transition from bilateral exchange to market organization, focusing on the role of intermediaries in mitigating inefficiencies arising from private information and transaction costs. We build on Myerson & Satterthwaite (1983) and introduce a time budget constraint to demonstrate how pooling multiple exchange pairs improves efficiency. The broker, acting as an intermediary on behalf of either a buyer or a seller, has an incentive to distribute price information of past transactions to increase own profits, thereby building the foundations of a market. Competition among brokers drives down prices and increases transaction volume until rising demand for brokerage services forces them to innovate and endogenously adopt an alternative market design. To motivate our model, we present the historical evolution of the Liverpool cotton market as a case study. We further discuss the persistence of heterogeneous price-finding mechanisms in fish markets and the coexistence of different matching methods in labor markets, both of which can be accommodated within our framework. Our findings contribute to a deeper understanding of market formation and the heterogeneity of market designs, emphasizing the role of private investment and information dissemination in sustaining efficient trade.

Keywords: bilateral exchange; market organization; brokerage; private investment; price information; competition.

JEL: D47; L11; G24.

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1 Introduction

The market has evolved to an universal, decentralized solution for organizing exchange in modern economies. It even lends its name to the group of economies that base fundamental coordination functions on market mechanisms. Loasy (1999, p. 115) explains that a central function of the market is to help limit options of action, which is particularly important in situations of significant uncertainty. Markets do so by providing information that make expectations about the future outcomes of today’s actions more reliable—even possible at all. This is in line with transaction cost theory arguing that markets are coordination infrastructures that reduce the costs for single transactions; thereby supporting a larger number of transactions to take place (Coase 1937, Williamson 1979).

Well-functioning markets enable the coordination of diverse actors’ beliefs and strategies in an efficient and relatively seamless manner. Imperfectly functioning markets still allow coordination but generate suboptimal aggregate outcomes and disadvantage certain participants who may search for alternative coordination mechanisms. Such alternatives include other market arrangements, contract solutions, or planning solutions involving state actors. In addition, there is always the outside option inactivity. While coordination involves costs, bad coordination or non-coordination involves even higher costs. These might not always be easily detectable. A bilateral exchange which did not take place often remains unobserved and the potential gains of trade remain unrealized, at least by the observer. Participants, in contrast, know about the foregone surplus and may work on arrangements that ease the organization of exchanges.

In the economics literature, theoretical work on markets focuses on analyzing the efficiency of alternative market arrangements (Spulber 1998, Belleflamme & Peitz 2015, Morasch 2026) but does not address how markets come into being in the first place. The benchmark, a market under perfect competition, is assumed to merely exist or to emerge in an unspecified way from demand and supply under the guidance of an ‘invisible hand’ (Smith 1976). Theoretical work on bilateral exchange (Myerson & Satterthwaite 1983, Satterthwaite & Williams 1989*a*), in turn, studies the efficiency of different coordination mechanisms for a single transaction but does not leave the realm of optimization within the one-unit exchange. In practice, however, buyers and sellers rarely engage in a one-time exchange. They participate in many exchanges of similar kinds and maximize aggregate profits within a certain period of time.

We present a model that helps to understand the transition from bilateral exchange to market organization. Our model shows how markets can evolve endogenously by deliberate investment in information provision and other exchange-supporting infrastructure to reduce the issue of incomplete information and overcome the inefficiencies entailed in bilateral exchange. Our model bridges the largely detached streams of theoretical work on market efficiency and bilateral exchange. The key innovation relative to studies on bi-

lateral exchange is to replace the optimization per unit of exchange, i.e., per transaction, with an optimization per unit of time. The consequences for the model solution are significant: To maximize profits within a given time constraint, it becomes optimal to reduce the price, and consequently the profit per transaction in order to increase the volume of transactions. The dissemination of price information increases profits and the transaction volume further via supporting self-selection of sellers and buyers into exchange. Competition decreases the brokerage price and thereby increases transaction volume. To exploit the potential of an increased number of profitable transactions given the time constraint, brokers have an incentive to innovate in technical and organizational infrastructure.

The market is an organizational solution that allows to facilitate a large volume of transactions in an efficient way. However, different market designs support different market outcomes (prices, volumes) in equilibrium. Which design is established depends on who invests in market building. Sellers, buyers, intermediaries or state actors may take the initiative. We chose to model the broker as investor. This choice was motivated by the evolution of the Liverpool cotton market, which serves as a guiding case study for our model. Moreover, the broker also acts as intermediary arranging exchange between buyers and sellers in Myerson & Satterthwaite (1983), a seminal work in mechanism design theory and the reference work for our model.

The remainder of the article is structured as follows: After reviewing the relevant literature in section 2 and discussing the problem with bilateral exchange in section 3, we present our model in section 4: In subsection 4.1, we compare the solution of the broker’s profit maximization problem per unit of exchange as given in Myerson & Satterthwaite (1983) with a solution that considers profit maximization per unit of time. In subsection 4.2, we show how the broker can improve her profits by providing price information that helps buyers and sellers to self-select into exchange and increase the ratio of successful transaction attempts. In subsection 4.3, we accommodate Aoki (2001)’s conceptualization of the market as a ‘summary representation of exchange’ that enables actors to coordinate beliefs and action choices. In subsection 4.4, we show how competition among brokers shifts trade surplus from brokers to buyers and sellers and increases demand for brokerage services. In subsection 4.5, we use the model of Dixit & Pindyck (1994) showing how uncertainty delays investment in production to illustrate how brokers’ investments in exchange infrastructure help buyers and sellers to form expectations about future outcomes of their production and trade investments. In subsection 4.6, we show how excess demand for brokerage services incentivizes brokers to innovate in internal and external organization structures to accommodate a larger volume of transactions and exploit profit opportunities. In section 5, we discuss the rise of Liverpool to the world’s largest marketplace for cotton exchange as a case study. In section 6, we discuss heterogeneity in and coexistence of different market designs. In section 7, we conclude.

2 Literature review

In stressing that a market arises from costly and deliberate actions, we agree with the intermediation theory of the firm (Spulber 1998, Belleflamme & Peitz 2015, Morasch 2026), which considers equilibrium price setting as an endogenous process and markets as being created and operated. Usually, it is firms that are engaged in these activities. This stream of literature therefore studies firm decisions regarding activities typically ignored in the neoclassical framework including price setting, purchase and sales decision-making, managing inventories, supplying information, and coordinating transactions (Spulber 1998, p. 26). Intermediation theory is interested in the efficiency of alternative modes of intermediation and uses perfect competitive markets as benchmark. Yet, a decision for one of several modes of intermediation and a perfect competition setup requires the existence of a market in the first place. If the research interest is to study how markets come into being, the appropriate benchmark should be an exchange mechanism of the non-market or pre-market type.

Our research interest is the transition from bilateral exchange to market organization of exchange. In this transition period, the market is created via some actor's investment and would not come into existence without it. To have an incentive to invest in exchange infrastructure, the actor has to optimize beyond a single transaction. The resulting coordination infrastructure allows to deal with the different frictions and imperfections of real word situations in a way that exchange can take place. The focus of our analysis is not so much on the intermediating firm, but on the resulting market. To grasp our focus, see Gehrig (1993) in comparison: Gehrig (1993) models the decision of consumers and suppliers whether to be randomly matched with each other or to buy from or sell to an intermediary at a known price. Consumers with the highest willingness to pay and suppliers with the lowest costs trade with the intermediary firm, the others use the default, the market. However, even the *opportunity* of random matching must be created. A place or platform needs to be known to everyone interested in the exchange with all rules required to make the exchange happen. We draw on Aoki (2001)'s idea of endogenous institutions created via the adjustment of beliefs and actions to understand what markets are and how they are created, sustained, and changed. Without such a structure, frictions in the search of exchange partners would be much larger.

Imperfect information is the most important friction in bilateral exchange. Buyers and suppliers do not know all possible trading partners, their costs or willingness to pay, the quality of the products they offer or look for, or the possible alternatives to the good or service. This is the setup in Myerson & Satterthwaite (1983), our starting point and the most suitable benchmark of the analysis. In the absence of an actor who invests to overcome the issues of imperfect information, there is no alternative to bilateral exchange transactions. The costs of establishing a market are mainly fixed costs. Profit per unit

are, therefore, not so important as profits per time period. Like Spulber (1998), we introduce time in our analysis. His observation that a time-costly search delays the gains from trade is important for us as well. Unlike Spulber (1998), we do not discount future surpluses but model opportunity costs of time of the market maker, in our case the broker. Our market-making broker maximizes profits per time mainly by intensifying brokerage activities of arranging exchange between buyers and sellers.

3 The problem with bilateral exchange

If no market is established, a potential customer needs to find a supplier who could offer the desired good in the required amount or the supplier searches for a customer. If the potential trading partner is found, the customer does ideally know her own willingness to pay v_b . But about the suppliers costs or minimum price for which he would sell the good, she does best know a distribution $f(t_s)$. The supplier does, in contrast, know his own costs v_s but does not know the value of the good for the customer. He might have an expectation, although very vague, at best a distribution $g(t_b)$. In such a setting, Myerson & Satterthwaite (1983, p. 266) inform us that “...it is generally impossible to have a mechanism that is incentive-compatible, individual rational and ex-post efficient.” The reason is that the supplier receives a higher share of the joint surplus generated by the trade, if he overstates his costs. The supplier would therefore announce a higher minimum price that he would accept. In the same vein, the buyer has an incentive to understate her willingness to pay. Consequently, there are ex-post some potentially surplus-generating relationships that are not realized because neither the supplier nor the customer reported truthfully their private information.

Myerson & Satterthwaite (1983) present a very simplified setting. They study a direct exchange of a good the characteristics of which are fully known. Only the valuation is private knowledge. The two players have been matched already, both participate in direct bargaining.¹ Even in such simplified situations, which in addition could use a coordinator or intermediary, price finding is difficult. Both parties face the dilemma to not close the deal at all if they try to gain a too large share of the surplus of the exchange. Yet, giving in too much reduces the own share on the surplus of the trade, in extreme to zero. Thus, while both sides might live well with the fact that the mechanism is not ex-post-efficient, being left with a likelihood not to be served at all is more problematic. The probability of not agreeing on exchange in a one-to-one relationship can be significant, as the example of a second-best mechanism in Myerson & Satterthwaite (1983) shows.

¹Myerson & Satterthwaite (1983, p. 267) define direct bargaining mechanism as ‘one in which each individual simultaneously reports his or her valuation to a coordinator or broker who then determines whether the object is transferred, and how much the buyer must pay.’

Individual rationality, however, is given. There exists beneficial trade although not to the extent which would be possibly conducted with full information.

Satterthwaite & Williams (1989*b*) and Rustichini, Satterthwaite & Williams (1994) show that this problem vanishes if buyers and sellers meet at a marketplace that overcomes the one-to-one relationship. Even a small number of traders on each side lets the inefficiency, that is the non-exploitation of gains via trading, fall fast. This result depends on the usage of a buyer's bid double auction or call option markets and an auctioneer. The reason is the larger number of potential trading partners in the market: *"Thus, as the market grows, competitive pressures quickly force buyers towards truthful revelation and the equilibrium outcome towards an ex-post-efficient, perfectly competitive allocation."* Satterthwaite & Williams (1989*b*, p.478). This result, however, requires that a trading platform is available that organizes the double auction.

It is costly to establish and retain a trading platform. Yet, markets using different matching and pricing mechanisms have been established as trading platforms all over the world. Many markets that have a large number of households on the demand side work with fixed-price offers. Hagerty & Rogerson (1987) argue for a fixed price combined with a take-it-or-leave-it-offer as pricing rule for these markets. The fixed price rule is not only simple, it is also robust against the fact that the prior of the distribution of the willingness to pay is not common for all customer and that customers valuations are not independent from each other. It makes sure that no trader is ex-post worse off by participating than by not participating. To solve the indeterminacy of setting a price, the auctioneer posts some price drawn according to a distribution function. Trade takes place if the buyer and the seller are willing to trade at the posted price (Hagerty & Rogerson 1987, p.101).

While Hagerty & Rogerson (1987) contribute to a stream of literature aiming to yield a theory of the design of trading institutions, our focus is different. We are interested in understanding how markets (of any design) come into being. Very seldom an auctioneer has been used and if then not from the beginning of exchange but only later when a bourse had been established. But a bourse is an infrastructure of exchange that must be established, organized, and paid for in the first place. Who invests in the building of exchange-supporting infrastructures such as a bourse and why? These questions guide our analysis. The answers to these questions should nevertheless be informative to literature on mechanism design and trading theory.

Myerson & Satterthwaite (1983) study an alternative to the imaginary auctioneer: A broker who intermediates the exchange for business. The advantage of this perspective on trade is the step towards a real institution of a decentralized economy. The broker acts on its own behalf maximizing profits from the deal. She diverts parts of the difference between buyer's willingness to pay and supplier's costs to her own profit. The broker thereby restricts trade by ignoring trade opportunities that are not characterized by a sufficiently

large difference between the valuations of buyers and sellers when announcing their values based on maximizing their profits. Myerson & Satterthwaite (1983) conclude that the exchange initiated by brokers is less efficient because even more trade opportunities are unused. We argue that this result does not necessarily carry over to a multiunit exchange with costs for pairing buyers and sellers.

4 From bilateral exchange to market organization

If there is a single unit to exchange, there is only one potential trade to be made. Without negotiations and time not costly, it is profit maximizing for an intermediating broker to restrict trade. If, in contrast, profit is maximized over a time budget, brokers have an incentive to reduce the *profit per unit* they aim to achieve in order to facilitate more trade, and not less as compared to the single unit maximization context that ignores time and further trade possibilities. The reason is that the broker has opportunity costs when the exchange is not taking place within an arranged match.

4.1 The broker's profit maximization

A broker who lives on arranging transactions needs to search for pairs of supplier and buyer which might be willing to close a deal. With several buyers and sellers, she could have closed more deals instead of just one, earning on the surplus of trade for several exchanges. It might thus be a good idea to forego some of the unit profits in each deal by increasing the probability ρ that the deal is closed to save the time for brokering more deals. Probability ρ is easily influenced by the broker by changing the offered payments x_s from the broker to the seller and x_b from the buyer to the broker. The broker's profit per unit of exchange U_{BR} is given in Myerson & Satterthwaite (1983) by

$$U_{BR} = \int_{a_b}^{b_b} \int_{a_s}^{b_s} (x_b(t_s, t_b) - x_s(t_s, t_b)) f_s(t_s) g_b(t_b) dt_s dt_b \quad (1)$$

where $f_s(t_s)$ and $g_b(t_b)$ are the distributions of the costs of the seller and the willingness to pay of the buyer, respectively. The distributions are known as are their lowest value a_i and their highest value b_i with $i = s, b$. Note that neither the seller nor the buyer should gain by lying to the broker about his/her true valuation v_s and v_b , respectively (Myerson & Satterthwaite 1983, p. 278).

Myerson & Satterthwaite (1983) show that profits have their maximum where brokers restrict trade greatly by setting a rather low price x_s offered to the seller and a rather high price x_b to the buyer. For the example using the uniform distribution in the interval $[0,1]$, the price offered to the seller x_s equals the valuation of the buyer minus one half:

$x_s = v_b - 1/2$. The price offered to the buyer x_b equals the valuation of the seller plus one half: $x_b = v_s + 1/2$. Thus, only potential pairs whose valuation differs by at least $1/2$ participate in trade. Myerson & Satterthwaite (1983) argue that a broker needs to restrict trade if she optimally uses her control over the trading channel. It is easy to see that broker's decision to set the price to buy from the supply side to $v_b - 1/2$ restricts the number of suppliers who can expect to take part successfully in exchange to $1/4$ in the uniform distribution example. The same on the buyers side, the optimal price reduces the number of buyers to $1/4$. Consequently, the probability ρ that the deal will be closed is $1/16$.

This holds not necessarily true if not trade of one unit is considered and made the criterion for profit maximization but profit realized from using the trading channel in a particular period of time. That requires to take into account the effect of pricing on the probability of exchanges which are concluded. With many actors, this probability translates into the number of trades. The broker's profit per unit of time π_{BR} is given by

$$\pi_{BR} = \lambda \underbrace{F(x_s)(1 - G(x_b))}_{\rho} (x_b - x_s) - w_{BR} \lambda t, \quad (2)$$

where x_s denotes the price the broker offers to the seller, x_b the price the broker asks from the buyer and F and G are cumulative distribution functions of the valuation of the seller and the buyer, respectively. w_{BR} denotes the costs of the broker which are per unit of time T , that is the time budget given to the broker, for example 60 hours per week. t is the time needed to arrange one potential transaction which gives $\lambda = \frac{T}{t}$ possible attempts within the period T . The term $\lambda F(x_s)(1 - G(x_b))$ gives the number of realized transactions in T , i.e., successful attempts. $(x_b - x_s)$ gives the profit per transaction and $w_{BR} \lambda t$ gives the time costs of the broker in period T , that is her wage. The number of realized transactions in T is the product of the total number of actions λ that can be negotiated multiplied with the probability ρ that a transaction is closed. ρ , in turn, depends on the spread between the two prices $(x_b - x_s)$. For the uniform-distribution example, the profit function is given by

$$\pi_{BR} = \lambda \left(v_b - \frac{1}{2} \right) \left(\frac{1}{2} - v_s \right) (v_s + 1 - v_b) - w_{BR} \lambda t, \quad (3)$$

which uses the price solution in Myerson & Satterthwaite (1983). If we denote the profit function in unit per time as we do in (3), however, the price solution in Myerson & Satterthwaite (1983) is no longer optimal. There is an incentive for the broker to increase the price x_s paid to the supplier and reduce the price x_b asked from the buyer, because this increases the probability ρ that the deal is successfully closed and therefore increases the number of realized transactions within T . To see this, we introduce a price premium

τ_s for the supplier and a price discount τ_b for the buyer in (3):

$$\pi_{BR} = \lambda \left(v_b - \frac{1}{2} + \tau_s \right) \left(\frac{1}{2} - v_s + \tau_b \right) (v_s + 1 - v_b - \tau_s - \tau_b) - w_{BR} \lambda t. \quad (4)$$

Starting from the solution in Myerson & Satterthwaite (1983) with $\tau_s = \tau_b = 0$, increasing price premium τ_s and price discount τ_b increases the broker's profits π_{BR} . Small per unit profits reductions are more than compensated by the larger number of transactions which are administered by the broker.

$$\frac{\partial \pi_{BR}}{\partial \tau_s} = \lambda \left(\frac{1}{2} - v_s + \tau_b \right) (v_s + \frac{3}{2} - 2v_b - 2\tau_s - \tau_b) \quad (5)$$

For the broker it is profit maximizing to introduce a price premium τ_s if all terms at the right hand side of (5) are positive. In the uniform-distribution example, which uses a valuation interval of $[0,1]$, this requires $v_s < \frac{1}{2} + \tau_b$. This hold, if $\tau_b = 0$. Profits can therefore be increased by raising the price for the supplier by τ_s . The broker's optimal price premium to offer to the seller is $\tau_s = \frac{v_s}{2} + \frac{3}{4} - v_b - \frac{\tau_b}{2}$.

Similarly, a lower price for the buyer increases the profit of the broker through the larger number of trades that use the broker's exchange mechanism. The partial derivative of the profits with respect to the offered price t_b is

$$\frac{\partial \pi_{BR}}{\partial \tau_b} = \lambda \left(v_b - \frac{1}{2} + \tau_s \right) (2v_s + \frac{1}{2} - v_b - \tau_s - 2\tau_b). \quad (6)$$

It is positive if $v_b > \frac{1}{2} - \tau_s$. Profits can be increased by offering a discount $\tau_b > 0$ to the buyer compared to the exchange solution. The optimal discount offer by the broker to the buyer in this example is $\tau_b = v_s + \frac{1}{4} - \frac{v_b}{2} - \frac{\tau_s}{2}$. Solving for τ_s and τ_b yields $\tau_s = \frac{5}{6} - v_b$ and $\tau_b = v_s - \frac{1}{6}$. That translates into the prices $x_s = v_b - \frac{1}{2} + \tau_s = \frac{1}{3}$ and $x_b = \frac{1}{2} - v_s + \tau_b = \frac{2}{3}$. The optimal profit per transaction U_{BR} is $\frac{1}{3}$, which is smaller than $\frac{1}{2}$, the price solution in Myerson & Satterthwaite (1983) that optimizes over one unit of exchange and irrespective of time. As defined above, the probability that both agree and the exchange is carried out is given by $\rho = x_s(1 - x_b)$ and yields $\rho = \frac{1}{9}$. Compared to the Myerson & Satterthwaite (1983) setting it almost doubles. The higher number of deals is the reason to forego some broker-monopoly mark-up related profits and replace them by a higher number of less profitable deals. If the number of potential transactions λ that the broker can strike is large, it might be a better strategy to increase the number of transactions than to search for the highest-profit matches as both is time consuming and time is the scarce resource of the broker.²

²Ellison (1886, p. 175) describes the introduction of brokering by using samples in the Liverpool cotton market, which illustrates this very well.

4.2 Efficiency gains via information provision

In addition to changing the price offers x_s and x_b , the broker has other means to affect her profits. Since profits are in units of time, each attempt to close a deal is costly and the broker has an incentive to increase profits by reducing the number of failed attempts. One way to do this is to give sellers and buyers the chance to self-select out of participation. If the broker could get rid of all potential buyers whose willingness to pay is too low and all potential suppliers whose costs are too high, the number of failed attempts will decrease considerably. In the Myerson & Satterthwaite (1983) setting and without additional information, the suppliers' probability that its costs exceed the willingness to pay of the buyer is $\frac{1}{2}$. Consequently, half of the potential combinations fail even if the broker does not charge any mark-up. The challenge for the broker is to get rid of those participants for exchange on both sides who's probability of success is too low due to too high costs in the group of sellers and too low willingness to pay in the group of buyers.

Within the model, the probability to strike a deal ρ depends on the product of the probability $F(x_s)$ that the supplier's costs are lower than the offered price x_s and the probability $1 - G(x_b)$ that the buyer's willingness to pay exceeds the price x_b . For the uniform distribution, $F(x_s) = \frac{x_s - a_s}{b_s - a_s}$, where a_s and b_s are the upper and lower boundaries of the distribution of sellers' costs, respectively. Likewise, $1 - G(x_b) = 1 - \frac{x_b - a_b}{b_b - a_b}$, where a_b and b_b are the upper and lower boundaries of the distribution of buyers' willingness to pay, respectively. The broker has an incentive to *reduce* the upper boundary b_s of the seller, which ceteris paribus *increases* the success rate ρ , since

$$\frac{\partial F(x_s)}{\partial b_s} = -\frac{(x_s - a_s)}{(b_s - a_s)^2} < 0. \quad (7)$$

In the uniform-distribution example, $a_s = 0$ and $a_s < b_s \leq 1$. For the buyer, in contrast, the broker has an incentive to *increase* the lower boundary of the distribution, because it would increase the success rate ρ , since

$$\frac{\partial(1 - G(x_b))}{\partial a_b} = \frac{(b_b - x_b)}{(b_b - a_b)^2} > 0. \quad (8)$$

Again, for the uniform-distribution example, $b_b = 1$ and $0 \leq a_b < b_b = 1$. One way the broker can influence the boundaries of the distributions is by providing information about prices x_s and x_b of previous transactions. Although future prices may deviate from past prices of transactions, they give hints about the success of transaction attempts by sellers with high costs and potential buyers with a low willingness to pay. Participants with very high costs and very low willingness to pay may refrain from participating in the exchange to save their own time costs. Their absence shifts b_s down and a_s upward.

Recall that in our setup the buyer is assumed to know at best the distribution of other buyers' willingness to pay and the sellers' costs. Buyers and sellers do not know whether a trading partner will be found for them. They form expectations. Knowing prices of past transactions x_b and x_s , allows them to form more reliable expectations concerning how likely it is that they will succeed in closing a deal. In our example, if buyers see that no price has been agreed on below $1/3$, regardless of boom or recession, high or low trading volume, peace or war, and whatever else might affect the price, buyers with a willingness to pay below $1/3$ might not waste their resources with the hopeless search for a deal. They expect that they are very unlikely to receive a seller's offer by the broker that they can accept. In the same manner, suppliers with costs higher than $\frac{2}{3}$ will expect that they are very unlikely to receive a profitable offer by the broker. If these sellers and buyers refrain from going for an exchange using brokerage services, the upper boundary of the distribution $F(x_s)$ of sellers changes to $b_s = \frac{2}{3}$ and the lower boundary of the distribution $G(x_b)$ of buyers changes to $a_b = \frac{1}{3}$. The probability ρ of a successful attempt more than doubles from $\frac{1}{9}$ to $\frac{1}{4}$ and is four times as high as in the Myerson & Satterthwaite (1983) setup.

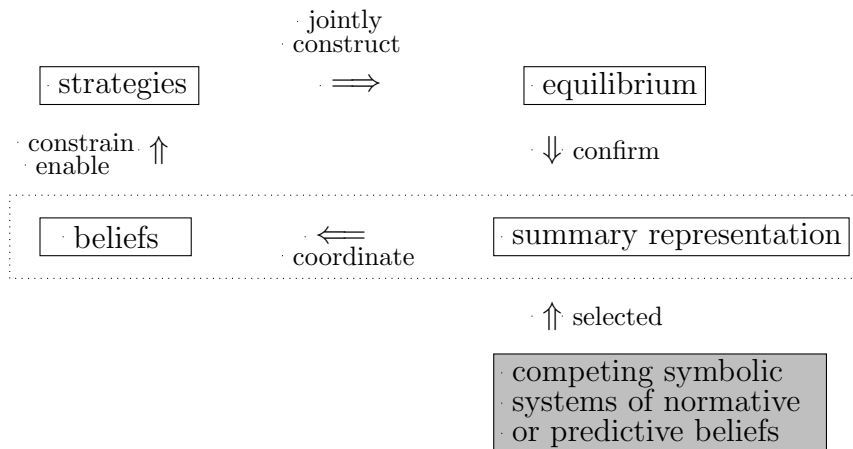
4.3 Market formation

The broker's incentive to truncate the distribution of buyers and sellers attempting to strike a deal, is driven by her own profit maximization as the broker's profit increases with decreasing number of unsuccessful negotiations. Collecting and distributing price information pays off if the costs to generate and distribute the information are smaller than the expected profits made from additional successful trade. For sellers and buyers, the price information helps to coordinate beliefs and strategies. Although the future price of exchange remains unknown, sellers and buyers received information, which eases assessing their own surplus in the exchange of the good. Self-selection in and out of trade changes the number of realized transactions within the broker's time budget. The new list of transaction prices includes more transactions, which might affect beliefs. The availability of past transaction prices reduce the problem of incomplete information and eases coordination for successful exchange a lot. Information that eases the assessment of the quality of the good or the place where exchange takes place help too. The availability of this information builds the core of a market which differs from the mechanism of exchange in (repeated) bilateral transactions by being able to strike more deals with anonymity of participants and simultaneity in exchange being made possible.

This conceptualization of the market is in accordance with Aoki (2001)'s description on the market as a *summary representation of exchange* and surplus possibilities. Aoki (2001) analyzes the market from an institutional perspective and visualizes the process of market building as done in Figure 1: Individual buyers, sellers and any intermediaries

like brokers coordinate with the help of the summary representation. Prices of past transactions are important signals that enable to reconcile the individual beliefs of sellers and buyers and help them to decide whether to engage in an attempt for dealing or not, thereby making it easier to strike a deal for those who participate.

Figure 1: Summary representation as equilibrium



Own representation of Figure 1.1 in Aoki (2001).

Reconciliation requires that each potential participant in exchange considers what others believe and are expected to do. The *aggregate equilibrium outcomes* of all participants' activities are considered. This includes the quantity of facilitated exchanges and price (averages) of previous transactions which result of *all* transactions undertaken, not a few individual ones. If the underlying exchange infrastructure is not built, bilateral exchanges secured by repeated interactions may prevail and no market is formed. Also, an existing infrastructure may be replaced by an alternative mechanism that is supported and being implemented by one or more powerful actors as long as it succeeds to coordinate beliefs and strategies of a large number of exchange participants.

In our model, the broker takes beliefs and strategies of all market participants into account to establish a market-based mechanism for coordination that serves her profit interests. Her investments in market infrastructure changes the number and composition of buyers and sellers. This reduces transaction costs for herself, but also for buyers and sellers. Yet, the infrastructure she sets up is only one among a number of possible solutions for coordination. She will pick one that serves her interests. There is uncertainty concerning whether her efforts will pay off such that she succeeds to coordinate beliefs and strategies successfully and whether the aggregate equilibrium outcomes will serve her interests and is supported by her environment. There is also uncertainty whether and when her position may be challenged by a competitor such as another broker who is lured into the profitable business of brokerage. The market solution supported by the broker

may also be challenged by buyers or sellers who invest in the building of an alternative infrastructure to replace the mediation in order to increase their share of surplus. Finally, the established market solution may be supported or challenged by the state.

4.4 Market competition

Until now, we looked at *one* broker who coordinates exchange between sellers and buyers. Irrespective of the brokers efforts, the volume of traded goods is restricted by her time budget. The number of maximum transaction attempts is given by λ , which gives her capacity constraint. More transactions cannot be handled by the broker. If more than λ buyers and sellers request profitable brokerage service, she may try to increase efficiency $\frac{1}{t}$ of brokering, e.g., by introducing a new technology, or she may arrange for additional capacity, e.g., by employing people to organize exchange. Both increases λ . If her efforts will not cover excess demand, additional brokers will enter the market.

To see how market entry of new brokers changes the market outcomes, it suffices to study the two brokers case with equal capacity constraint λ : Denote the total demand for brokerage service with $\mathcal{D}$, which is the sum of demand by buyers $\mathcal{D}_b$ and sellers $\mathcal{D}_s$. As long as $\mathcal{D}$ exceeds the capacity of the two brokers 2λ , each broker continues to maximize her profit following (4). As soon as $\mathcal{D} < 2\lambda$, the brokers are in competition and each broker's decisions regarding prices x_b and x_s do not only consider her own transaction prices but also the transaction prices of the competing broker.³ Demand of brokerage services by buyers $\mathcal{D}_b$ falls in the price the broker requests from the buyers, $x_b - \tau_b^c$, while demand of brokerage services by sellers $\mathcal{D}_s$ increases in the price the broker offers to the seller, $x_s + \tau_s^c$. Price discount τ_b^c and price premium τ_s^c continue to be chosen by the brokers within their profit maximization. However, in the case of $\mathcal{D} < 2\lambda$, the brokers' profit maximization problem changes to

$$\pi_{BR} = \mathcal{D}(\tau_b^c, \tau_s^c) \underbrace{\left(v_b - \frac{1}{2} + \tau_s^c \right) \left(\frac{1}{2} - v_s + \tau_b^c \right)}_{\Phi} (v_s + 1 - v_b - \tau_s^c - \tau_b^c) - w_{BR} \mathcal{D} t. \quad (9)$$

First, total demand $\mathcal{D}$ constrains profits in the case $\mathcal{D} < 2\lambda$ and not the capacity λt , which is the relevant constraint in the case $\mathcal{D} > 2\lambda$. As $\mathcal{D}$ becomes the binding constraint, it is important to consider that an increase in the price premium offered by the broker to the seller τ_s^c and increase in the price discount offered to the buyer τ_b^c will increase demand $\mathcal{D}$ for brokerage services. To see how the optimal price premium τ_s^c and price discount τ_b^c change in a competitive setting, we again study first derivatives of (9). We start with the

³In the benchmark case with full information and a well-defined homogeneous product, Kreps & Scheinkman (1983) have shown that in price competition with endogenous capacity setting, prices depend negatively on the aggregate capacity and are larger than marginal costs.

price premium τ_s^c :

$$\frac{\partial \pi_{BR}}{\partial \tau_s^c} = \frac{\partial \mathcal{D}_s}{\partial \tau_s^c} \Phi + \mathcal{D}(\tau_b^c, \tau_s^c) \left(\frac{1}{2} - v_s + \tau_b^c \right) (v_s + \frac{3}{2} - 2v_b - 2\tau_s^c - \tau_b^c) = 0. \quad (10)$$

The first term on the right hand side of equation (10), $\frac{\partial \mathcal{D}_s}{\partial \tau_s^c} \Phi$, is positive, since $\mathcal{D}_s$ increases in τ_s^c . Consequently, in optimum, the second summand must be negative.⁴ Since the first two factors in the second summand are positive, the third factor must be negative. It follows that:

$$\begin{aligned} v_s + \frac{3}{2} - 2v_b - 2\tau_s^c - \tau_b^c &< 0, \\ \underbrace{\frac{v_s}{2} + \frac{3}{4} - v_b - \frac{\tau_b^c}{2}}_{\tau_s} &< \tau_s^c. \end{aligned} \quad (11)$$

With competition, the optimal price premium that the broker gives to the seller increases as compared to the monopoly situation: $\tau_s^c > \tau_s$. Consequently, seller's demand for brokerage services will be higher in the competitive setting. Also, too low demand for brokerage can be solved or at least alleviated by increasing the price premium paid to the suppliers. To study the buyers' side, we take the first derivative of (9) with respect to τ_b^c :

$$\frac{\partial \pi_{BR}}{\partial \tau_b^c} = \frac{\partial \mathcal{D}_b}{\partial \tau_b^c} \Phi + \mathcal{D}(\tau_b^c, \tau_s^c) \left(v_b - \frac{1}{2} + \tau_s^c \right) (2v_s + \frac{1}{2} - v_b - \tau_s^c - 2\tau_b^c) = 0. \quad (12)$$

The first term in in (12), $\frac{\partial \mathcal{D}_b}{\partial \tau_b^c} \Phi$, is positive. Within the second part, since the first and the second term are positive, the last term must be negative to equate the whole condition to zero. It follows:

$$\begin{aligned} (2v_s + \frac{1}{2} - v_b - \tau_s^c - 2\tau_b^c) &< 0, \\ \underbrace{v_s + \frac{1}{4} - \frac{v_b}{2} - \frac{\tau_s^c}{2}}_{\tau_b} &< \tau_b^c. \end{aligned} \quad (13)$$

With $\tau_b^c > \tau_b$, the profit per transaction of the broker given by $x_b - \tau_b^c$ is smaller in competition as compared to the monopoly situation. Yet, the broker is willing to accept a smaller profit per transaction since the additional profits from a larger number of realized transactions more than compensate for the loss in profit per unit of transaction. Growth in $\mathcal{D}$ is the (unintended) aggregate equilibrium outcome from higher optimal price premiums and higher optimal price discounts in the competitive setting. If the increases on total

⁴In the derivation, we ignored the last term $w_{BR} \mathcal{D} t$ in the equation which captures the outside option wage. By doing this, we assume that the broker does not use her time for non-brokering activities.

demand $\Delta\mathcal{D}$ cannot be covered by the existing brokers, market entry of further brokers results as long as there are profits to be made in the market, which requires $\mathcal{D}\Phi \geq w_{BR}T$ for new entrants.

4.5 Demand for brokerage service

The previous sections have underlined the importance of information provision to allow a transition from bilateral exchange to an exchange organized within a market setting. Exchange within the market, allows the broker to increase profits by striking more deals at price offers more advantageous for sellers and buyers compared to the bilateral exchange setting. Competition among brokers induces the brokers to make even better offers to sellers and buyers, further spurring demand for brokerages services. Up to this point, we have assumed that total demand in brokerages services $\mathcal{D}$ will increase as price information increases and sellers and buyers obtain a higher fraction of surplus of exchange. Such a response in demand $\mathcal{D}$, however, may not be realized without further investments by the broker into exchange-supporting infrastructure in situations where the exchange is characterized by other sources of uncertainty.

Frequently encountered problems and restrictions to market growth are the separation of demand and supply or investment and production in time and space. In this environment, sellers and buyers need to make investment decisions in the context of (i) uncertainty over the future returns of the investment, and (ii) partial irreversibility of investments. Dixit & Pindyck (1994, p. 3) show if investment decision are made in such an environment, the usual investment rule—the present value of the project V shall exceed the investment costs I —is not valid.

To see this, consider the model presented in Dixit & Pindyck (1994) and first proposed by McDonald & Siegel (1986). The model addresses the question *when* an investment I should be made if the present value of the project V evolves according to the geometric Brownian motion

$$dV = \alpha V dt + \sigma V dz, \quad (14)$$

where dz is the increment of a Wiener process. α denotes the drift, the trend growth, and σ the deviation from this trend. σ^2 is the variance of the process. Dixit & Pindyck (1994) denote $F(V)$ the value of the investment opportunity. The aim of the investor is to maximize this value which changes over time since the value of the project V_t changes over time according to (14). The cost of the investment I is known and does not change over time. When will be the investment time that maximizes the value of the investment opportunity $F(V)$?

$$F(V) = \max \mathbb{E} [(V_t - I)e^{-\mu T}], \quad (15)$$

where μ denotes the discount rate and $\mathbb{E}$ the expectation operator. It must hold that $\alpha < \mu$. Uncertainty affects the decision. The investment should be done when the value of the project V exceeds a critical value V^* . A higher value of σ results in a higher critical value V^* . Hence, uncertainty delays investment. While waiting, there is no cash flow but a change in the option value of the project $\mathbb{E}[dF]$. According to the Bellman equation, it is optimal to invest if the expected change of the value of the project equals the expected return on the investment opportunity $\mu F dt$ over the time period dt . Expanding dF using Ito's Lemma yields

$$dF = F'(V)dV + \frac{1}{2}F''(V)(dV)^2, \quad (16)$$

where $F' = dF/dV$ and $F'' = d^2F/dV^2$. If dV is substituted by the process (14), expected value is taken and $\mathbb{E}[dz] = 0$ accounted for, we can write (16) as

$$\mathbb{E}[dF] = \alpha V F'(V)dt + \frac{1}{2}\sigma^2 V^2 F''(V)dt. \quad (17)$$

Dividing by dt and using $\mathbb{E}[dF] = \mu F dt$ from above, yields the Bellman equation

$$\alpha V F'(V) + \frac{1}{2}\sigma^2 V^2 F''(V) - \mu F = 0. \quad (18)$$

The option value $F(V)$ of the project must satisfy the Bellman equation. Moreover, $F(V)$ must satisfy the boundary conditions:

$$F(0) = 0, \quad (19a)$$

$$F(V^*) = V^* - I, \quad (19b)$$

$$F'(V^*) = 1. \quad (19c)$$

Condition (19a) is a natural condition, given process (14). If the value of the project is zero, value V will stay zero which makes the option value $F(V)$ zero. This condition restricts the option value to the functional form $F(V) = AV^{\beta_1}$, with $\beta_1 > 1$. Condition (19b) is a 'value matching function'. The value of waiting equals the difference of the project value V and the investment costs I . From (19b) and (19c), A and V^* can be determined, see Dixit & Pindyck (1994):142:

$$V^* = \frac{\beta_1}{\beta_1 - 1} I \quad (20a)$$

$$A = \frac{(\beta_1 - 1)^{\beta_1 - 1}}{(\beta_1)^{\beta_1} I^{\beta_1 - 1}} \quad (20b)$$

The critical value V^* in (20a) increases in investment costs I but depends negatively on β_1 . β_1 , in turn, decreases in uncertainty σ . Hence, the higher uncertainty, the higher

the critical value V^* and the longer is the time period until $V \geq V^*$: Uncertainty delays investment. To see that σ affects β_1 negatively, note that β_1 is the positive solution of a quadratic equation⁵

$$\frac{1}{2}\sigma^2\beta(\beta - 1) + (\mu - \delta)\beta - \mu = 0, \quad (21)$$

which is

$$\beta_1 = \frac{1}{2} - (\mu - \delta)/\sigma^2 + \sqrt{\left[(\mu - \delta)/\sigma^2 - \frac{1}{2}\right]^2 + 2\mu/\sigma^2} > 1, \quad (22)$$

where $\delta \equiv \mu - \alpha > 0$. With increasing σ , β_1 approaches 1 from above. With $\beta_1 \rightarrow 1$, the critical value V^* approaches infinity according to (20a). Increasing uncertainty ruins investment plans. At best, investments are postponed. If uncertainty can be reduced, suppliers' output can be stimulated by lowering the critical value V^* , which must be exceeded to decide in favor of starting production or expanding the production of the good traded by the brokers.

Price information decreases uncertainties σ and fosters self-selection as discussed in subsection 4.2. This helps but may not suffice to ensure a sustainable growth of the market. Introducing codes of conduct for the exchange, standardizing product measures and qualities, improved transportation technologies, establishing insurance and futures markets or offering long-term fixed price options all reduce σ further and to a considerable degree, stimulating sellers and buyers to undertake investments and demand brokerage services. Reduced uncertainties change beliefs and alter strategies of the participants in exchange as discussed in subsection 4.3. A supply or demand shock following market entries must be 'digested' by existing participants. Consequently, an existing equilibrium is tested and either re-enforced or challenged in the following periods. If no equilibrium was found yet, a market may finally form.

4.6 Innovation

As demand for brokerage service $\mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c)$ increases, broker's profit π_{BR} increases up to the capacity constraint λ . If the demand increases further, either (i) productivity $\frac{1}{t}$ or the success rate ρ must rise to satisfy demand for brokerage among the existing broker(s), or (ii) the number of brokers must increase. The broker has an incentive to innovate and ease her capacity constraint for two reasons: First, a higher brokerage capacity λ strictly increases the number of possible exchange attempts of the broker and weakly increases the profit per unit of time, see equation (4). Second, a higher number of brokers decreases the profit per unit of exchange in the new oligopoly with one additional broker as soon as the capacity of all brokers exceeds total demand for brokerage service

⁵Use $F(V) = AV^\beta$, $F'(V) = \beta AV^{\beta-1}$ and $F''(V) = \beta(\beta - 1)AV^{\beta-2}$ in (18), factor out AV^β and rewrite the result as (21).

(higher τ_b^c and τ_s^c and consequently a smaller profit per unit of exchange for the broker become optimal, see chapter 4.4). Increased competition coupled with a constant λ weakly decreases profits per unit of time for each broker. For the two brokers case with equal capacity constraints, profits (9) can be written as

$$\pi_{BR} = \begin{cases} \rho [x_b^c - \tau_b^c - (x_s^c + \tau_s^c) - w_{BR}] \mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c) & \text{if } \mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c) < 2\lambda, \\ \rho [x_b^c - \tau_b^c - (x_s^c + \tau_s^c) - w_{BR}] T / t & \text{if } \mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c) \geq 2\lambda. \end{cases}$$

If $\mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c) < 2\lambda$, demand for brokerage services constrains the brokers' profits w_{BR} in each unit of time and brokers have the incentive to invest to increase demand. As soon as $\mathcal{D}(x_b^c - \tau_b^c, x_s^c + \tau_s^c) \geq 2\lambda$, the brokers' productivity becomes the binding constraint and brokers have the incentive to invest in innovation. Investments in communication and transport infrastructure, learning, and changes in the organization of negotiations with sellers and buyers can increase λ , ρ , or both and therefore the broker's profits, see equation (2).

Depending on the characteristics of the goods or service traded as well as the existence and nature of uncertainties present in the exchange, the most effective measure to increase productivity is case-specific. One consequent way to reduce the time t needed to handle a transaction, is to spare the price negotiations and fix the price for the brokerage service. If the broker sets the price as a fraction of the transaction value, she aligns her incentives with the party that pays for the brokerage service. This method of pricing is commissioning. For brokerage, this kind of pricing is common. Commissioning supports high put-through and high transaction values. In such a trading mechanism, even low mark-ups generate high profits for the broker. Note the vast difference to the optimization problem and its solution for the single bilateral exchange studied in Myerson & Satterthwaite (1983), our point of departure in the analysis.

5 The building of the Liverpool cotton market

The switch from bilateral exchange to market organization as modeled in section 4 is motivated by historical records of the development of the Liverpool cotton market to the largest and dominant raw cotton market in the world during the 19th century. Investments of cotton brokers established Liverpool as the most important cotton port and trading hub in England and ensured a thriving cotton textile industry. In the 1790s, Liverpool overtook London as the leading port for cotton trade. From 1810 to 1900, the volume of cotton that was channeled through Liverpool increased by a factor of more than ten. Many innovations, changes, and adjustments were needed to facilitate the increase of the transaction volumes over the years (International Cotton Association 2022, Aldous & Coyle 2021).

The first cotton transaction in Liverpool recorded by the press was an auction of 28 bags of Jamaica cotton by Richard Robinson on 16 June 1757. The auction took place at 1 pm at the Merchants' coffee house. This auction was more a bilateral exchange as described in section 3. No market had established yet. The first broker who specialized on cotton was Joshua Holt. Since 1770, Joshua Holt was commissioned (1% of the transaction value) by cotton dealers in Manchester and Lancashire to buy raw cotton on their behalf because Holt's deep knowledge let him judge cotton quality particularly well. This business model became the dominant model for organizing cotton exchange over the next 150 years.

Liverpool cotton brokers have gained a major advantage over their competitors in Manchester through distributing price information. Prices of previous cotton deals were communicated starting in 1787 on a monthly and individual basis, after 1805 on a weekly basis, and since 1832 daily and for the whole market (International Cotton Association 2022, Aldous & Coyle 2021).⁶ Price information decreased uncertainties and lured raw cotton suppliers and customers into the Liverpool cotton market. Past prices for exchange were references but sufficient uncertainties remained concerning prices and profits of future deals: There was a time lag between price information received and the transaction of the cotton. Cotton producers in the US, India, Brazil, or Egypt obtained information on transaction prices for cotton deals in Liverpool with a time lag of ten weeks. For the cotton producer, production started much before (four to five months) the decision to send the harvest to Liverpool. The investment decision to start or continue cotton production had to be made even earlier. Regular price currents enabled to follow price changes and form beliefs about future trends. This was helpful to reduce some uncertainties but in isolation it was insufficient to address all the unknowns present in the cotton industry that was characterized by (i) the large time lag between investment, production, and trade of cotton, and (ii) the large geographic distance between the producers of cotton in the Americas and South Asia and the buyers that were dealing and processing the cotton in England; they were four to six thousand nautical miles apart from each other.

The uncertainties for participants in the cotton trade were immense and it required massive investments in the transportation and communication infrastructure by suppliers, buyers, brokers, and state actors to reduce the uncertainties and support market growth. Key milestones were the opening of the Manchester–Liverpool railway in 1830, the advent of steamship-based Atlantic transport around 1840, and the completion of the Transatlantic Telegraph Cable in 1866.

⁶A typical circular in the 1790s, as printed in Ellison (1886), included prices for raw cotton separated by countries of origin and other characteristics. The name of the buyer was also given. The prices of the categories were averaged. Two lots in the same category of raw cotton might have had different prices even if they were both bought by the same customer. 'The price' of (a particular category/brand of) cotton was more a price index, in these early days, generated by ad hoc averaging. Averaging required standardization of units, measures, and qualities.

Reductions in the uncertainties helped to structure beliefs and strategies for all actors involved in the cotton trading and consequently reduced price volatility. Demand for storage in warehouses fell relative to transaction volume over the years. While a certain warehouse space remained necessary since neither demand nor supply could completely be smoothed, volatility in volumes reduced as much as volatility in prices. Despite the improvements, a considerable risk in the transatlantic trade in raw cotton remained. Several auxiliary services were introduced to reduce the risk and the costs of risk mitigation: The Bank of Liverpool was founded in 1831; a Hedge Fond system and futures exchange system were established in 1867; a futures market was formalized in 1871; the Liverpool cotton clearing house was established in 1874; and the Liverpool cotton bank was founded in 1878. These institutional innovations facilitated the growth of the global cotton industry in general and the development of Liverpool to the central marketplace for cotton exchange in particular.

These investments in market infrastructure allowed the transition from bilateral exchange to market organization. The first recorded cotton deal concerning the 28 bags Jamaica cotton in Liverpool was a bilateral exchange in the form of an auction. The exchange was announced in the ‘Liverpool Chronicle and Marine Gazetter’ on 3rd June 1757 in an advertisement by Richard Robinson, a merchant (International Cotton Association 2022). Robinson did not know whom to address and sent his message to everyone who reads the ‘Liverpool Chronicle and Marine Gazetter’. Already in the 1790s, the organization of cotton trade has changed drastically: Buyers and sellers met very regularly in ‘Change hours’ at the upper end of Castle St, a place that had become too small already in 1808, when the meeting place for exchange moved to Exchange Flags. With regular hours, harmonized weights and measures, categorized qualities, and the price current, a cotton market has been formalized in the 1790s. The organizational structure of the exchange adjusted over time and with the growth in transaction volumes.

The move of the meeting place to Exchange Flags in 1808 was an important event. Friday meetings of the brokers to compile the ‘General Circular’ evolved into a permanent organisation in 1842. Ninety firms involved in brokerage services joined (International Cotton Association 2022).⁷ Subsequent milestones were the publication of the first edition of a Constitution in 1863; the formation of the Liverpool Cotton Market Association in 1882, which balances the relationship between brokers and dealers; the move of the cotton market indoors in 1896; and the opening of the new Cotton Exchange Building in 1906. The series of organizational innovation has continued until today. The most recent of the

⁷ “[C]omprehensive information on the cotton market was sent to the spinners inland, who could then make better-informed decisions to purchase as a result. The Liverpool brokers also developed a hugely successful system of arbitration to settle disputes between buyers and sellers, quickly and simply, without the need of expensive and time-consuming legal redress. Buyer and seller would nominate a broker to represent them and if two brokers could not agree, a third would be selected to arbitrate. It is a system which survives in essence today” (International Cotton Association 2022).

organizational changes was the reformation of the association to become the International Cotton Association, which happened only in 2004.

Throughout the last 250 years, cotton brokers looked for possibilities to increase profits, mainly through productivity increases. An important change in the broker’s way to organize the negotiations between buyers and sellers was the use of samples which were first introduced in 1810. The International Cotton Association (2022) reports: “[T]he time-consuming process of inspecting cotton in bulk could be replaced by buying from samples shown on a counter. Although there was initial opposition, it was soon realized that this was a viable proposition. The brokers could do their work much more quickly, and even though they reduced their commission rate from 1% to 0.5% (which pleased the dealers), they still had more than enough work as a consequence of the increasing imports.”

6 Heterogeneous market designs

Rodrik (2011) starts his analysis of the development of markets and states with a historical newspaper announcement similar to the one on the first recorded cotton trade in Liverpool: “On the fifth of December [1671], ensuing, There Will Be Sold, in the Great Hall of this Place [Garraway’s coffee-house], 3000 weight of Beaver Skins, comprised in thirty lotts, belonging to the Honourable, the Governour and Company of Merchants-Adventurers Trading into Hudson’s Bay” (Rodrik 2011, p. 3). The fur trade of the 17th century relied on state-granted monopolies and rules set by the monopolist trader. The monopolist trader tried to extract the maximum profit from auctioning the imported furs to wealthy Londoners. On the supply side, the Hudson Bay Company (HBC) set the terms of trade for the Cree Indians. The price paid to the supplier x_s was as small as possible, the price x_b paid by the buyers as high as possible, similar to the Myerson & Satterthwaite (1983) trading setup. Fur trade was organized along these lines until 1870 when HBC surrendered its trade monopoly and territorial control was given to the newly formed Dominion of Canada. Competition as described in subsection 4.4 evolved only after the Dominion of Canada introduced private exchange-supporting institutions.

Some institutional elements introduced by HBC persisted and were integrated into the newly established private exchange-based system. The institutional elements HBC introduced to organize fur trade were very different from those the CBA introduced to organize cotton trade even though the trade of fur and cotton showed similarities in goods, production, and trade-related characteristics and therefore had to cope with similar uncertainties. Although a similar solution may potentially have evolved to organize the trade in the two goods, the way transatlantic fur trade has been organized varies considerably compared to the way transatlantic cotton trade has been organized until today.

6.1 Persistent differences in market organization

Over the 250 years of development of the Liverpool cotton market and at many instances or conjectures, different technical and institutional innovations than the ones that were realized could have been possible. The consequence would have been different trajectories of market development with alternative market designs and market outcomes. The market would have looked differently when dealers from Manchester would have structured cotton trade to a larger extent. It is the initiative of one or more individuals or firms with their respective interests in combination with some random elements that structure the organization of trade at a particular point in time. Starting from the existing structure, trade participants react by adjusting their strategies in order to increase their profits. These reactions might stabilize the existing market structure, reaffirming the equilibrium, or pushing for adjustments of others and a new equilibrium. Consequently, market organization and outcomes differ across time and space.

This holds even for markets of the same good. Fish markets are good examples of persistent differences in market organization and outcomes. Economic analyses of fish markets have a long tradition. Kirman (2011) studies the coordination mechanisms used in these markets, which strongly influence the organization of the markets. The fish markets he looks at differ significantly in their setup and particular organization. In Marseilles, all transactions are pairwise. Prices are not posted. In spite of the good experiences with auctions in other markets and auctions' superiority in theory, traders in Marseilles rejected the introduction of the auction mechanism after a reorganization of the market in the 1980s. Their pairwise negotiation mechanism works well. It uses the experiences that buyers and sellers have gained in the extensive use of pairwise transactions in this market. This might be the reason why market participants have been reluctant to change the coordination mechanism. Distinct loyalty characterizes market relationships.

Kirman (2011) compares Marseilles' fish market to the market in Ancona where the Dutch auction is used as coordination mechanism. Interestingly, loyalty emerges in the auction setup too in spite of this rather clinical mechanism. Specific knowledge and experience are also necessary to enable the high speed at which the transactions are pushed through. Higher speed allows more transactions, which yields higher overall profits in a particular time span. In accordance with our model, in the Marseilles' fish market as described in Kirman (2011, p. 113), the optimization calculus per unit of time dominates the calculus of achieving the highest profit on each transaction.

The price mechanisms established at the fish market in Marseilles differs from the fish market in Ancona. In Marseilles, there is no announced price. All transactions are settled in bilateral negotiations, which might take the form of take-it-or-leave-it offers by the seller. The seller is nevertheless constrained by other sellers and by prospects of future transactions. There is significant variation in transaction prices, not only between

different sellers but also in the transactions involving the same seller. Loyalty is related to *higher* prices, but higher probability of being served. At the fish market in Ancona, there is not *one* price for fish; not even for each sort of fish. Three Dutch auctions take place simultaneously, each selling similar portions of fish at a speed of five transactions per minute. Prices are not independent of each other because each sale competes with others later to come and those from the other two auctions taking place at the same time. Similarly, in bilateral negotiations, as preferred in Marseilles, there is not one price clearing the market. As done for cotton with the use of the ‘Circular’, an average price for fish is calculated and distributed to the participants in fish trade to ease forming strategies and reassure the equilibrium in the respective fish market.

6.2 Different mechanisms within the same market

At the fish market in Tokyo, traders use different price finding mechanisms. Bilateral negotiations, take-it or leave-it offers, and different types of auctions (Dutch and English) are used within the same market, at the same time, and for the same sort of fish. Certainly, the famous tuna auction takes place between 5:30–6:30am but tuna can also be bought from the counter. The mechanisms are used in parallel. The fish market in Tokyo functions as a place where different pricing mechanisms jointly generate the aggregate outcome but not necessarily the *one* market-clearing price. Although actors act rationally, they prefer different price finding mechanisms.

In part, we saw similar developments for the Liverpool cotton market: While cotton trade was organized by the brokers and performed in bilateral negotiations, the future market, which became an integral element of the cotton market in 1871, used the auction mechanism (Hall 1999). The auction mechanism has been improved several times and stabilized clearing house and future exchange to become Britain’s first future market. The hedging function of the future market made the large growth in the volume of the cotton market possible, even in times of falling prices.

In labor markets, different matching mechanisms have evolved over decades for different kind of jobs. Some mechanisms disappeared, others remained, yet others have been reinvented after some time. Since the 20 century, public labor agencies have matched the bulk of open positions to job seekers in many European countries. Yet, some segments of the labor market that concentrated on more specialized tasks and people with very specific skills relied on decentralized two-sided matching. Private job agencies were banned after bad experiences in the last three decades of the 19th century. With the turn of the millennium, private job agencies came back to complement public job agencies in the hope of better matching outcomes. All matching institutions, job seekers, and firms posting open positions together form the labor market. The different matching mechanisms are used alternatively or jointly to generate stable employee-employer relationships.

7 Summary and concluding remarks

Imperfect information on the main characteristics of the trading partner yields too little exchange and unused opportunities in the absence of exchange-supporting infrastructure. Myerson & Satterthwaite (1983) show that with private information of buyers' willingness to pay and sellers' marginal costs, trade will necessarily be inefficient. Since many real-life situations are characterized by incomplete information, economic agents have invested in the building of markets to mitigate the inefficiency. How this is done depends on the characteristics of the goods or services exchanged, the broader institutional setup, and the investing agents. It is therefore not surprising that markets too evolve different characteristics across time and space.

Roughly following the example of Liverpool's establishment as the leading world market for the exchange of raw cotton, where brokers undertook major investments in exchange infrastructure, we model the building of a market starting from the bilateral exchange situation discussed in Myerson & Satterthwaite (1983) with the broker as market-creating investor. We consider different options of the broker to increase her profits given the existing equilibrium but emphasize the role of providing price information on previous transactions. Price information structures beliefs and supports synchronization of exchange participants' action choices. This helps to find, stabilize, and reaffirm an equilibrium as illustrated in Aoki (2001) and eventually results in the growth of the transaction volume and the building of a market. Participants in exchange continuously update their beliefs and actions and may or may not react to changes. Some changes are endogenous to the participants, such as organizational innovation and marketing activities in order to increase the transaction volume. Other changes are exogenous to them, such as broader innovations in transport and communication technology, production and processing techniques that, however, change the available infrastructure for exchange.

Finally, it should be acknowledged that in a world with incomplete information, there is always a random element in the aggregate outcomes that characterize the market. Markets yield structure but not certainty. The structure can in general be changed, but not all investments to induce change will be successful. Also, since market participants look for their private advantage, there is no reason to assume that the aggregate outcome is the social optimum. There might be scope for improvement. Consequently, interference by third parties including state actors is not bad as such. However, state interference may not produce the desired outcome either. Since the market bundles and guides a complex network of private action choices that can be influenced but not controlled, the outcome of the interference is uncertain and the intended change may not be achieved. The new market outcome may even be worse than the one that was intended to be improved.

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