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1 Introduction

Price rigidity is a major concern in macroeconomics and is, as an aggregate of individual behavior, rooted in microeconomics. The potential failure of prices to adjust in order to adequately reflect the information of a good's scarcity has a multitude of macroeconomic implications. Although price rigidity forms a central assumption in many modern macroeconomic applications, its microfoundations are somewhat lacking. Indeed, prices are often empirically found to be sticky, but there is no consensus as to why prices are sticky in the first place. In microeconomic theory there exists a wide range of theories why prices are sticky. This thesis aims to shed light on one particular theory, the theory of implicit contracts. Consider a goods market where either high or low quality is traded, but quality is only revealed to the buyer after the purchase. Standard theory would predict the so-called "lemons outcome", where only low quality is traded at low prices, because low quality goods can not be distinguished from high quality goods. When sellers and buyers can identify their counterparts and engage in recurring transactions, they may form customer relations. In such a customer relation a buyer sticks with her seller, and a seller provides high quality. From such a customer relation both parties can gain, as the buyer enjoys high quality and the seller enjoys both a recurrent customer and a higher price. Such bilateral exchange relations may be kept together by an implicit contract, i.e. a tacit understanding of a fair sharing of the surplus generated by their relation.

Such fairness considerations now can theoretically impair the ability of prices to adjust properly to an economic shock. For example price increases when demand is high are commonly viewed as unfair, which may let sellers fear the termination of the relation by their customers if they were to increase prices. On the other hand if price increases can be justified by an increase in costs, which decrease the surplus that is generated, a price hike may be viewed as fair. So sellers would be less reluctant

to raise prices if they can justify the increase. Vice versa the same holds true. In times of low demand sellers would not need to decrease prices, as buyers would not insist on a larger share. But if customers know about a decrease in costs, they may insist on their sellers decreasing their prices. So there is a first asymmetry in price rigidity for demand versus cost shocks, which should work in both directions. Another asymmetry commonly posited in the literature is that customers tolerate price increases when sellers' costs rise more than they insist on price cuts when costs decrease. Furthermore such bilateral exchanges may create powerful reference prices to which prices return after a shock. Reference pricing is a phenomenon observed in pricing behavior, where after sales prices commonly return to their previous levels.

This thesis studies an economic experiment conducted by Elke Renner and Jean-Robert Tyran between 2002 and 2003. In the experiment a customer market is set up as is an anonymous market. On the customer market sellers and buyers are randomly matched and may trade with each other. These customer relations are set up exogenously and may be endogenously upheld, if a customer takes her seller's offer. Participants can not endogenously form new relations, so customer search is left out of the picture. If a customer relation breaks, then the participants are left to trade on the anonymous market. On this market there is a steady oversupply and buyers can not identify their sellers. This market should lead to the cited lemons outcome with low quality and low prices. Indeed, on the anonymous market prices and quality are lower than on the customer market, but prices seem to approach the lemons outcome only very slowly, if at all. Participants on the customer market are found to behave in line with the idea of implicit contracts. Customers react adversely and end the relation if they feel their implicit contract violated through price increases, high prices in general or the provision of low quality. In such a market environment it is studied how prices react to temporary positive and negative cost shocks in different

informational environments. Note that the data on positive cost shock treatments has already been analyzed in Renner and Tyran (2004), so this thesis extends this article by also including negative cost shocks in the analysis. Renner and Tyran (2004) find that for positive cost shocks prices are more sticky if the customers are not made aware of the cost shock. The inclusion of negative cost shocks now makes it possible to check if the behavior in response to negative cost shocks is similar to the asymmetric behavior in response to positive cost shocks. Also it may be checked if the responses to positive and negative cost shocks are similar or if there is another asymmetry associated with the direction of the shock.

The literature on customer markets now predicts prices to be more sticky for demand shocks than for cost shocks. This hypothesis can not be tested directly, as demand shocks are not modelled in the experiment per se. It can be argued though that if only sellers but not buyers are aware of a cost shock then the implications of such a shock are similar to a demand shock. If a seller experiences more or less demand in a demand shock, then the surplus of a customer relation remains unchanged. Similarly if the customers do not know that the costs of production have changed, then they would believe the surplus of a customer relation to be unchanged. So sellers can not or need not adjust prices properly without antagonizing their customers. Note that this argument rests on an assumption on customers' beliefs. Also it is implicitly assumed that customers only care about the split of the (believed) surplus, but not about other circumstances such as an increase in demand. For a sound empirical statement one would have to explicitly model demand shocks. Indeed, there is evidence of considerable price rigidity for both negative and positive cost shocks if they are not common knowledge. Literature on price rigidity also often posits prices to be more rigid downwards than upwards when costs of production change. There is no evidence of such behavior, instead prices seem to be more

flexible upwards than downwards when publicly know cost shocks hit a customer relation. This puzzling result might be caused through a case of mental accounting, where sellers code windfall gains from a cost decrease differently than the burden of a cost increase. The design does not allow this hypothesis to be tested directly, but it shows a possible avenue for future research. Also the pricing behavior in response to these temporary shocks exhibits signs of reference pricing, as after a shock has passed, prices return to their previous levels. This result is surprising considering the short amount of time that is needed to generate such a reference price.

The further plan of the thesis is as follows. First in section 2 it is discussed why price rigidity is a central problem in economics. Then the idea of implicit contracts on customer markets is worked out in detail and how such institutions may lead to sticky prices. This section is concluded by a review of existing literature and related fields in economics. In section 3 the experimental procedure is presented, experimental treatments are defined and testable hypotheses are worked out. Section 4 analyzes the collected data in detail. It is discussed how prices and quality evolve over time. Also the determinants of the breakup of customer relations are identified. Finally, section 5 summarizes the evidence and discusses its implications.

2 Literature

2.1 Why study price rigidity?

In any modern economic system it is a central question how resources should be allocated. In order to allocate these resources efficiently information is needed. The main problems that an economic system has to solve thus are: Which amount of a good is needed how badly? How much of a good can be provided at what cost? In market economies the price system plays the central role of an information transmission sys-

tem. Most famously, this line of thought has been cultivated by the Austrian school, especially by Hayek (1945) in his argument against central planning. In his view the information necessary for an efficient allocation is dispersed among individuals within the economy. The beauty of the price system as an information transmission channel lies in its simplicity. As goods become more or less scarce prices increase or decrease. Individuals react to these changes without the need for any deeper understanding of the nature of the price change. They simply receive the central information how scarce a certain good is, but whether this is due to a change in supply or demand is of no immediate concern to them.

So if prices play such an informational role then they need to adequately reflect information about a good's change in scarcity. If prices do not adjust properly to changes in supply and demand then their informational value is threatened. Prices that do not or only sluggishly change over time in response to such a change in fundamentals may be called rigid or sticky. Hayek acknowledges this problem and argues: "We must look at the price system as such a mechanism for communicating information if we want to understand its real function — a function which, of course, it fulfills less perfectly as prices grow more rigid." Hayek (1945, p. 526)

The idea that prices are rigid is a central assumption in Keynesian macroeconomics. Price adjustment is in the Keynesian view is sluggish and takes time. Arguing with psychological intuition Keynes (1936) also postulates that for price changes there is less friction in upwards than in downwards direction. So there should be an asymmetry in how easily prices change, i.e. an inflationary bias in the conomy. There is no Keynesian theory of why prices should be rigid in the first place though. This lack of microfoundation has been a part of the multi-pronged attack on Keynesianism by the Neoclassical revolution in the 1970s and 1980s. After this academic revolution price rigidity was no longer a central field of research. Since the rise of New Keynesian

economics in the 1990s price rigidity has prominently returned to macroeconomics. New Keynesian macroeconomic models nowadays sport microeconomic foundations of price rigidity. But which model of price rigidity to choose? Blinder et al. (1998) for example presents 12 different models of price rigidity in their study – and that is after only including those theories that could easily be explained in simple English, leaving out more technical and complicated ideas. The New Keynesian consensus is that price rigidity is caused by menu costs (see e.g. Rotemberg (1987)), i.e. that changing prices is costly. This concept leads to firms only changing their price if the necessity of a price change becomes large enough so that the benefits of a price change outweigh the costs. In the recent past doubt has been cast on this idea though. Using micro-level price data Nakamura and Steinsson (2008) for example convincingly show among other things that price changes due to sales are both very common and transient. Furthermore prices return to their original levels post-sale. Similar evidence is provided by Eichenbaum et al. (2011). Such price setting behavior isn't in line with the idea that changing prices is costly.

While there certainly is no lack of models of price rigidity, there is a certain lack of hard empirical evidence. The macroeconomic implications of price rigidity make a microeconomic analysis worthwhile. This thesis focuses on one specific theory, namely the idea that implicit contracts on goods markets are a source for price rigidity. This idea also has recently been macroeconomically formalized by Söderberg (2011) who integrated it into the the New Keynesian framework in lieu of the standard menu costs postulate. As he shows implicit contracts may macroeconomically not only work as a source of price rigidity, but also lead to substantially different results than standard models and allow current inflation to be dependent on past inflation. The scope of this thesis is not to study the macroeconomic implications of implicit markets though, but to microeconomically analyze how they work.

2.2 Customer Markets and Implicit Contracts

Customer markets are goods markets that are characterized by relationships between sellers and buyers. Okun (1981) argues that such a relation is formed and upheld through implicit contracts, which he defines as "arrangements that are not legally binding but that give both sides incentives to maintain the relationship" (Okun, 1981, p. 49f).

2.2.1 Implicit Contracts in Labor and Customer Markets

Originally, the idea of implicit contracts stems from the conception of the labor market by Azariadis (1975), Baily (1974) and Gordon (1974). It is worthwile to consider these roots as it shows why labor market literature and considerations are more related to the idea of customer markets than one might think. In this line of argument risk-neutral firms and risk-averse workers may form tacit agreements. Firms tacitly agree to keep the wages stable and thus provide an insurance to workers. Okun also applies the idea of implicit contracts to his conception of the labor market as follows. On the labor market firms hire workers and workers search for job offers. Searching is costly for workers, while hiring a new worker incurs costs for the firm in form of training and the like. Furthermore a relationship between firm and worker is plagued by moral hazard as a worker may shirk after she gets the job. As we do not live in a world where perfect contracts are possible, Okun argues that firm and worker enter an implicit contract. The worker implicitly promises that she will not shirk and will stick with the firm, while the firm promises that it will pay a fair wage. Thus the worker can avoid the search costs, while the firm can avoid both the costs of training newly hired workers and the cost of having a worker shirk on the job. Such an implicit contract generates a surplus for both parties.

This idea may be applied to a goods market where buyers go shopping for the lowest

price. As in the labor market shopping, i.e. searching is costly for buyers. Recurrent buyers are valuable for a seller as demand is smoothened over time. Also the good that is traded may be an experience good. For such a good buyers do not know ex ante which quality they are offered, but sellers do know which quality they sell. So sellers clearly have an incentive to take advantage of the buyer and sell low quality. The result of this moral hazard may be the famous lemons market as characterized by Akerlof (1970), with only low quality being traded at low prices. In such a setup, Okun argues, buyers and sellers enter an implicit contract and a customer market emerges, where buyers and sellers endogenously form and uphold customer relations. In their implicit contract a buyer implicitly promises to stick to a seller, while a seller promises not to exploit the buyer and to offer good quality at a fair price. The tacit agreements to stick to a seller and to offer good quality are intuitively clear, but the key question is what is perceived as fair. To Okun the fairness question boils down to the participants' share of the surplus that is generated by the customer relation. "If customers believe that their share of the surplus associated with the relation is being trimmed, they are bound to react adversely." (Okun, 1981, p. 154)

2.2.2 Implications of Implicit Contracts

The central implicit promise of a fair share may now act as a source of price rigidity when there are temporary shocks. In a cyclical economy there are two main sources of temporary shocks that should lead to price adjustments. Demand shocks mean that a seller temporarily experiences more (less) demand for her products. Such an increase (decrease) in demand means that the good just became more (less) scarce and on a standard market this would lead to sellers charging higher (lower) prices. Note that a demand shock does not change the surplus generated by a customer relation though. An increase in price in response to an increase in demand would thus result in a decrease of the buyer's share of the surplus. Such a move would be

seen as exploitative by the customer. She would see the implicit contract violated and respond by terminating the customer relation. So sellers should be reluctant to increase prices in order not to antagonize their customers. A decrease in price in response to a temporary decrease in demand on the other hand would be against the seller's interest as well. If a seller decreased prices she might attract new customers. But as the seller knows that the decrease is not permanent, she knows that she would have to increase prices again after the shock was over. Such an increase would antagonize new and old customers alike as they might expect low prices to continue. From these considerations it follows that prices should be sticky in both upwards and downwards direction for demand shocks.

The second main source of temporary shocks are cost shocks. If a seller's costs of producing temporarily increase (decrease) she should increase (decrase) prices as well to reflect the change in the good's scarcity. Unlike a demand shock a cost shock decreases (increases) the surplus that has to be split. An increase (decrease) in price thus means that the burden (windfall gain) of the cost shock is shared between seller and buyer. Their respective shares of the surplus are at least potentially preserved. So if customers believe that sellers charge higher prices due to an increase in costs, they are more inclined to accept those higher prices. Interestingly, Okun not even once explicitly discusses the possibility of a negative cost shock and solely focuses on positive cost shocks. That may be explained by the book's publishing date. In 1981 with inflation rates of well above 10 % in the US negative cost shocks probably were not Okun's concern. Still it is easy to deduce from his framework that if customers believe that sellers' costs actually dropped, they would insist on on lower prices. Else they would see their share of the now larger surplus threatened.

So following Okun prices should respond a lot to cost shocks but not to demand shocks. But what about upward and downward symmetry of price adjustments?

Is it due to customer markets that price increases might be more prevalent than price decreases? Okun suspects that pricing behavior in customer markets is at least partially responsible for such a general inflationary bias in the economy. Still he admits that there is no general evidence pointing at pricing behavior on customer markets as a root for inflation. So we may expect two different kinds of asymmetric price rigidity. First there may be asymmetry between the reaction to demand and cost shocks. Second the price response to cost shocks may itself be asymmetric.

Still the question remains why sellers would enter an implicit contract in the first place. After all sellers that form an implicit contract make a promise not to exploit their customers in order to earn on their loyal customers in the future. But the future never arrives and sellers can never earn on their loyal customers. Nakamura and Steinsson (2011) offer an extension of Okun's model. They develop a model based on implicit contracts and argue that sticky prices work as a commitment device for sellers that helps them not to exploit their customers. Thus sellers commit to set their prices below a price cap which is dependent on the customers' loyalty. Above the price cap prices are rigid, while below the price cap prices are flexible. So this framework would allow for temporary sales which are commonly observed in reality, i.e. more downwards flexibility of prices.

2.3 Related Literature

The hypothesis that implicit contracts in goods markets give rise to price rigidity in presence of demand shocks but not cost shocks is difficult to test empirically. Implicit contracts are by nature tacit agreements between sellers and buyers and hard evidence is difficult to come by in the field.

2.3.1 Survey Evidence

A well explored alternative approach to the standard approaches in economics is survey evidence. In an interview study Blinder et al. (1998) survey experienced individuals. They interview a sample of managers representative for the US economy and present them with various theories on price rigidity including implicit contracts. The managers are then asked whether the theory fits the situation that they see their firm in and various follow-up questions. In total 64 % of the managers claim that implicit contracts play a role in their firm. Those managers answering positively also rate it as very important in slowing down price adjustments in their company, with a mean response of 3.16 on a scale of 1 (unimportant) to 4 (very important). Furthermore Blinder et al. find that managers statistically significantly believe their customers to tolerate price increases in presence of an increase in costs more (71.2 %) than to insist on price decreases when costs decrease (50.6 %). So they find indicative evidence that prices should be more rigid downwards than upwards.

Blinder et al.'s study spurred interest mainly among central bankers. As public stakeholders concerned with price rigidity central banks funded similar research projects. Hall et al. (2000) report that in their survey among British firm mangers 46 % recognize implicit contracts in the relations with their customers. Those managers who recognize them rate the importance of implicit contracts rather highly with 2.9 on a scale from 1 (high importance) to 7 (low importance). Similarly Swedish managers rank the importance of implicit contracts on average with 3 (Apel et al., 2005) and European managers with 2.7 (Fabiani et al., 2005), both on a scale from 4 (very important) to 1 (unimportant). Fabiani et al. also report that price flexibility may depend on the nature of the shock. They find downwards price rigidity for cost shocks, and upward price rigidity for demand shocks. Finally Amirault et al. (2006) report that 32 % of Canadian firm managers recognize implicit contracts in their pro-

fessional behavior. Out of those managers only 38 % claim that implicit contracts keep them from raising prices in "tight markets". Furthermore out of those only 35 % state that their customers insist on price cuts in "weak markets". They deduce from these findings that prices seem to be more rigid upwards than downwards. But this result may be due to the authors' ambiguous way of posing their questions. Managers are asked if an implied understanding with their customers keeps them from raising prices in "tight" or "weak" markets. It is not entirely clear though what tight or weak exactly mean, i.e. if they imply cost or demand shocks. That might have confused managers, which would also explain that implicit contracts only rank 1.6 on a scale of 4 (very important) to 1 (not important).

2.3.2 Field and Experimental Evidence

The aforementioned studies only rely on survey evidence among firm managers though. A rare piece of direct field evidence is provided by Young and Levy (2010) who cite the Coca-Cola company's historical pricing strategy. They make the case of the company explicitly making an implicit promise to keep the nominal price and quality constant. Indeed, they document that over a period of roughly 70 years between 1886 and the mid-1950s Coca-Cola sold for the same nominal price of $ 0.05. Over those 70 years seven changes were made to the formula of Coca-Cola, but as the authors argue those were minor adjustments that did not impact quality. Furthermore they show that the Coca-Cola company understood well to explicitly advertise their implicit contract with their customers by stressing the price of 5 cents and promising constant quality. Less direct evidence for the implicit contract theory is provided by Anderson and Simester (2010). They run a randomized field experiment with more than 50,000 customers of a publishing company who receive product catalogs. Customers would randomly receive either a normal catalog or one offering a sale on 36 items. It turns out that customers issue 14.8 % fewer orders over the next 28 months

from said company if they bought a product from the same company before and see the price drop due to the sale. They argue that these customers are antagonized because they feel to have paid too much and react adversely which would be well in line with the idea of implicit contracts.

Economic experiments offer a promising addition to surveys and field studies when studying implicit contracts. While implicit agreements are very difficult to observe in the field, in the controlled environment of an experiment such phenomena may become directly testable. Experimental evidence of price stickiness due to implicit contracts is first provided by Cason and Friedman (2002). They exogenously set up customer relations but let customers change sellers and thus endogenously form new relations. They find that customers are less likely to switch sellers if the associated costs of switching are high. As demand becomes less elastic the sellers' market power increases and prices become more sticky. The market is opaque in the sense that customers neither observe their sellers' costs nor get information in which direction the cost shock went. Thus price changes are not justifiable by changes in costs, which is an important issue in implicit contracts. The same design is employed by Cason et al. (2003) to study differences in price rigidity between bargaining and posted price competition in customer markets. They find that prices are stickier under bargaining than under posted price competition. Renner and Tyran (2004) employ a similar design, though customer relations may not be formed endogenously. In their experiment the market still is opaque as customers do not know their sellers' true costs. They run a treatment though where information on the direction of the positive cost shock and its relative magnitude is shared with the customers. If price increases are justifiable by such a commonly known rise in costs prices are much less sticky. Still the authors only consider positive cost shocks. As argued before the labor market shares a few important parallels with customer markets. The idea of implicit

contracts originally stems from the labor market and thus the mechanism should apply in a labor market context as well. Brown et al. (2004) run a laboratory labor market experiment which shows signs of implicit contracts, though their design does not cover price rigidity. In their experimental design firms hire workers, but workers may shirk after being hired. If contracts can not be enforced by a third party but if identity is trackable, firms and workers form what the authors call "bilateral trading islands". Low effort by the worker is sanctioned with the termination of the relation by the firm. Their findings thus are in line with implicit contract theory.

2.3.3 Trust, Fairness and Reference Points

As in customer markets customers can not observe quality ex ante, this thesis also ties in with the literature on trust. Customers have to trust their sellers to fulfill their implicit contract and deliver good quality. Most famously Berg et al. (1995) show that trust and reciprocity form a basic element in human behavior. They experimentally show that even in a one-shot interaction most senders are willing to entrust an anonymous receiver. Senders give a sum of money to the receiver, which is then tripled by the experimenter. Afterwards the receivers may send a part of that money back to the sender, and indeed, they send back considerable amounts of money. Kollock (1994) experimentally examines the role of trust in a lemons markets where individuals may interact several times and endogenously form relations. He finds that sellers and buyers form relations when they can. Customers trust their seller and they reciprocally honor the trust put in them. Fehr and Gächter (2000) extend the idea of trust and reciprocity and demonstrate that in markets with incomplete contracts such behavior may serve as a powerful contract enforcement device. If two parties engage in an incomplete contract and one exploits the other's trust, the latter will react adversely. But what does it mean for one party to exploit another, respectively for someone to feel exploited? The idea of exploitative behavior on its own is ill-

defined and has to be measured against some benchmark that is non-exploitative behavior. Fehr and Gächter thus link the idea of reciprocity to fairness. If one of two parties feels that the other party acts unfairly then the former is bound to react adversely.

So this thesis also links with the literature on fairness. The most robust evidence of fairness considerations in bilateral economic interactions comes from ultimatum game experiments. In an ultimatum game a sender gets to propose a split of a sum of money between herself and a receiver. If the latter rejects the proposal then nobody gets anything. Güth et al. (1982) find that the receivers reject very unequally split proposals even though that means that they do not get anything. The experiment has been run in a wide range of countries ever since and yielded similar results. See for example Oosterbeek et al. (2004) for a meta-analysis of ultimatum game experiments. Fehr and Schmidt (1999) offer a powerful model of fairness that covers many phenomena found in the experimental literature. They model fairness considerations as self-centered inequity aversion. People care for the relative distribution of payoffs and resent unequal payoffs. They are willing to pay for more equitable outcomes, but only if they are concerned themselves. Inequity among other people is of no concern to them though. This notion of fairness fits well into Okun's concept of customer markets, where customers care about their share of the surplus. Evidence for this idea is provided by Kahneman et al. (1986a) who conduct a series of telephone interviews. Respondents are put in different hypothetical situations and are asked whether they judge the behavior of some firm as acceptable or unfair. They find that up to 91 % of respondents judge a rise in prices due to an increase in demand as unfair. If a price increase is due to an increase in costs though, up to 79 % of respondents judge this increase as acceptable. On the other hand an unchanged price in presence of a decrease in costs is only judged as unfair by 47 % of respondents.

This evidence gives suggestive evidence to Okun's intuition of an asymmetry in pricing behavior. Kahneman et al.'s findings are corroborated by Frey and Pommerehne (1993) who also run a telephone survey with similar questions. The implications of such fairness considerations on prices has recently been formalized by Rotemberg (2011). He shows both that the sellers' fear of disappointed customers can explain price rigidity in response to demand shocks and that prices are more responsive to cost than demand shocks.

These considerations may not capture the entirety of fairness considerations in pricing. For example Kahneman et al. (1986b) argue that framing is an essential moment in fair pricing. They argue in line with prospect theory (Kahneman and Tversky, 1979) that instead of considering the absolute relative payoffs, changes have to be interpreted with respect to a reference point. Such a reference price may not only be formed through fairness considerations of self-centered inequity aversion, but may also root in the price history of a trading relation between a seller and a buyer. In the marketing literature reference prices have already been studied extensively. They find that consumers use reference prices when making consumption choices. Also they find that the formation of reference prices relies on past prices, competitor prices and the selling firm's input costs. See Kalyanaram and Winer (1995), Xia et al. (2004) and Mazumdar et al. (2005) for surveys on the topic. In economics Eichenbaum et al. (2011) recently showed using supermarket scanner data that although prices may vary from week to week they return to some reference price after some time. The reference prices themselves only adjust slowly, and on average reference prices change only every 3.7 quarters. Similar evidence is provided by Nakamura and Steinsson (2008).

3 Experimental Design

3.1 General Design

As this experiment is an extension of Renner and Tyran (2004) the general experimental design is the same as in the aforementioned paper. The description of the experimental procedure provided here thus closely follows the aforementioned experiment.

The base game used in the experiment takes the form of a trust game. First sellers decide at which price to offer their good and whether to offer high or low quality. Providing high quality is twice as costly for the seller than providing low quality. For the buyer high quality is twice as valuable than low quality though. Only the price offer is disclosed to the buyers who then decide whether to take an offer or not. If the buyer chooses to accept an offer, only then she is informed of the quality of the traded good. The good in question thus can be characterized as an experience good. A buyer's payoff in any period is given by *value* - *price* while a seller's payoff is given by *price* - *cost*.

The good is traded on two markets. On the customer market (CM) a seller is matched with a buyer at the beginning of a trading phase. In each session there are 5 successive phases and each trading phase consists of 10 successive trading periods. At the beginning of each period the seller decides at which price and quality to offer the good, but only the price offer is sent to the buyer. If the buyer accepts the seller's offer, their customer relation persists and the two are rematched in the next period unless it is a phase's last period. Then their customer relation is broken up anyway. If the buyer rejects the seller's offer, their relation is terminated and they continue trading on the anonymous market (AM) in the same period. After all interactions on the CM have been carried out, the procedure continues with the interactions on

the AM. On the AM the sellers' offers are pooled and anonymously presented to the buyers on their screen in a list. If there is more than one active buyer on the AM, the buyers move sequentially in a randomly determined order. If it is her turn a buyer may choose either to take any offer that has not yet been taken or to take none at all. So participants may only move from the CM to the AM but not vice versa. Customer relations are exogenously formed and may be endogenously continued, but they can not be formed endogenously. By leaving consumer search out of the picture on purpose this design eases the study of endogenously upheld customer relations.

At the beginning of a session the participants are randomly assigned their role and informed whether they are a seller or a buyer. They keep their role for the entire session. As mentioned before each session consists of 5 trading phases. At the beginning of each phase participants are randomly assigned to either the CM or AM. A seller/buyer pair is never rematched and the participants are informed about this fact. In each session there are 12 participants. 8 are assigned the role of a seller and 4 the role of a buyer. At the start of each phase 3 sellers and 3 buyers are matched on the CM, whilst 5 sellers and 1 buyer interact initially on the AM. If customer relations break down the number of participants trading on the AM increases. This setup ensures that there is a steady oversupply of at least 4 units of the traded good, which leads to the AM being a very competitive market. Both buyers and sellers do not know the exact number of individuals in the CM or AM, but they're made aware that there are more sellers in the AM than there are buyers.

In all treatments all participants know how payoff is calculated for both sellers and buyers, how many trading phases and periods they will face and what the buyer's values for high and low quality are. The sellers' exact costs are only available to the sellers, though buyers are made aware that the costs of providing low quality is lower than those of providing high quality for sellers. Buyers also know that costs are the

same for all sellers. Full instructions are provided in the appendix.

3.2 Experimental Treatments

In the base game providing high quality incurs costs of 80, while providing low quality incurs costs of 40 for the seller. To the buyer high quality is worth 200 and low quality 100. So for high quality trades the generated surplus is 120, while for low quality the surplus is only 60. In all treatments participants experience a temporary cost shock in the third trading period in each phase. This shock alters the costs of providing both high and low quality for the seller, but only for the third period. In the following periods the costs return to their previous levels. In total there are four treatments that differ across two dimensions.

	Buyer's Value	Sellers' Costs if		
		No Shock	Positive Shock	Negative Shock
High Quality	200	80	120	40
Low Quality	100	40	60	20

Table 1: Values and Costs

First treatments differ in the direction of the shock. In the positive cost shock treatments costs temporarily increase by 50% in the third period while in the negative cost shock treatments costs temporarily decrease by 50%. Thus in the first treatment costs increase from 80 (40) for providing high (low) quality to 120 (60). In the second treatment costs decrease from 80 (40) to 40 (20). These numbers lead to an increase respectively decrease of the surplus of 33 %. For high quality trades the surplus decreases from 120 to 80, and for low quality trades from 60 to 40. Thus the positive and negative cost shocks are symmetric. Buyers' values do not vary with the shock. Table 1 summarizes the payoff parameters for all participants. Note that the positive shock treatments form the basis of analysis in Renner and Tyran (2004).

Second treatments differ in the informational conditions. Information about the

shock is always provided at the beginning of period 3. In the private information treatments only sellers are informed of the cost shock and its temporary nature. They are also made aware that buyers do not know about the cost shock. In the public information treatments both sellers and buyers are informed of the cost shock and that it will only be temporary. Both sellers and buyers are also made aware that their trading partner is informed as well, because the cost shock is publicly announced by the experimenter at the same time. Buyers only know that the sellers' costs changed by 50% though, and lack any information on the actual level of costs.

Thus we have four different treatments. These treatments will be referred to as PRIPOS (private information, positive cost shock), PUBPOS (public information, positive cost shock), PRINEG (private information, negative cost shock) and PUBNEG (public information, negative cost shock), as summarized in Table 2.

	Private Information	Public Information
Positive Cost Shock	PRIPOS	PUBPOS
Negative Cost Shock	PRINEG	PUBNEG

Table 2: Experimental Treatments

3.3 Testable Hypotheses

From the theoretical discussion there follow a few hypothesis that may be checked using the outlined design. The main hypotheses are as follows.

Hypothesis 1. *Prices are more rigid if cost shocks are not commonly known.*

The experimental design allows a cost shock that is not common knowledge to work similar to a demand shock. A customer who does not know of her seller's positive cost shock will feel exploited if her seller tries to raise the price. So the price should remain sticky, as customers threaten to terminate the relation. If the seller's positive cost shock is common knowledge, then a customer should not feel exploited

and temporarily accept higher prices. Similarly, a customer who is not aware of a negative cost shock will not feel exploited if her seller pockets the windfall gains. If the customer knows that there is a negative cost shock though, she sees the share of her surplus threatened and insists on lower prices. So in both cases prices should be more sticky if the cost shock is not common knowledge. As demand shocks should have a similar impact on the customers as unknown cost shocks, this hypothesis indirectly tests for an asymmetry between demand shocks and cost shocks. Note that this argument rests on two assumptions. First that customers' beliefs on the costs of production remain unchanged. Second that customers only care about the (believed) surplus that has to be split and not about any other circumstances such as more demand for the product.

Hypothesis 2. *Prices are less rigid upwards than downwards if cost shocks are commonly known.*

As surveys show managers believe their customers more to accept higher prices after increases in costs than to insist on lower prices if prices decrease. So survey evidence suggests that prices should be more rigid downwards than upwards, as is also the Keynesian intuition.

Hypothesis 3. *Post-shock prices return to their pre-shock levels.*

The literature on reference prices suggests that after temporary price hikes prices return to their reference level. As the shock in this experiment is only temporary post-shock prices should return to their previous levels.

Hypothesis 4. *Prices increase over time within a trading phase.*

Upholding a relation should mainly be beneficial for the seller. In a customer relation on the CM the seller is a monopolist whereas on the AM there should be cut-throat competition due to guaranteed the oversupply. But as a trading phase

progresses there are fewer and fewer periods in which a customer relation is potentially upheld. Thus a customer relation gets less valuable by each period. A seller who sees his customer relation getting less valuable has two options to act. Either increase the price offer or decrease quality. Price offers can be adjusted almost continuously, but the choice in quality is binary. So for a crawling adjustment that is the devaluation of a customer relation the seller's price choice should be more suited than her quality choice. So prices may be expected to slowly rise over time because of this devaluation effect.

Hypothesis 5. *Customers terminate the relation if the implicit contract is violated.*

An implicit contract between seller and buyer features an agreement on the provision of high quality at a fair price. Thus there are three ways of violating the implicit contract. First if a seller offers her good at a high price, she offers only a low share of the buyer who is then bound to react adversely. Second if the seller and the buyer have established a reference price, then a price increase would be seen as unfair by the customer. Third if a seller provides low quality, this antagonizes buyers as well, because her trust has not been repaid reciprocally.

4 Results

The experiment was run in a computerized laboratory and implemented using the z-tree software (Fischbacher, 1999). In total 480 individuals participated in 40 sessions in the experiment, with 12 individuals participating per session. All sessions were conducted between July 2002 and November 2003 at the University of Erfurt. The PRIPOS and PUBPOS treatments were executed in 12 sessions (i.e. with 144 participants) each, while the PRINEG and PUBNEG treatments were executed in 8 sessions (i.e. with 96 participants) each. One PRINEG session had to be restarted

after a software crash in the second phase, but could be successfully concluded in the second run. Participants on average earned 1,289.875 points which were valued at 0.012€ each. So average earnings were 15.48€ within about 120 minutes.

4.1 Overview

Table 3 provides descriptive statistics for the main results. Trading high (low) quality is coded as 1 (0). The first thing to compare are traded quality and transaction prices across CM and AM. In 59% of all transactions on the CM high quality is traded. This incidence of high quality is accompanied by an average transaction price of 113.6. On the AM high quality is only traded in 18% of transactions with an average price of 79.1 for all transactions. So the customer relation on the CM seems to induce higher quality at higher prices than the anonymous interactions on the AM, as shown by Renner and Tyran (2004). It is still surprising that traded quality and transaction prices are so high on the AM though. Remember that this market is highly competitive with at least four units of excess supply at all times. Such a setup should induce cut-throat competition among sellers. Prices would be expected to approach marginal cost and quality to approach zero, providing the lemons market outcome suggested by standard theory. Still there seems to be substantial amount of trust and reciprocity in the market. There is a substantial aamount of buyers who buy at relatively high prices and sellers who sell high quality.

On average buyers earn 45.9 points, while sellers earn 49 points on the CM. On the AM though profits are a little lower on average. Active buyers, i.e. those buyers who choose to take an offer on the AM earn 39.2 on average. If those few buyers who choose not to trade in the AM are included, average earnings drop to 39. So for a buyer interacting on the AM might yield lower profits on average, but trading on the AM is far from ruinous. An active seller on the AM earns on average 31.5. This

	ALL	PRIPOS	PUBPOS	PRINEG	PUBNEG
Customer Market					
Traded Quality	0.59	0.65	0.55	0.64	0.56
Transaction Price	113.6	117.0	113.6	115.4	107.2
Buyer Profits	45.9	47.6	41.0	49.0	49.0
Seller Profits	49.0	47.4	48.2	53.5	48.4
Anonymous Market					
Traded Quality	0.18	0.23	0.15	0.18	0.15
Transaction Price	79.1	81.3	80.8	77.2	76.9
Active Buyer Profits	39.2	42.2	37.5	37.7	38.3
All Buyer Profits	39.0	42.1	37.4	37.6	38.1
Active Seller Profits	31.5	29.7	29.4	35.7	32.9
All Seller Profits	13.1	12.6	11.8	15.0	13.8

Table 3: Averages across all Sessions, Phases, Periods and Individuals

number only counts those sellers who were lucky enough to find a buyer. If all sellers trading on the AM are included, average seller profits drop to 13.1. This demonstrates that a buyer in a customer relation on the CM carries a big stick. By ending the relationship she can punish her seller with an average loss of $49 - 13.1 = 35.9$. Furthermore trading on the CM is mutually beneficial for both buyer and seller on average. Thus both buyer and seller should strive to uphold their relation.

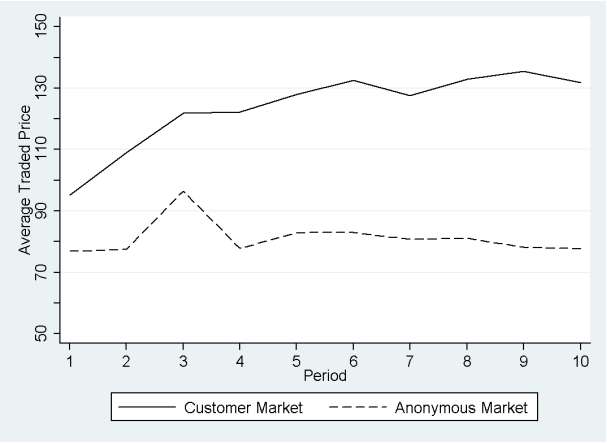
If we further compare the averages across treatments, we observe nothing out of the ordinary. The results look roughly the same across all treatments even though the shock periods are included.

The in-depth analysis will proceed as follows. First the evolution of prices in the markets and the reaction to the cost shocks are analyzed. The second part of the analysis deals with the traded quality. Finally, the determinants of upholding customer relations are analyzed. All statistical analysis was carried out in Stata 12.1, if not explicitly noted otherwise.

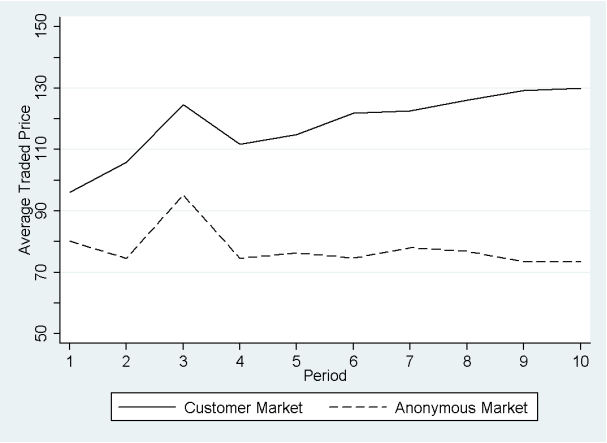
4.2 Prices

Figure 1 (a) to (d) shows the evolution of average prices on the two markets for all four treatments. First consider the anonymous market. On the AM prices do not change much within phases apart from the spikes in response to the shocks in the third period. Between phases there seems to be a decrease in prices though. After pooling all the AM observations except for the shock periods, average prices drop from 85.1 in the first phase to 75.1 in the last phase. A Mann-Whitney test rejects the null of equality of distributions at a significance level of 1 %. So prices seem to drop over phases on the AM, which may indicate an effect of learning. Still prices fail to reach the predicted lemons market price of 40 even after 5 phases with 10 trading periods each. So a certain level of trust seems to persist in the market. The price spikes in response to the cost shocks themselves are of minor interest. They can not serve as a baseline for the price response to the cost shock on the CM because on the AM there is more low quality traded than on the CM. As the cost shocks change the costs of providing high and low quality differently, the price responses on the AM and CM are incomparable. The AM serves as a threat and punishment for sellers, but is of no interest beyond that.

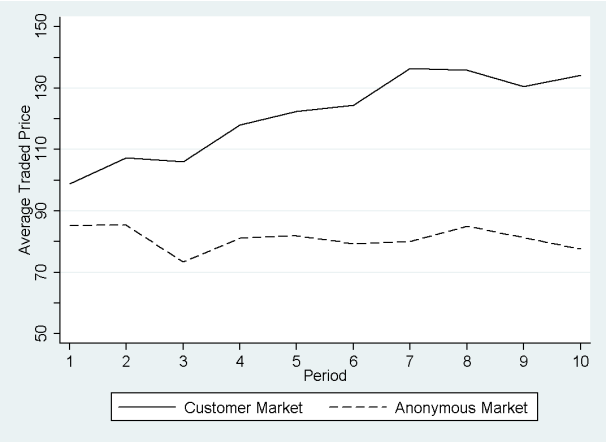
Now consider the customer market. When looking at the CM in all treatments there seems to be an upward trend in the average price over the ten trading periods. This trend may be explained by two different effects. First there may be a selection effect. Sellers offering low quality at low prices see their relations terminated by their customers. This results in only sellers delivering high quality at high prices staying in the CM. The second effect may be a time trend in the prices due to the devaluation of a customer relation as stated in hypothesis 4. The selection effect is rather easy to correct for. In order to compare two periods it is best to only consider those relations that are upheld in both periods. This way the selection effect cancels out entirely.



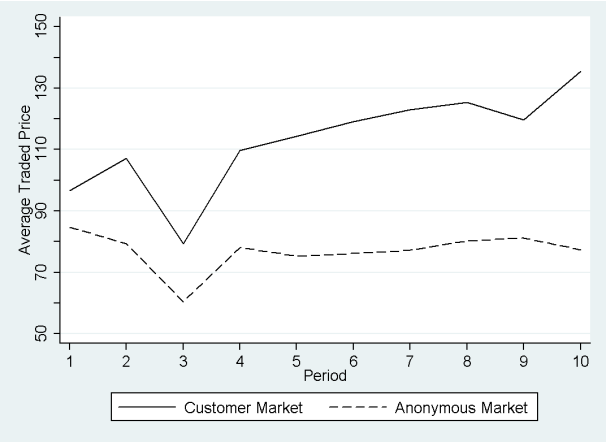
(a) Private Information x Positive Cost Shock



(b) Public Information x Positive Cost Shock



(c) Private Information x Negative Cost Shock



(d) Public Information x Negative Cost Shock

Figure 1: Average Price across all Sessions, Phases and Individuals

The devaluation effect is more tricky to work out. This effect will be dealt with later, for now it is sufficient to keep it in mind when looking at the evolution of prices.

4.2.1 Reference Pricing

In the third period in all trading phases the sellers are hit by either a positive or negative temporary cost shock. Afterwards costs revert to their original levels in the fourth period. But how do prices react to the end of the temporary cost shock? Before examining the responses to the cost shocks in detail it has to be checked how prices behave before and after the cost shock. Table 4 gives the average prices on the CM

Treatment	# obs	Average Price in			Mann-Whitney
		Period 2	Period 3	Period 4	p-value
All	234	112.8	113.8	115.2	0.3746
PRIPOS	59	119.8	123.7	122.3	0.4275
PUBPOS	85	109.9	125.2	111.7	0.6642
PRINEG	44	112	110.5	118	0.4688
PUBNEG	46	109.9	83.2	109.7	0.9591

Notes: Only relations are considered that last at least until period 4. Mann-Whitney tests test for the equality of distributions between period 2 and period 4.

Table 4: Average Prices on the CM from Pre- to Post-Shock

for pre-shock period 2, shock period 3 and post-shock period 4. In order to account for selection effects only those relations are considered which last until period 4. This results in 234 customer relations with an average transaction price of 112.8 in period 2 and 115.2 in period 4. In all four treatments average prices only differ marginally pre- and post-shock. Mann-Whitney tests for equality of distributions yield no significant difference in prices between period 2 and period 4 for all treatments both pooled and individually. This evidence supports hypothesis 3, which states that prices return to their reference price after the shock. It seems that as few as two interactions in the two periods before the shock are sufficient to create a reference price. When the cost shock hits the relation in period 3 prices may adjust, but in period 4 average prices return to the reference price and no difference in prices is discernible between pre- and post-shock periods.

4.2.2 Price Asymmetries

Now focus on the price changes in the shock periods on the CM. As the trading phases are repeated five times, we might expect the participants to learn and anticipate the shock in later phases. If that were the case, then we would see differences in the price changes in response to the cost shocks between individual phases. This can be checked by running Mann-Whitney tests, i.e. testing for the equality of distributions.

Comparing all ten possible phase pairs (1&2, 1&3, 1&4, 1&5, 2&3,...) for all four treatments yields 40 tests. Of those 40 test only two are significant and one is weakly significant at conventional levels. Thus there is no significant evidence of a learning effect in the response to the shock and it should be safe to pool the price changes. Table 5 summarizes the average price change within a relation on the CM. Note that these numbers only include those relations that were upheld in both the second and the third period in order to control for a selection effect.

A first glance the "all trades" line seems to paint a pretty clear picture. Comparing across informational treatments, prices seem to be more rigid when there is no common knowledge of the cost shock in both directions. The absolute average price reaction in PRIPOS of 4.15 seems to be smaller than the reaction in PUBPOS of 16.4. Similarly, the absolute average price change in PRINEG of 1.85 seems to be smaller than the reaction in PUBNEG of 27.82. These descriptive statistics would indicate support for the first asymmetry hypothesis 1, which states that prices are more rigid if a cost shock is not publicly known. Surprisingly, the absolute average price change in PUBPOS seems to be smaller than in PUBNEG which would indicate a price asymmetry in reaction to cost shocks, but in a different direction than the second asymmetry hypothesis 2 predicted. Prices seem to be more sticky upwards than downwards. But it is questionable to simply compare price reactions across different treatments as a seller's price choice is intertwined with her quality choice. Consider for examples the sellers that offered high quality in period 2. Those sellers who keep offering high quality in period 3 may set different prices than those who choose to offer low quality instead. Suppose that those sellers who offer low quality after having offered high quality set prices that are lower by 10 on average than those sellers who keep offering high quality. Then the absolute average price reaction for the positive cost shock treatments would decrease by 10, while for the negative

Quality	PRIPOS		PUBPOS		PRINEG		PUBNEG	
	# obs	avg	# obs	avg	# obs	avg	# obs	avg
All Trades	72	4.15	98	16.4	52	-1.85	55	-27.82
$(1,1)$	44	4.89	38	18.18	28	0.35	25	-23.56
$(0,0)$	17	9.18	37	22.51	17	-3.8	19	-25.37
$(1,0)$	10	-15.8	20	-8.6	4	-35	9	-60.56
$(0,1)$	1	90	3	85	3	33	2	43
Mann-Whitney p-values								
comparing			all trades		only (1,1)		only (0,0)	
PRIPOS & PUBPOS			0.0000		0.0000		0.0624	
PRINEG & PUBNEG			0.0000		0.0000		0.0036	
PRIPOS & -PRINEG			0.6351		0.2505		0.2994	
PUBPOS & -PUBNEG			0.0119		0.2138		0.6264	

Notes: Only relations are considered that lasted at least until period 3. High quality is coded as 1, low quality as 0. The numbers in brackets describe (quality in period 2, quality in period 3).

Table 5: Average Price Responses on CM

cost shock treatments the reaction would increase by 10. Thus it is best to split the trades by traded quality in periods 2 and 3 as is done in table 5. Interestingly, most sellers seem to stick with their quality choice. 81.2 % of sellers offer the same quality in period 3 as they had offered in period 2. Out of the 18.8 % that change quality 82.7 % change from high quality to low quality, and only 17.3 % change from low quality to high quality. Differences in pricing behavior between different quality choices may thus well be a source of the differences.

Due to the aforementioned reasons it is best only to compare the price reactions of trades that show the same level of quality in periods 2 and 3. All test results are reported in table 5. First consider the positive cost shock treatments. Mann-Whitney tests applied to the price changes in PRIPOS and PUBPOS yield highly significant evidence that both reactions stem from different distributions when comparing all trades and the subsample high quality trades only. Comparing only low quality trades there is only weakly significant evidence. But Mann-Whitney tests only test for an inequality in underlying distributions. So we might be inclined to

run a t-test and test whether the absolute average price response in PUBPOS is larger than in PRIPOS. Two-sample t-tests with unequal variances yield highly significant evidence at conventional levels that the absolute average price reaction in PUBPOS is larger than in PRIPOS for all trades and high quality trades and significant evidence for low quality trades. The same procedure may be applied to the negative cost shock treatments. Mann-Whitney tests consistently yield highly significant differences between the price reactions in PUBNEG and PRINEG for all trades as well as the subsamples of high and low quality trades. Similarly, two-sample t-tests with unequal variances yield highly significant evidence that the absolute average price reaction in PUBNEG is larger than in PRINEG. So these findings give evidence for hypothesis 1, that prices are more sticky if there is no common knowledge of the cost shock.

Using t-tests may be problematic though because of the rather harsh assumptions of finite variance and normally distributed standard errors they employ. Alternatively, we can use a non-parametric test for stochastic inequality outlined by Schlag (2012). The test for stochastic inequality compares two samples Y_1 and Y_2 and tests the null hypothesis of $H_0 : P(Y_2 > Y_1) - P(Y_2 < Y_1) \leq 0$ against the alternative hypothesis of $H_1 : P(Y_2 > Y_1) - (Y_2 < Y_1) > 0$. In words it tests whether the probability of Y_2 being larger than Y_1 is larger than the probability of Y_2 being smaller than Y_1. The test's procedure can roughly be described as follows. Data from sample Y_1 and Y_2 is randomly matched in Monte Carlo simulations. If more data points from Y_2 are bigger than Y_1 than would be expected under the null hypothesis, the null hypothesis is rejected in favor of the alternative hypothesis. For more information and proofs see Schlag (2012).

The test for stochastic inequality[1] provided by Karl Schlag[2] was run in R 2.12.2.

[1] version of 4 March 2012

[2] available on his homepage http://homepage.univie.ac.at/karl.schlag/ (Last accessed on 13 May 2012)

There is highly significant evidence that the reaction in PUBPOS tends to be larger than in PRIPOS for all trades and for high quality trades only at a significance level of $\alpha = 0.01$ and a test power of $\beta = 0.2$. When comparing low quality trades though, there is no significant evidence at conventional levels that PUBPOS tends to be larger than PRIPOS. These findings lend support to hypothesis 1 and corroborate the findings of Renner and Tyran (2004) for high quality trades. Yet there is no significant evidence that public information on a positive cost shock leads to higher price changes than private information for low quality trades.

Similarly, tests for stochastic inequality yield highly significant evidence that the reaction in PUBNEG tends to be larger in absolute terms than in PRINEG for all trades and high quality trades again at a significance level of $\alpha = 0.01$ and a test power of $\beta = 0.2$. For low quality trades there is significant evidence at a significance level of $\alpha = 0.05$ and a test power of $\beta = 0.2$ for this hypothesis. These results lend further support to hypothesis 1. Thus public information on a negative cost shocks leads to significantly lower prices than private information both for high and low quality trades. Note that these findings are robust to a possible time trend. Such a time trend should have the same impact on prices in both informational treatments for both the positive and negative cost shock treatments.

Now focus on the price reactions in the symmetric negative and positive public shock treatments in Table 5. Is the reaction asymmetric, i.e. is there a significant difference between PUBPOS and -PUBNEG as would be suggested by hypothesis 2? If again all trades are considered it seems clear that the price change in PUBNEG is larger in absolute terms than in PUBPOS. If the trades are split up as before by high quality and low quality trades, the difference becomes smaller though. Indeed, Mann-Whitney tests find significant evidence of a difference in price reactions between PUBPOS and -PUBNEG for all trades. But if the trades are split up by high and

low quality there is no significant difference between the reactions in the public information treatments for both subsamples.

4.2.3 Correcting for the trend

These insignificant results may be caused by a time trend though. Consider for example a positive time trend that increases prices by an amount x each period. This would result in an increase of the absolute average price change in the positive treatments by x, while the absolute average price change in the negative treatments would decrease by x. Thus such a time trend has to be controlled for. This can be done by regressing the price changes on the CM on the shock periods in the different treatments in a panel regression. After the cost shock in period 4 costs return to their original values, so a post-shock dummy has to be included as well to capture the return to the reference price. As argued before price changes may differ by changes in quality, which has to be controlled for. As the price changes on the CM are the first differenced prices, a possible common time trend in prices should be controlled for by the constant. The panels are grouped by individual customer relations, as each pair of buyer and seller constitutes its own observations. Standard errors are clustered for each relation to control for possible panel-wide heteroskedasticity. Two equationsa are estimated, the first excluding quality controls and the second including quality controls as well as interaction effects with the treatments. The panel regression is run using random effects as Hausman tests yield no significant evidence in both specifications that the difference in coefficients between fixed and random effects is systematic.

The results of the regression are summarized in table 6. In total there are 1,773 observations across 368 customer relations. In regression (1) only the listed variables are used as regressors, while in regression (2) controls are included in the equation. These controls include dummies for all four possible quality changes between period 2

VARIABLES	(1) Price Change	(2) Price Change
Shock Period PRIPOS	-0.147	3.046
	(3.055)	(2.437)
Shock Period PRINEG	-5.561**	-2.115
	(2.534)	(1.603)
Shock Period PUBPOS	12.109***	15.613***
	(3.105)	(2.525)
Shock Period PUBNEG	-31.574***	-25.219***
	(3.802)	(3.979)
Post-Shock Period PRIPOS	-5.541	-0.83
	(3.81)	(1.244)
Post-Shock Period PRINEG	3.817	0.183
	(3.295)	(0.832)
Post-Shock Period PUBPOS	-17.625***	-18.527***
	(3.434)	(2.6)
Post-Shock Period PUBNEG	22.6***	21.714***
	(3.455)	(3.291)
Constant	4.246***	2.069***
	(0.546)	(0.548)
Observations	1,773	1,773
Number of Customer Relations	368	368
Controls included	NO	YES
Within-R^2	0.12	0.50
Wald-Test p-values		
Shock Period = Shock Period		
PRIPOS = PUBPOS	0.0037***	0.0003***
PRINEG = PUBNEG	0.0000***	0.0000***
PUBPOS = -PUBNEG	0.0001***	0.0410**
Shock Period = -Post-Shock Period		
PRIPOS	0.0930*	0.2459
PRINEG	0.5354	0.3064
PUBPOS	0.0402**	0.0837*
PUBNEG	0.0066***	0.2271

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Random effects GLS regression using clustered standard errors, grouped by customer relations. Controls include dummies for quality changes and interaction effects with the shock and post-shock period dummies.

Table 6: Determinants of Price Changes on CM

and period 3 with high quality trades as baseline. Furthermore interaction effects between quality changes and (post-)shock periods are included to account for possible differences in reaction to the shock. Table 8 in the appendix includes regression results for the controls. Note that both equations roughly yield qualitatively the same results for the variables of interest.

Now consider the results for the dummy variables for the shock periods in the four treatments. For the PRIPOS treatment the change in prices in the shock period is positive but insignificant in both specifications. So there is no evidence that prices increase in response to a positive cost shock when there is no common knowledge of the cost shock. For the PRINEG treatment there is significant evidence of a drop in prices in regression (1), but when the quality changes are controlled for, this price change becomes insignificant. So sellers do not seem to pass on temporary cost decreases when buyers do not know about the negative cost shock. Furthermore there is no significant evidence that prices change after the cost shock disappears, as the post-shock dummies are insignificant for both treatments in both specifications.

In the PUBPOS treatment there is highly significant evidence that a publicly known positive cost shock increases prices in both specifications. When quality changes are controlled for, prices increase on average by 15.6. When the positive cost shock disappears, there is highly significant evidence of a price drop of 18.5 on average. Similarly, in the PUBNEG treatment prices drop highly significantly in both regressions. Thus when quality changes are controlled for, on average prices decrease by 25.2 when there is common knowledge of a negative cost shock. Note that in the post-shock period prices again highly significantly rise by 21.7. Finally, there is highly significant evidence for a common time trend in prices as the constant is highly significantly positive in both regressions. When controlling for quality changes this trend leads to an increase of 2.1 per trading period. Thus there is highly significant

evidence supporting hypothesis 4 that there is a gradual increase in prices.

The hypotheses on asymmetry in price rigidity and reference pricing may now be checked by running Wald coefficient tests. There is highly significant evidence at conventional levels that the average price reaction in response to the cost shock in the PRIPOS and PUBPOS treatments is different in both specifications. Similarly the difference between PRINEG and PUBNEG is highly significant in both specifications. These findings corroborate the previous results and lend further support to hypothesis 1 of price rigidity if a cost shock is not commonly known.

A Wald test also yields highly significant evidence that the reaction in PUBPOS is different from the reaction in -PUBNEG for regressions (1). After controlling for quality changes though, the difference is still significant in regression (2). This result now is robust with respect to a time trend though, as such a trend is captured by the constant. It is surprising that the absolute average price drop in PUBNEG is larger than in PUBPOS, which indicates an asymmetry in price reactions in an unexpected direction. Recall that hypothesis 2 states that prices are more rigid downwards than upwards. Instead there is significant evidence that prices react stronger to a negative cost shock than to a positive cost shock, when there is common knowledge about the shock.

Finally, it may be checked if prices return to their reference price. To this end Wald tests are run to compare the reaction in the shock periods with the reactions in the post-shock periods. If the change in prices in the shock period can not be distinguished from the negative change in prices in the post-shock period then there is evidence of the prices returning to their reference point. In regression (1) only the difference between the two price adjustments within the PRINEG treatment is insignificant. For the PRIPOS treatment there is weakly significant evidence that there is a difference between these price adjustments. For the PUBPOS treatment there is

significant evidence and for the PUBNEG treatment highly significant evidence that the price adjustments differ. After controlling for quality changes in regression (2) though the difference between price adjustments is insignificant within the PRIPOS, PRINEG and PUBNEG treatments. Only the PUBPOS treatment shows weakly significant evidence that the price reaction in the shock period and the post-shock period is different. Note that the difference in prices is not only just weakly significant but also economically negligible: Between the two price adjustments there is a difference of only $18.5 - 15.6 = 2.9$. Recall that the price trend alone accounts for an increase in prices of 2.1 per period. These results give at least suggestive evidence supporting hypothesis 3, which says that prices return to their reference levels after the shock.

4.2.4 Is the shock passed on?

So who bears the burden of the temporary cost shocks, respectively who can pocket the windfall gains? For the treatments with private information the answer is easy. As regression (2) in table 6 shows the coefficients of the price change in the PRIPOS and PRINEG treatments are insignificant. Thus in the treatments with private information and a positive cost shock the sellers have to bite the bullet and keep prices low as they can not justify price increases. If there is private information and a negative cost shock though, the sellers can pocket the windfall gains without antagonizing the sellers.

For the treatments with public information both the responses in the treatments PUBPOS and PUBNEG are highly significantly different from zero. Thus it can be concluded that the increase and decrease in costs is passed on to the customers. But in order to assess the magnitude of the response we have to construct some measure. Recall that the baseline in regression (2) is a trade where high quality is traded both in periods 2 and 3. The production costs of high quality increase/decrease by 40.

So if these responses in PUBPOS and PUBNEG are significantly different from 40 and -40 respectively then the change in costs is not passed on entirely. Indeed, Wald tests reject the nulls that the response in PUBPOS equals 40 and the response in PUBNEG equals -40 at a significance level of 0.01. Thus there is highly significant evidence that if high quality is traded then the cost shocks are shared between sellers and buyers.

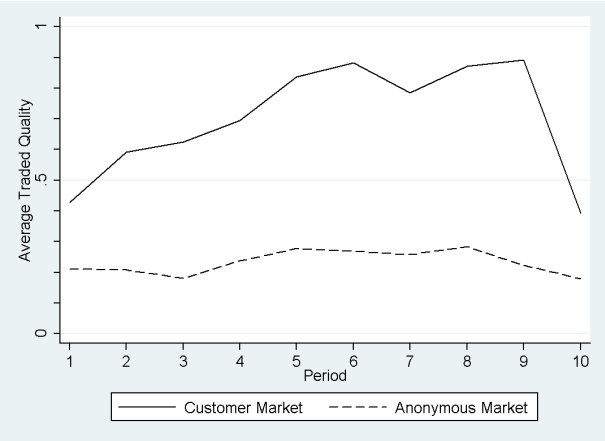
As table 8 in the appendix shows there is no significant difference in price changes between relations that keep trading high quality and relations that keep trading low quality. Interestingly, the interaction effects of the shock periods of all four treatments and low quality trades are all insignificant as well. Thus the responses in PUBPOS and PUBNEG may be tested directly against the cost changes for the provision of low quality. The costs of providing low quality only increase/decrase by 20. Wald tests can not reject the null hypothesis at conventional levels that the average response in the PUBNEG treatment is significantly different from -20. For the PUBPOS treatment though there is weakly significant evidence that the reaction is different from 20. Thus there is no definite evidence of cost sharing if low quality is traded. Customers seem on the one hand to partially accept price hikes when they are justifiable but on the other hand to insist on price cuts when costs decrease if their seller provides them with low quality.

4.3 Quality

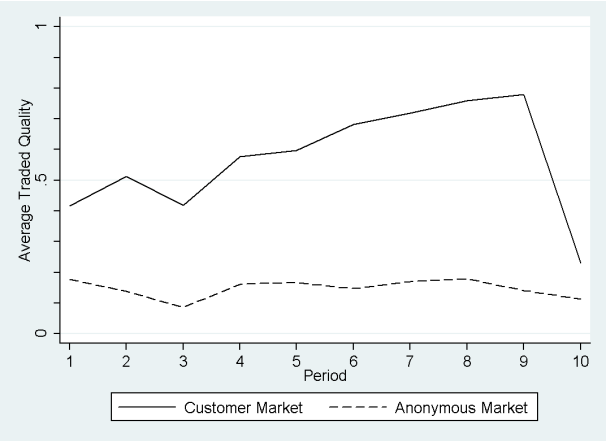
Figure 2 (a) to (d) shows the evolution of quality across the 10 periods for the 8 different markets. On the AM quality seems to be stable over time, and as Renner and Tyran (2004) showed quality on the AM is significantly lower than on the CM. On the CM there is a steady increase in quality over time which may be explained by a selection effect. As low quality trades are terminated only high quality trades

remain. Evidence for such a process will be presented in section 4.4, which deals with the determinants of customer relation termination. Most striking are the pronounced end-game effects though. There is a sharp drop in quality in the second-to last period which indicates that sellers strategically provide high quality in order to uphold the customer relation. In the last period though there is no incentive for fulfilling the implicit contract and most sellers switch to low quality instead. Sellers and buyers seem to fail to use backwards induction. As in the last period there is no incentive to uphold the relation, the relation effectively would end in the second-to-last period. Thus the relation should be terminated one period before and so on, until no relations are formed at all. Still implicit contracts seem to hold until the last period. This behavior is consistent with end behavior commonly observed in finite games. (Selten and Stoecker, 1986)

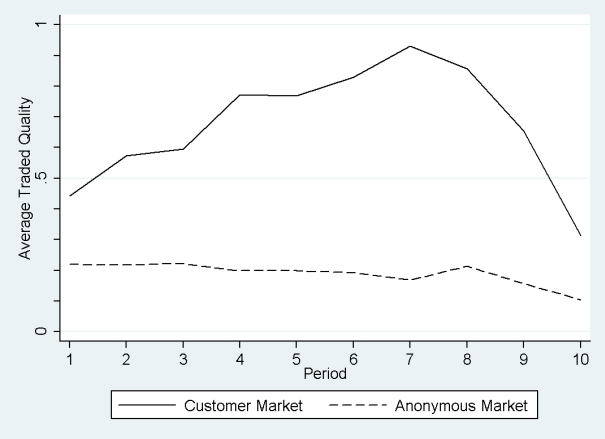
Judging from figure 2 there seems to be a drop in quality in the public information treatments associated with period 3 compared to the private information treatments. Such an effect may be tested for. As in section 4.2 a possible selection effect is controlled for by considering only those relations that are upheld in periods 2 and 3. Then it is tested whether the quality choices in period 3 after having provided high (low) quality in period 3 differ significantly across treatments using Mann-Whitney tests. There is no significant difference between the quality choices in the PRINEG and PUBNEG treatments for both high and low quality. Comparing the PRIPOS and PUBPOS treatments there is no no significant difference for low quality, but a weakly significant difference in distributions for high quality. Furthermore comparing the quality choices across shock treatments and within information treatments, there is no significant difference between the PRIPOS and PUBPOS as well as the PRINEG and PUBNEG treatments for both high and low quality. Out of 8 tests there is one weakly significant test statistic, which may well be a statistical fluke. Thus it should



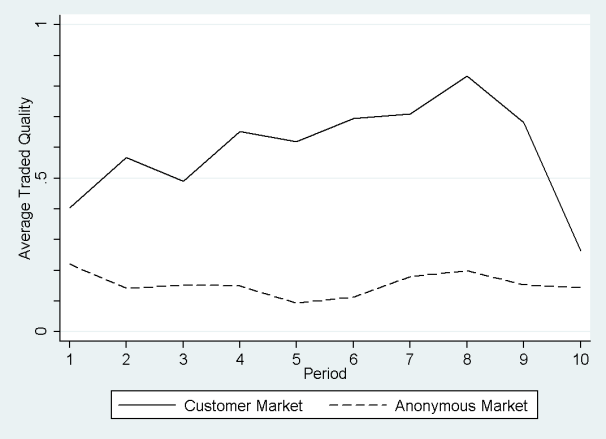
(a) Private Information x Positive Cost Shock



(b) Public Information x Positive Cost Shock



(c) Private Information x Negative Cost Shock



(d) Public Information x Negative Cost Shock

Figure 2: Average Quality across all Sessions, Phases and Inviduals

be safe to conclude that there is no significant difference in quality in response to the cost shocks between the treatments.

4.4 Determinants of Relation Breakups

Over the course of a trading phase there is a considerable level of attrition for customer relations. While in the first period on average 82.9 % of all customer relations hold, only 14.8 % of all customer relations are upheld for all 10 periods of a trading phase. Figure 3 shows that most relations are terminated in the first few periods. Afterwards customer relations seem to stabilize somewhat. Note that there is no

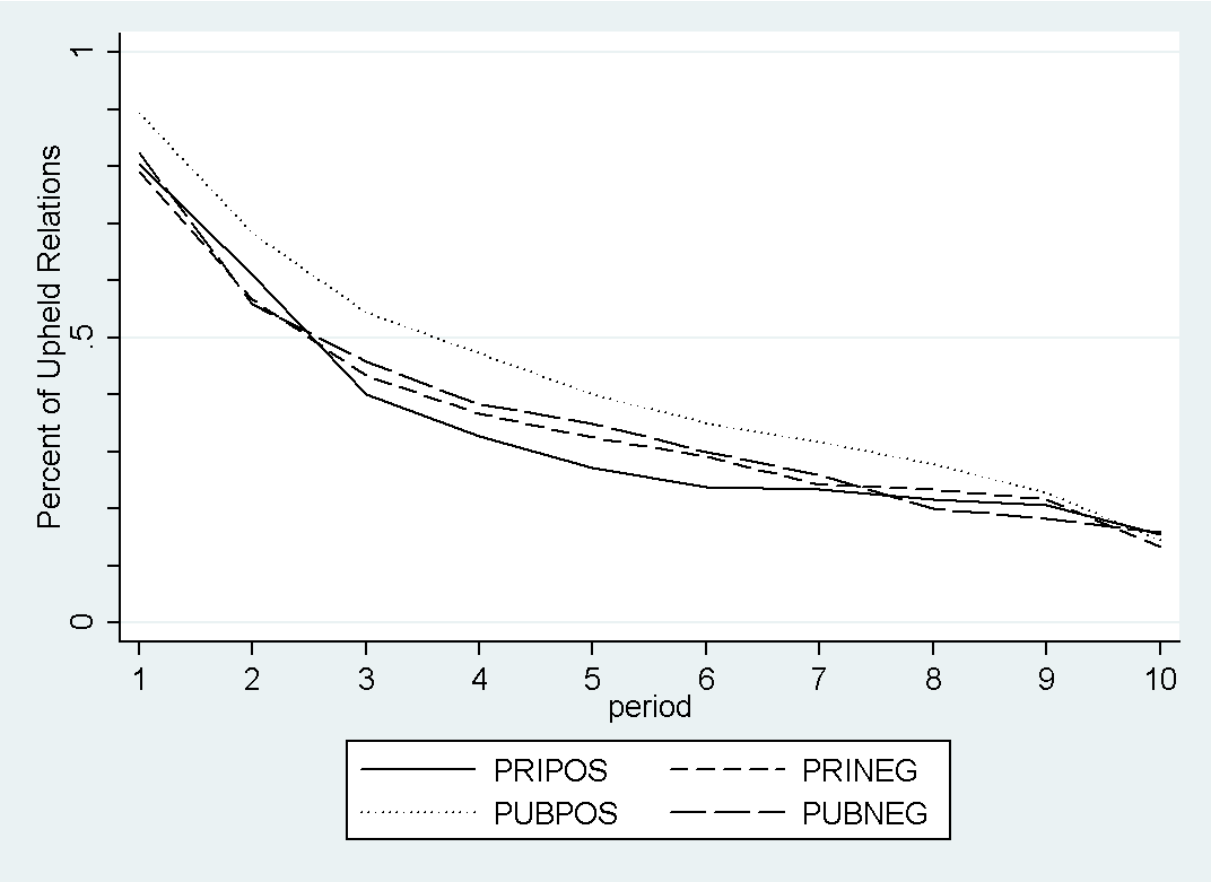


Figure 3: Relations across all Sessions, Phases and Individuals

graphically observable difference in attrition behavior across the four treatments. If one compares the evolution of customer relations with the evolution of traded prices on the CM depicted in the box plots in figure 4, the picture becomes clearer. Prices vary a lot in the first few periods, but converge after some time. There are fewer high prices and fewer low prices. This may be due to customers terminating relationships if they see the implicit contract with their sellers violated. So if sellers try to charge too high prices or if sellers sell low quality, which is correlated with low prices, customers react adversely and terminate the customer relation.

So breakups play a big role, as they provide the selection effect working for both the upward trend in prices and quality. For a complete picture the reasons for a breakup have to be statistically analyzed. The decision to break a relation likely is

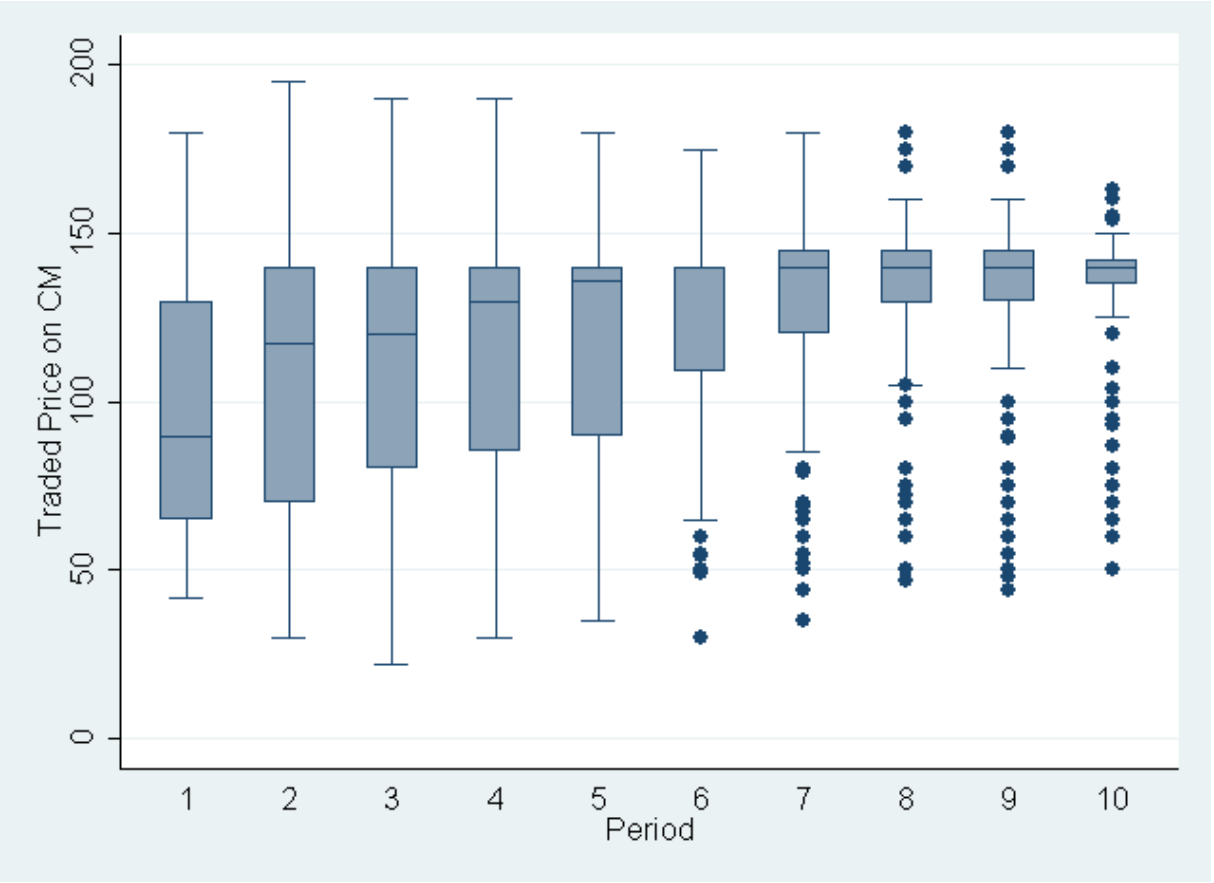


Figure 4: Traded Prices pooled across all Sessions, Phases and Individuals

correlated within an individual buyer. The fairness perceptions may well differ across individuals, which would lead to different customers having different tendencies to end relations. Thus it is best to analyze the data on relation breakups as a panel, i.e. for each individual buyer within a session. The model of choice is a logistic panel regression with random effects. As a logistic regression estimates the non-linear influence of the independent variables using a latent variable, the results can not be directly interpreted without calculating marginal effects on probability. In total there are 480 individuals of which 160 are buyers. On average a buyer spent 13.65 periods in a customer relation, which yields a number of 2,184 observations.

Table 7 summarizes of the results the logistic panel regression with random effects. The reported numbers are the average marginal probabilities and exclude controls

such as phase dummies, period and period squared. Table 9 in the appendix reports both the estimated coefficients and the calculated average marginal probabilities for all used variables. The controls are insignificant except for a weakly significant coefficient on period. Thus there seem to be no effects related to learning between phases.

First consider variables (i) to (vi) in table 7, which cover prices and last period's quality. Variable (i) is a dummy which takes the value 1 if the seller posts a higher price than in the last period. An increase in price is highly significantly associated with an average increase in probability of a breakup of 9.3 %. Surprisingly, a large increase in price, which is captured by dummy variable (ii), significantly on average decreases the probability of termination of the customer relation by 14.3 %. It seems as if a large increase in prices is interpreted by customers as a signal of high quality. The coefficient of the dummy for a large decrease in in prices (iii) is insignificant though, so large price cuts have no measurable effect on the buyer's decision. As variable (iv) shows, higher absolute prices are highly significantly associated with a higher probability of rejection by the buyer. On average a higher price of 10 increases the probability of the relation breaking up by 3 %. The change in prices (v) has no significant impact on relation termination, at least not beyond the effects captured in (i) and (ii). Also customers react adversely if in the previous period their seller sold them low quality, as (vi) is highly significant. Note that the coefficient is negative, as high quality is coded as 1. Trading low quality thus on average increases the probability of the relation breaking up by 34.5 %. So the evidence presented here lends support to hypothesis 5. If a seller offer high absolute prices, increases price or sold low quality in the previous period, the customer sees the implicit contract violated and her probability of terminating the relation increases.

Dummies (vii) to (x) cover the shock period in the four different treatments. There

VARIABLES	(1) Relation Breakup
(i) Price Increase (Dummy)	0.093***
	(0.025)
(ii) Large (>30) Price Increase (Dummy)	-0.143**
	(0.047)
(iii) Large (>30) Price Cut (Dummy)	0.074
	(0.055)
(iv) Posted Price	0.003***
	(0.0004)
(v) Price Change	-0.0003
	(0.0009)
(vi) Previous period's Traded Quality	-0.345***
	(0.03)
(vii) Shock Period PRIPOS	0.129***
	(0.035)
(viii) Shock Period PRINEG	0.08*
	(0.047)
(ix) Shock Period PUBPOS	-0.04
	(0.037)
(x) Shock period PUBNEG	0.044
	(0.053)
(xi) Last Period (Dummy)	0.142**
	(0.056)
Observations	2,184
Number of Individuals	160

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Regression estimated as random-effects logistic regression. Regression include phase dummies, period and period squared as controls. Reported numbers are average marginal probabilities.

Table 7: Logistic Panel Regression on Customer Relation Breakup

seems to be no effect of the shock on the probability of a relation breaking up in the public information treatments, as (ix) and (x) are insignificant. In the PRIPOS treatment though the probability of a relation breaking up in the shock period increases by 12.9 %. So not all pricing effects seem to be captured by variables (i) to (v), as there is no other explanation as to why there should be an increase in relation breakups if not for price effects. There is also weakly significant evidence that in the PRINEG treatment the probability of a relation breaking up in the shock period increases by 8 %, which is surprising. Still this result is only weakly significant. Finally, dummy (xi) covers the end game effects and relates to section 4.3, where a large drop in quality could be observed in the last period of a trading phase. In the last period there is highly significant evidence that the probability of a breakup increases on average by 14.2 %. Thus the drop in quality in the last trading period seems to be anticipated by the buyers.

5 Discussion

Customer markets in general are considerably more efficient than anonymous markets. On the anonymous markets high quality is only traded in 18 % of trades, whereas on the customer market high quality is traded in 59 % of trades. This incidence of high quality on the customer market also is accompagnied by considerably higher prices. Customer relations on the customer market turn out to be very fragile as 85.2 % of relationships are terminated before a trading phase ends. Customers are very sensitive to high prices, price increases and low quality. The customers' behavior is well in line with literature on fairness. If customers feel their implicit contract violated, they react adversely and terminate the relationship with their seller. This attrition in customer relations leads to low quality trades and high prices being weeded out and after some time only relations trading high quality at reasonable

high prices prevail. Also there is highly significant evidence of a gradual increase in prices which may best be explained by a slow devaluation of customer relations as a trading phase progresses. Furthermore there are pronounced end game effects in the last period as sellers try to take advantage of their customers. Customers seem to anticipate this though and preemptively terminate the customer relation in the last period. As is established in the literature sellers seem not to apply backwards induction and anticipate the termination of the relationship by the customer in the last period. Thus the first message of this thesis is that implicit contracts indeed, matter on customer markets, as sellers try not to antagonize customers and customers react adversely to a violation of the implicit contract.

The main aim of this thesis was to investigate if such implicit contracts lead to asymmetric price rigidity in customer markets. The literature posits two asymmetries in price reactions. First there may be an asymmetry between demand and cost shocks. Under two assumptions In shocks in the experiment can be interpreted as cost shocks that were not common knowledge. First customers' beliefs on the sellers' production costs have to remain unchanged. Second customers only have to care about the split of the surplus, but not about the circumstances such as increased demand. Under these assumptions cost shocks that the customers do not know about have similar implications as a demand shock, as in both customers see their share of the surplus threatened. Indeed, there is highly significant and considerable price rigidity for both positive and negative cost shocks if customers are not aware of them. There is no evidence of prices adjusting at all if only sellers know about the shocks. If on the other hand customers are made aware of the cost shocks, they either temporarily accept higher prices for positive cost shocks or insist on temporary price cuts for negative cost shocks. For high quality trades sellers and customers seem to share the temporary change in surplus. For low quality trades there is weakly significant evidence of

cost sharing for positive cost shocks, but no evidence for negative cost shocks. So the second message is that implicit contracts in customer markets may lead to significant price rigidity in both positive and negative direction for not commonly known cost shocks. Furthermore it would be possible to adapt the experimental procedure to cover demand shocks as well without allowing consumer search and thus endogenous formation of customer relations. For example one could consider letting buyers on the anonymous market buy from a seller who is already in another customer relation, but only for one shock period. That way the seller would temporarily experience an increase in demand without having to consider consumer search.

Second the literature indicates that there should be an asymmetry in price adjustment for cost shocks. It is commonly argued that positive cost shocks would increase prices more than negative cost shocks would decrease prices. Such an asymmetry can not be found in the data. Instead there is significant evidence that prices drop more after negative cost shocks than they increase after positive cost shocks. This puzzling outcome might be a result of mental accounting, that individuals tend to underweigh opportunity costs as opposed to costs. (Thaler, 1980) It might be that sellers mentally code windfall gains from cost decreases differently than the burden of cost increases. If sellers see the windfall gains that they receive as opportunity costs and the burden of the cost increases as costs, they might be more inclined to decrease prices as they underweigh the opportunity costs. This idea is not directly testable with this design though and should be taken with a grain of salt. Thus this thesis' third message is the possibility of a future avenue of research to investigate this idea, if mental accounting plays a role in pricing behavior.

Finally, there is also indication of reference pricing in the data. After a shock prices seem to return to their pre-shock levels, which is surprising as the shock already hits in the third period. Also buyers do not have any information about the cost

structure of the sellers apart from the relative magnitude of the shock. Still as few as two interactions between a seller and a buyer within a relation seem to be enough to induce a reference price to which the price returns post-shock. Only for the commonly known positive cost shock there is weak evidence of a difference in prices pre- and post-shock, which is not of an economically relevant magnitude though. As the main aim of this thesis was not reference pricing but asymmetric price rigidity, the experiment was not designed to directly test for it. So the fourth message is another future direction of research. It may be viable to check whether reference pricing in customer markets is robust to shocks that last longer than only one period or hit later than in the third period, when price formation may still be underway.

So this thesis finds that implicit contracts may microeconomically be a considerable source of price rigidity. The macroeconomic implications of rigid prices due to implicit contracts have only recently been formalized and yielded interesting results. (Söderberg, 2011) Thus it may be another option of research in macroeconomics if inflationary behavior is more in line with price rigidity due to customer markets than due to the standard theory of menu costs.

6 Appendix

6.1 Instructions

Please note that the instructions provided here are reprinted from Renner and Tyran (2003).

(Original instructions were in German. The instructions were the same in both treatments. In the private information treatment the information on the temporary cost shock was shown on sellers' screens only at the beginning of period 3. In the public information treatment the information about the cost shock was shown on all participants' screens.)

General information on the experiment

You are taking part in a market experiment. At the end of the experiment you will be paid according to the decisions you make. Please read these instructions carefully.

Earnings. During the experiment you earn points. The total income in points you earn during the experiment will be converted in Euros at the rate 1 point = 0.012 € and paid to you in cash.

Please note: During the experiment all participants decide independently and anonymously, i.e., no participant will ever learn the identity of the persons with whom he interacts. Therefore it is imperative that all participants observe the following rule: **During the experiment all communication is prohibited, i.e. you are not allowed to speak or express otherwise yourself**. Should you have any questions please ask the experimenter.

Overview of the experimental procedures In the experiment there are **buyers**

and **sellers**. Whether you are a buyer or a seller will be randomly determined at the beginning of the experiment and displayed on your computer screen. You will keep your role throughout the whole experiment.

The experiment is divided into several trading periods.

In every trading period a seller can sell one unit of a good and a buyer can buy one unit of the good. The seller can produce the good either in high or in low quality. The quality determines the production costs the seller incurs and the value of the good to the buyer.

Sellers and buyers can earn points by concluding a trade. A seller earns points if he sells the good at a price which exceeds his costs of production, a buyer earns points if he buys a good whose value exceeds the purchase price.

In every period a seller's task is to determine the price at which he sells the good. Moreover, he determines whether he will deliver high or low quality. This determines the production costs he incurs and the value of the good to the buyer. At the time of purchase a buyer knows **only the price** but **not the quality** of the good and hence he does not know the value of the good.

Calculation of your income in a period

- **Income of a buyer**. For a buyer, a unit of a good has the following values: **low quality: 100, high quality: 200**. These values are the same for all buyers. The income of a buyer is calculated as follows: income = value of the delivered good – price. If a buyer decides not buy a good in a period, his income is 0. If he buys at a price that exceeds the value of the good delivered, he makes a loss. Losses will be subtracted from your income.

If a buyer decides not to buy a good in a period, his income is 0. If he buys at a price that exceeds the value of the good delivered, he makes a loss. Losses will be

subtracted from your income.

- **Income of a seller**. A seller has low production costs if he produces a low quality good and high production costs if he produces a high quality good. The exact production costs are only known to the sellers and will be displayed on the sellers' computer screen. The production costs are the same for all sellers.

If a seller does not sell his good in a particular period, his income is 0 in this period. If he sells his good, his income is calculated as follows: income = price – production costs subject to quality.
Every participant receives an additional 150 points at the beginning of the experiment.

How to trade

There are two markets: **market I** and **market II**. Trading rules differ across markets.

Trading rules for market I

On market I, a specific seller trades with a specific buyer, i.e. a seller and a buyer form a fixed matched trading pair as long as they are trading on market I. This means that you deal with **the same person** as long as you stay on market I.
A seller makes an offer by determining a price and the quality he will supply. This also determines his production costs and the value of the good for the buyer in case he accepts. On market I a seller sees the following input screen:

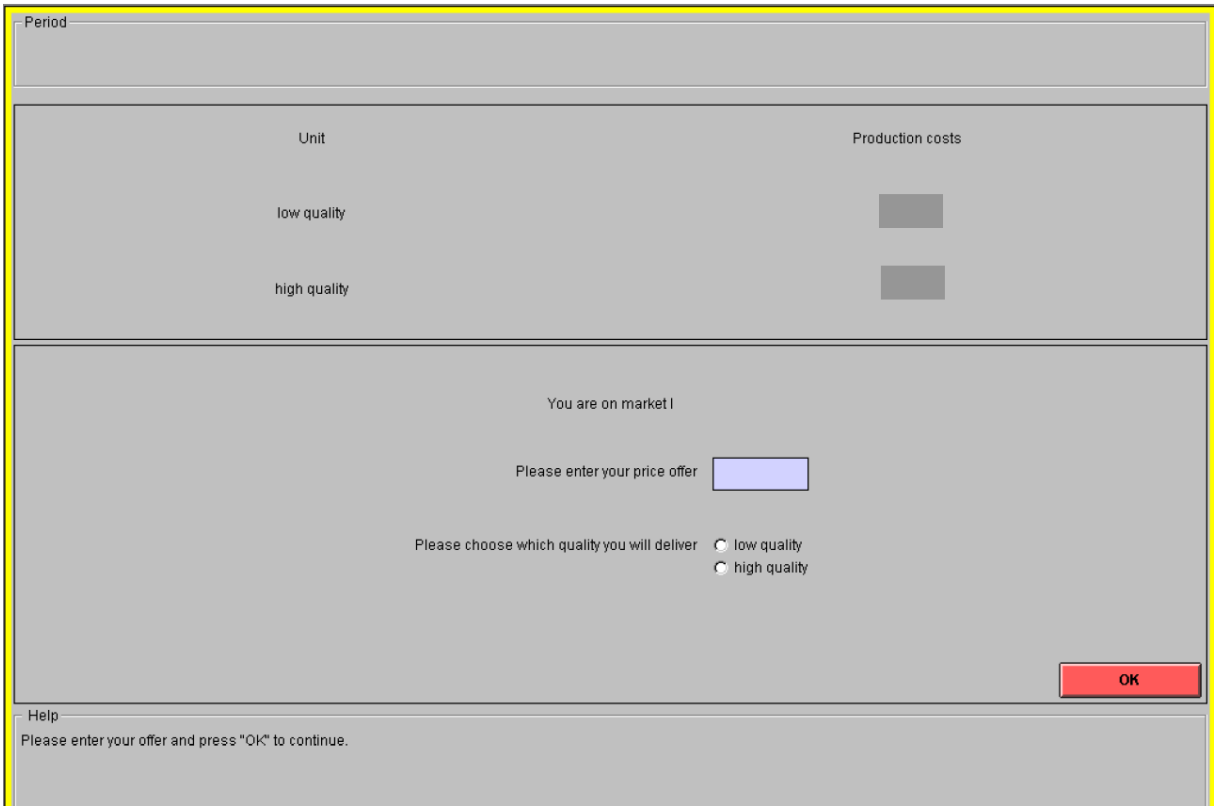


Figure 5: Instruction Screen 1

The production costs of high and low quality will be displayed. The seller makes his offer by entering a price and clicking on the quality he delivers if the buyer accepts. By clicking on the o.k.-button he submits his offer to the buyer. After this, the offer can not be revised.

The production costs of high and low quality will be displayed. The seller makes his offer by entering a price and clicking on the quality he delivers if the buyer accepts. By clicking on the o.k.-button he submits his offer to the buyer. After this, the offer can not be revised.

A buyer will see the following screen:

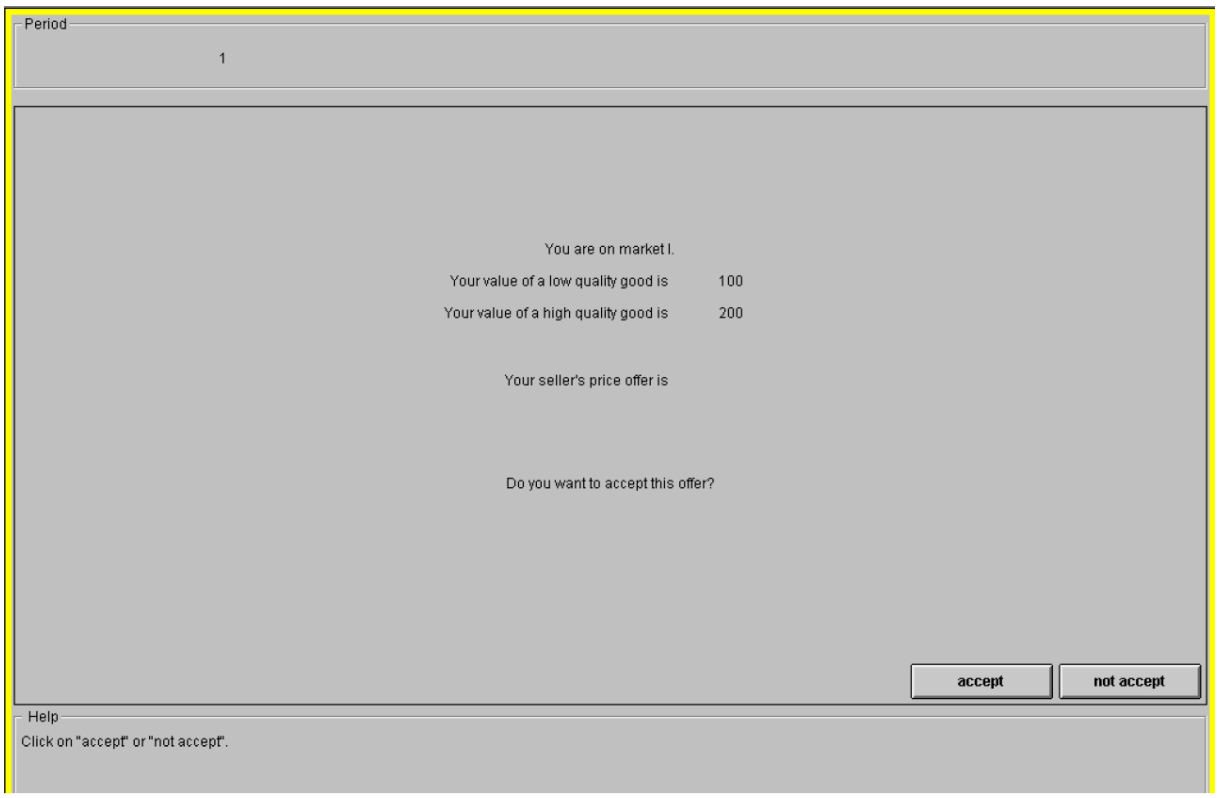


Figure 6: Instruction Screen 2

The buyer decides, whether to accept or reject the offer by clicking the corresponding button.

- **The buyer accepts the offer**

The buyer will see an income screen with the following information: price; the delivered quality of the good (low or high); the value of the good (100 or 200) and his income for this period (= value – price)
The seller receives an income screen with: the price; his production costs, subject to the quality he has produced; his income in this period (= price – production costs subject to the produced quality).
Only if the buyer has accepted the offer, will both stay on market I, i.e., the seller will submit an offer to the same buyer in the following period.

- **The buyer rejects the offer**

After a rejection on market I, both buyer and seller trade on **market II**. The seller submits a new offer for the current period and the buyer can buy one of the available offers on market II.

Trading rules on market II

On market II there are **several** sellers and **several** buyers. **There are always more sellers than buyers, i.e. even if all buyers accept an offer there will be some sellers, who will not sell their good.** Contrary to market I an offer can not be submitted to a specific buyer and a buyer can not identify which seller has made a particular offer.

How to submit an offer

Every seller has to submit an offer in every period by determining a price and the quality of his good.

A seller will see the following input-screen:

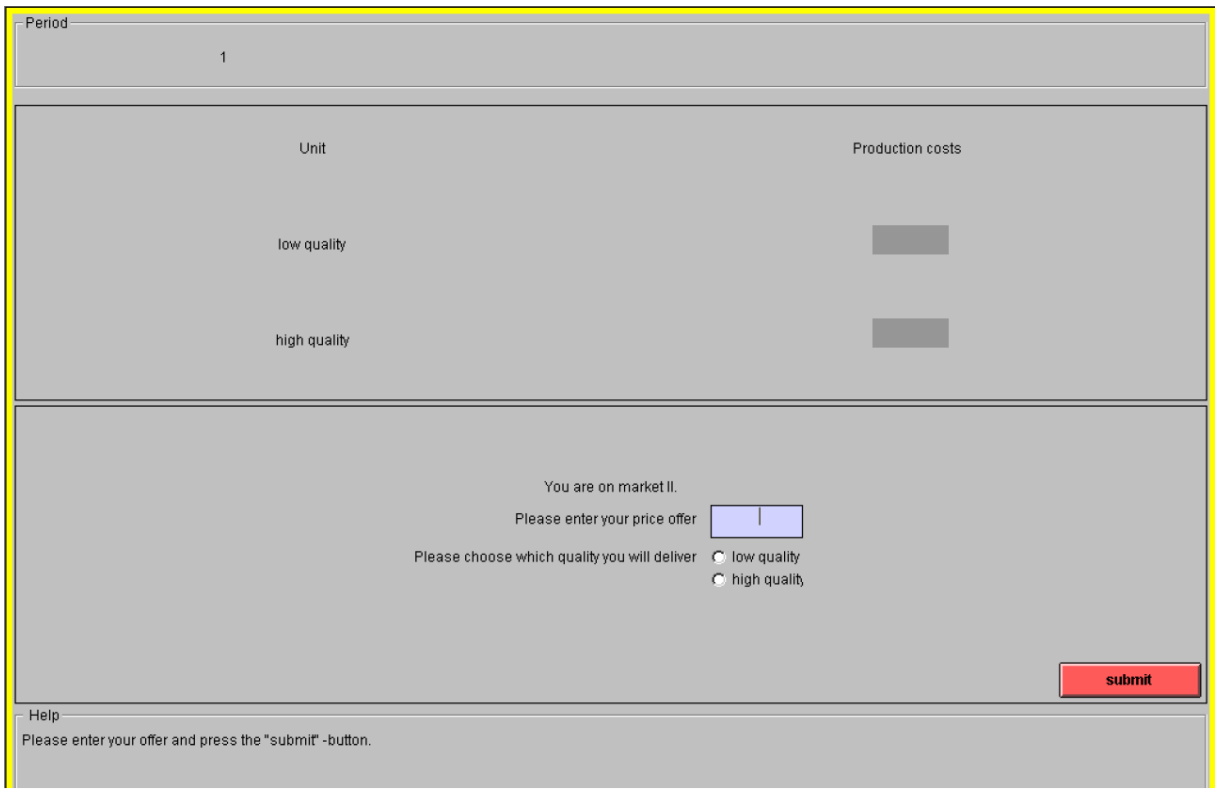


Figure 7: Instruction Screen 3

The production costs of a high and low quality good will be displayed. The seller makes his offer by entering a price and clicking on the quality he will produce if a buyer accepts his offer. By clicking on the "submit"-button with the mouse he submits his offer. Once an offer is submitted it can not be revised.

- **The decision of the buyers**

A list of all offers on market II in decreasing order of price will be displayed to buyers on that market. It is not possible to infer which seller has made a specific offer.
Please note: Buyers can only see the prices offered but not, which quality will be delivered. Only on acceptance does a buyer learn the quality of the good he bought and thus whether it has a high or a low value for him and which income he has earned in this trade.
Buyers will see the following input-screen:

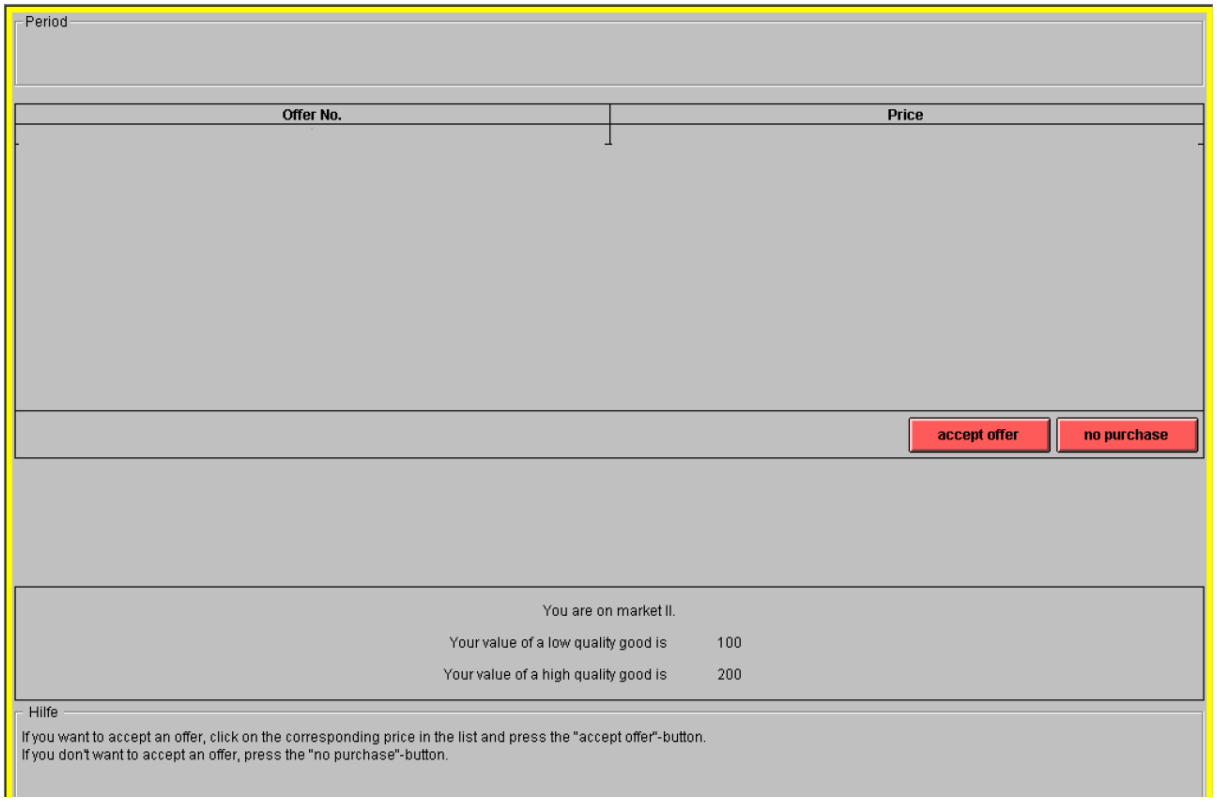


Figure 8: Instruction Screen 4

The buyers on market II are asked, one after another, whether they want to accept one of the available offers. A first buyer is randomly chosen. This buyer will see all available offers on market II. If he wants to accept an offer, he clicks on it with the mouse. With another click on the "accept offer"-button the trade is concluded and the offer is removed from the list. If he does not want to buy any offer he clicks on the "no purchase"-button. As soon as the first buyer has finished his decision, the next buyer is randomly chosen. He will see all offers that are still available on market II and decide whether to accept an offer.

Once all buyers have decided they will be informed via an income screen:

whether they have concluded a trade; at which price they have purchased; whether the good is of low or high quality; the value of the good (100 or 200) and the income in this period (= value – price).

Sellers, in turn, are informed via their income screen: whether they have sold their good; their income in this period (= price – production costs subject to the produced quality).

Therewith the trading period is over and a new one starts in which new trades can be concluded.

Trading phases and access to market I and market II

There will be several trading phases. Every trading phase consists of 10 trading periods.

When a new phase starts the period counter at the top left of the screen will start again with period 1. In every trading phase some sellers and buyers start on market I. A seller and a buyer stay on market I as a fixed pair, as long as the buyer accepts the seller's offers. As soon as the buyer rejects an offer they both join market II and stay there until the trading phase ends after 10 periods. It is not possible to return to market I. The sellers and buyers who start on market I are randomly chosen and randomly matched.

At the beginning of a new trading phase sellers and buyers are again randomly chosen and matched such that nobody will trade with the same person when starting again on market I.

All sellers and buyers who do not start on market I are on market II for the whole 10 periods of a trading phase.

6.2 Cost Shock Announcements

Please note again that the instructions here are replicated from Renner and Tyran (2003).

At the beginning of period 3 the information on the temporary cost increase was shown on the screens below. In the private information and positive cost shock treatment (PRIPOS) the following screen was shown to sellers:

Figure 9: Cost Shock Announcement Screen 1

In the public information and positive cost shock treatment (PUBPOS) the following screen below was shown to both sellers and buyer.

Figure 10: Cost Shock Announcement Screen 2

The information for the negative cost shock treatments (PRINEG and PUBNEG) was presented analogously.

6.3 Full Regression Results

VARIABLES	(1) Price Change	(2) Price Change
Shock Period PRIPOS	-0.147	3.046
	(3.055)	(2.437)
Shock Period PRINEG	-5.561**	-2.115
	(2.534)	(1.603)
Shock Period PUBPOS	12.109***	15.613***
	(3.105)	(2.525)
Shock Period PUBNEG	-31.574***	-25.219***
	(3.802)	(3.979)
Post-Shock Period PRIPOS	-5.541	-0.83
	(3.81)	(1.244)
Post-Shock Period PRINEG	3.817	0.183
	(3.295)	(0.832)
Post-Shock Period PUBPOS	-17.625***	-18.527***
	(3.434)	(2.6)
Post-Shock Period PUBNEG	22.6***	21.714***
	(3.455)	(3.291)
$(0, 0)$		-0.263
		(1.572)
$(1, 0)$		-11.396***
		(2.316)
$(0, 1)$		47.719***
		(3.757)
Shock Period PRIPOS x $(0, 0)$		3.437
		(8.212)
Shock Period PRIPOS x $(1, 0)$		-11.103
		(10.523)
Shock Period PRIPOS x $(0, 1)$		42.807***
		(4.895)
Shock Period PUBPOS x $(0, 0)$		4.752
		(4.427)
Shock Period PUBPOS x $(1, 0)$		-16.74*
		(10.11)

continued ...

. . . continued

VARIABLES	(1) Price Change	(2) Price Change
Shock Period PUBPOS x $(0,1)$		27.809***
		(5.709)
Shock Period PRINEG x $(0,0)$		-2.352
		(2.8)
Shock Period PRINEG x $(1,0)$		-21.281*
		(11.493)
Shock Period PRINEG x $(0,1)$		-10.552
		(18.484)
Shock Period PUBNEG x $(0,0)$		-0.065
		(6.78)
Shock Period PUBNEG x $(1,0)$		-23.45***
		(5.882)
Shock Period PUBNEG x $(0,1)$		21.408***
		(7.390)
Post-Shock Period PRIPOS x $(0,0)$		-11.067
		(7.599)
Post-Shock Period PRIPOS x $(1,0)$		-79.538***
		(6.362)
Post-Shock Period PRIPOS x $(0,1)$		20.831***
		(3.762)
Post-Shock Period PUBPOS x $(0,0)$		-4.185
		(5.477)
Post-Shock Period PUBPOS x $(1,0)$		-35.672*
		(20.967)
Post-Shock Period PUBPOS x $(0,1)$		-6.919
		(12.548)
Post-Shock Period PRINEG x $(0,0)$		8.848*
		(5.204)
Post-Shock Period PRINEG x $(1,0)$		-66.137***
		(2.769)
Post-Shock Period PRINEG x $(0,1)$		-4.873
		(9.9)
Post-Shock Period PUBNEG x $(0,0)$		-1.924

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VARIABLES	(1) Price Change	(2) Price Change
		(6.729)
Post-Shock Period PUBNEG x $(1,0)$		-12.434
		(19.211)
Post-Shock Period PUBNEG x $(0,1)$		-14.687*
		(8.076)
Constant	4.246***	2.069***
	(0.546)	(0.548)
Observations	1,773	1,773
Number of Customer Relations	368	368
Within-R^2	0.12	0.50

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Random effects GLS regression using clustered standard errors, grouped by customer relations. High quality is coded as 1, low quality as 0. The numbers in brackets describe (quality in previous period, quality current period).

Table 8: Determinants of Price Changes on CM, Full Results

VARIABLES	(1) Relation Breakup	(2) Relation Breakup
Period	-0.305*	-0.041*
	(0.163)	(0.022)
Period Squared	0.026	.003
	(0.015)	(0.002)
Price Increase (Dummy)	0.7***	0.093***
	(0.185)	(0.025)
Large (>30) Price Increase (Dummy)	-1.071***	-0.143**
	(0.352)	(0.047)
Large (>30) Price Cut (Dummy)	0.556	0.074
	(0.411)	(0.055)
Posted Price	0.023***	0.003***
	(0.003)	(0.0004)
Price Change	-0.003	-0.0003
	(0.007)	(0.0009)
Last period's Traded Quality	-2.588***	-0.345***
	(0.231)	(0.03)
Shock Period PRIPOS	0.972***	0.129***
	(0.262)	(0.035)
Shock Period PRINEG	0.602*	0.08*
	(0.352)	(0.047)
Shock Period PUBPOS	-0.303	-0.04
	(0.278)	(0.037)
Shock period PUBNEG	0.329	0.044
	(0.397)	(0.053)
Last Period (Dummy)	1.064**	0.142**
	(0.42)	(0.056)
Phase 2 (dummy)	0.27	0.036
	(0.216)	(0.029)
Phase 3 (dummy)	0.212	0.028
	(0.213)	(0.028)
Phase 4 (dummy)	0.232	0.031
	(0.221)	(0.029)
Phase 5 (dummy)	0.281	0.037
	(0.218)	(0.029)

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VARIABLES	(1) Relation Breakup	(2) Relation Breakup
Constant	-2.583***	
	(0.506)	
Observations	2,184	2,184
Number of Individuals	160	160

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Regressions estimated as random-effects logistic regression. Column (1) reports logistic regression coefficients, (2) reports average marginal probabilities.

Table 9: Logistic Panel Regression on Customer Relation Breakup, Full Results

6.4 Description of the Source Data File

variable	range	description
SessionID	string	session's string ID
phase	$[1, 5] \in \mathbb{N}$	current phase in session
InfoTreat	string	Treatment dummy Public: both seller and buyer are informed of the cost shock Private(seller): only seller is informed of the cost shock
direction shock	string	Treatment dummy positive: cost increase for seller negative: cost decrease for seller
Period	$[1, 10] \in \mathbb{N}$	current period in phase
shock Period	$\{0, 1\}$	1 if shock in current period
Subject	$[1, 12] \in \mathbb{N}$	ID of subject within session
type (1=seller= [sic!]	$\{0, 1\}$	1 if subject is seller
Profit	$[-100, 200]$	subject's realised payoff in current period
subgroup	$\{0, 1, 2, 3\}$	0: subject participates in AM 1, 2, 3: identifies pairs of buyer/seller in CM
posted price MI	$[0, 10^{18}]$	seller's posted price on CM (CM seller only)
accepted price MI	$[0, 200]$	buyer's accepted price on CM (CM buyer only)

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variable	**range**	**description**
rejected price MI	$[0, 10^{18}]$	buyer's rejected price on CM (CM buyer & seller only)
TradeMktI	$\{0, 1\}$	1 if trade is conducted on CM (0 for participants in AM AND if relation breaks)
break relation	$\{0, 1\}$	1 if buyer in CM rejects current offer (CM buyer & seller only)
break relcustomer	$\{0, 1\}$	1 if buyer in CM rejects current offer (CM buyer only)
status subject	$\{1, 2, 3\}$	1 if subject is in CM and accepts offer 2 if subject is originally in AM 3 if subject is originally in CM and currently in AM
TradedQualMI	$\{0, 1\}$	1 if high quality was bought on CM (CM buyer only)
PricechangeMI	$[-2 * 10^{18}, 2 * 10^{18}]$	change in posted price from last period on CM (CM seller only)
PostedPriceMII	$[0, 10^{1}8]$	seller's posted price on AM (AM seller only)
AcceptedPriceMII	$[0, 200]$	buyer's accepted price on AM (AM seller only)
OfferedQualMII	$\{0, 1\}$	1 if seller offers high quality on AM (AM seller only)

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variable	**range**	**description**
TradedQualMII	$\{0, 1\}$	1 if high quality was traded on AM (AM seller only)
Cost[0]	$\{0, 20, 40, 60\}$	cost of providing low quality (0 for buyers)
Cost[1]	$\{0, 40, 80, 120\}$	cost of providing high quality (0 for buyers)
Value[0]	$\{0, 100\}$	payoff for receiving low quality (0 for sellers)
Value[1]	$\{0, 200\}$	payoff for receiving high quality (0 for sellers)
regular	$\{0, 1\}$	1 if subject is in CM at the end of current period; redundant ($\equiv$ TradeMktI)
TraderV	$\{0, 1\}$	1 if subject sold on AM
TraderK	$\{0, 1\}$	1 if subject bought on AM
PriceMarktI	$[0, 10^{18}]$	seller's posted price on CM (CM buyer & seller)
KostenMarktI	$\{0, 20, 40, 60, 80, 120\}$	seller's chosen cost on CM (0 for CM buyers and AM buyers & sellers)
gelQualitaetMartkI	$\{0, 1\}$	1 if seller in CM offers high quality
Verkaufspreis	$[0, 10^{18}]$	seller's posted price on AM (0 for AM buyers and CM buyer s& sellers). redundant, see PostedPriceMII above

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variable	**range**	**description**
Kaufpreis	$[0, 200]$	buyer's accepted price on AM (0 for AM sellers and CM buyers & sellers)
Kosten	$\{0, 20, 40, 60, 80, 120\}$	seller's chosen cost on AM (0 for AM buyers and CM buyers & sellers)
Wert	$\{0, 1\}$	1 if high quality was bought on AM (0 for AM sellers and CM buyer & sellers)
regularaktuell	$\{0, 1\}$	1 if subject is in CM at the beginning of current period. no info for first period though
typ	$\{1, 2\}$	2 if subject is seller; redundant ($\equiv$ type $+1$)
subgroup	$\{0, 1, 2, 3\}$	redundant, see variable subgroup above

Table 10: List of Variables in Source File (alldata CM_nov_03.csv)

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Abstract

This thesis analyzes experimental data collected by Elke Renner and Jean-Robert Tyran between 2002 and 2003. On a market where an experience good is traded, sellers and buyers of the good are exogenously matched to create customer relations that may be endogenously upheld. It is shown that implicit contracts matter on an experimental customer market and that pricing behavior seems to be driven by fairness concerns. The institution of customer relations and implicit contracts give rise to two different asymmetries in price rigidity: First there is considerable price stickiness for both positive and negative temporary cost shocks when customers do not know about them. The setup allows such shocks to be interpreted similarly to demand shocks under a few assumptions. Second prices are more flexible upwards than downwards for commonly know temporary cost shocks. Furthermore there is indications of reference pricing as prices tend to return to their previous levels after a shock.

Zusammenfassung

Diese Magisterarbeit analysiert Daten, welche von Elke Renner und Jean-Robert Tyran zwischen 2002 und 2003 im Zuge eines ökonomischen Experiments gesammelt wurden. Auf einem Markt, auf welchem ein Erfahrungsgut gehandelt wird, werden Verkäufer und Käufer in Paare zugewiesen um exogen Kundenbeziehungen zu schaffen. Diese Kundenbeziehungen können endogen aufrecht erhalten werden. Es wird gezeigt, dass implizite Verträge auf solch einem experimentellen Kundenmarkt eine wichtige Rolle spielen, und dass das Preissetzverhalten durch Fairnesserwägungen erklärt werden kann. Solche Mark-

tinstitutionen führen zu zweierlei asymmetrischen Preisrigiditäten: Erstens kommt es zu starker Preisrigidität für sowohl positive als auch negative temporäre Kostenschocks, wenn Kunden nichts von diesen Schocks wissen. Das Design erlaubt es unter ein paar Zusatzannahmen, diese Schocks in ähnlicher Weise wie Nachfrageschocks zu interpretieren. Zweitens sind Preise, wenn die Kostenschocks allgemein bekannt sind, nach oben bei positiven Kostenschocks flexibler als nach unten bei negativen Kostenschocks. Schließlich findet sich in den Daten Indizien zu Referenzpreissetzung, da Preise nach den temporären Schocks auf das Niveau zurückgehen, welches sie vor dem Schock hatten.