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The Impact of Feedback under Information Asymmetry on Market Dynamics: Results from a Classroom Experiment

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Abstract: This paper focuses on the problem of so-called "lemon markets", first described by George Akerlof, where information asymmetry about product quality leads to dysfunctional outcomes such as poor average product quality and relatively low levels of trade, resulting in a loss of collective wellbeing. In the age of online commerce, the problem is especially relevant, given that consumers buy many more products without relying on personal experience than at any time in the past. Possible solutions to the problem suggested in the literature are reputation building on the part of producers and improving the information available to consumers, e.g., by way of publicly accessible consumer reviews (even though these can be gamed or faked by sellers). The paper presents the results from a classroom experiment that simulated a "lemon market". The advantage of using a classroom experiment is that while the market is recreated along a small number of rules and incentives, in line with neat economic models, the participants are real, living decisionmakers, displaying the deviations of actual human behaviour from that of a hypothetical "rational actor". In all, 294 students majoring in business information technology participated, making up 11 simulated markets. The results presented focus mainly on the supply side, namely, the quantities and prices of goods offered, and nine supply curves are estimated (for three quality grades of goods in three phases of the game). The research concludes that under perfect information, the market performs efficiently. In the condition where only sellers but not buyers have information about product quality, the volume of trade declines, although not as drastically as previous findings have suggested, and the market shows signs of recovery, albeit at a suboptimal equilibrium. After the option of consumer feedback is introduced, the market shows further convergence toward the socially optimal state. The results reaffirm that consumer feedback plays an important role in filling the information gap when product quality is uncertain; however, it is not sufficient in itself to overcome the "lemon market" problem. Other important influences on consumer behaviour under uncertainty are suggested, such as risk-taking, changing attitudes towards the act of (online) purchases, and cultural factors.

Keywords: behavioural economics; classroom experiment; consumer feedback; information asymmetry; lemon market.
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1. Introduction. As Thaler (1985) would tell, the rational actor in mainstream economics (Econ) has a perfectly ordered and stable system of preferences, so his decisions are predictable, whereas ordinary people (Humans) perceive their environment differently. A higher-quality good costs more to produce, but it is worth more to the buyers. When buyers can observe both price and quality, there is competitive pressure on sellers to provide good quality at a reasonable price. The buyers' reference prices are fitted to the costs of the sellers and to the costs that are kept fair by the buyers (Kolnhofer-Derecskei, 2020 based on Thaler, 1980).

If the quality is hidden from the buyers before purchase, then a so-called asymmetrical market situation occurs, which subverts this market equilibrium and leads to unpredictable consequences. Holt (2019) suggested classroom experiments to study the role of pricing and used these experiments in several cases to prove how the supply and demand sides match and find each other. With all this, he points out how a simulated situation differs from the perfect competitive modelled markets. It also derives the results obtained in the "usual" coordinate system, where it interprets the concepts of reserve price and consumer surplus for the mainstream market (Mankiw, 2011). This method and theory, as Thaler (1986) underlined, "More generally, the theory presented here represents a hybrid of economics and psychology that has heretofore seen little attention". Moreover, these are unusual in traditional economic teaching.

One of the main motivations for interdisciplinary investigations in economics is that people sometimes make decisions that are difficult to explain with standard economic theories. For example, the phenomena of trust and fairness, or the fact that people are prone to make predictable and usually avoidable mistakes, are not central to standard theory. This is why behavioural economics uses social, cognitive and emotional factors to understand the economic decisions of actors and institutions. Additionally, behavioural economists have turned to experiments to study human subjects. Moreover, mainstream economists "cannot perform the controlled experiments of chemists or biologists because they cannot easily control other important factors" (Samuelson & Nordhaus, 1985). This statement sounds fair enough. Researchers can also double-check their assumptions by testing subjects in a hypothetical situation. Moreover, if we bring experiments into the classroom, students can be trained to avoid serious mistakes because they can easily understand practical and theoretical economic concepts such as opportunity costs—the value of foregone opportunities (Jensen, 1982).

This paper aims to present and evaluate the well-known phenomenon of Akerlof's (1970) lemon market through a classroom experiment, where various market structures can be observed and tested. In a classic free market, supply and demand can easily meet, as they are the two sides of the same set of transactions, and imbalances can be referred to as the impact of the market price. In contrast, in Akerlof's lemon market, this situation requires strong trust from purchasers. The question, then, is how this situation influences the market where bad products can be sold at the same price as good products. We observe that simulated markets converge upon outcomes predicted by Akerlof's model: towards low-quality goods and low prices. However, the added element of customer feedback helps in restoring trust towards sellers somewhat, although not entirely. In either condition, the market does not "collapse" in terms of the volume of trade.

The main aim of this work is to gain insight into the dynamics of a market under information asymmetry and consumer feedback by running a classroom experiment and presenting new findings. The article is structured into six main sections. The next section provides a review of the literature on Akerlof's lemon market and classroom experiments. On the basis of the broad literature review, three main hypotheses were defined. The fourth section describes the data used and the methodology applied. The fifth section is dedicated to our results and discussion. The last section concludes and provides limitations, further orientations and possible implications.

2. Literature Review. The article uses a classroom experiment to gain insights into the workings of a market under incomplete information ("lemon market"). The literature for those two main topics will be reviewed, starting with the latter.

2.1. Lemon markets: theoretical models and empirical relevance

In classic free markets, products are homogeneous in quality, information is considered to be "complete", and owing to the famous invisible hand, demand and supply meet to determine the equilibrium price and quantity, which generally results in the collectively optimal allocation of resources as measured by total surplus (Friedman, 2021). In contrast to that perfect ideal, Akerlof (1970) presented the model of the "lemon market", where there are good products and bad products, but buyers' only reference point is the price, and they make their purchases in the absence of information about product quality. Naturally, this information asymmetry leads to sellers' selfish (i.e., profit-oriented) behavior. Sellers will be motivated to offer goods of the lowest possible quality at the highest possible price, whereas buyers will face the risky choice of paying too much for a bad product. There are several problems caused by such a market structure:

1) bad average product quality;
2) convergence on low prices and/or a diminished level of trade, together representing;
3) a loss of utility for individuals and of total surplus at the collective level, and further;
4) consumers' trust in the damage to sellers. The empirical relevance of the "lemon market" problem, as well as possibilities for overcoming it, has been demonstrated in the literature.

Although Akerlof's (1970) original article referred to used cars, similar observations were made elsewhere, such as the pharmaceutical market, which can be characterized as a multilevel market with information asymmetry because the side effects of drugs are often hidden. Light & Lexchin (2021) reported that new medical products with few benefits but greater or poorly understood risks thrive in such a market and can, in fact—contrary to Akerlof's theory—cost even more than cheaper and better-known old drugs because of the use of certain marketing methods (such as recruiting physicians to promote them). Salmi (2022) presented a case study of e-commerce from Algeria, which appeared to show that a sizeable proportion of prospective buyers refrain from confirming their orders, possibly due to a lack of information or trust. Mandl (2023) referred to the financial crisis of 2007--2008 as an example of a lemon market, which was preceded by several sellers offering low-quality financial instruments. The author noted that when consumers become aware of quality problems and react strongly, even one seller's demise can initiate the collapse of the whole market. Woods & Moore (2020) studied warranties for information security products and reported that cyber warranties may not significantly change the incentive to invest but can prevent vendors from exaggerating product functionality, thereby improving the quality of information.

Notably, while the practical relevance of lemon markets is substantial, the number of empirical studies on the topic is outweighed by those that use simulations or controlled experiments. Barron & Qu (2014) conducted a study on simulated financial markets, where share prices were determined on the basis of investors' expectations and available information. Their research showed that informative prices can reduce information asymmetry between informed traders (those with private information about a given firm) and uninformed traders in a centralized market. Even after earnings are realized, the learning-from-price effect significantly contributes to enhancing price efficiency (Gong et al., 2021). Asriyan & Vanasco (2024) warned that information asymmetry affects the design of financial instruments as well when a provider (e.g., a bank) sells products to relatively uninformed buyers. The authors' modelling indicated that nonexclusive markets bear a greater risk of mispricing securities than exclusive markets do (Asriyan & Vanasco, 2024).

Researchers noted that Akerlof's (1970) prediction of market failure was made under the assumption that actors maximize their expected utility, a paradigm that was challenged by Tversky & Kahneman's (1992) unexpected utility approach. Working within the latter framework, Baharad & Kliger (2013) demonstrated that a high level of loss aversion on the part of consumers intensifies market failure, but mainly in markets where mostly high-quality products are traded, and less so where low-quality goods dominate. Giannakas & Fulton (2020) expanded Akerlof's original model by observing that, in many cases, inferior products can coexist with superior ones and stated that low-quality goods can only crowd out better ones if the total cost of the low-quality good for all producers is lower than the cost of the high-quality good. Several authors have made suggestions for solving the problem of lemon markets or at least some aspects thereof. One recurring theme is that of improved information. Barron & Qu (2014) claimed that earnings forecasts have the potential to improve price efficiency by reducing information asymmetry in the market. Lin's (2012) game-theoretical model of e-commerce reached the conclusion that creating a community for buyers to share information (along with sellers' support) can provide a solution. Thierer et al. (2015) asserted that the internet, especially its realms labelled the "sharing economy", could provide a solution to the lemon problem through the real-time reputation feedback mechanism and that the existence of information asymmetry could actually create opportunities for entrepreneurs to offer innovative solutions. Hossain et al. (2018) developed a model of online group buying (OGB) for consumers in China and reported that the perceived quality of vendors and products significantly increased consumers' likelihood of buying from OGB websites. Mamada (2022), in a sequential Bayesian game model analysis, suggested that reliance on certain pieces of information ("indices"), which are good indicators of product quality, could alleviate the lemon market problem, provided that the cost of obtaining those indices is not prohibitive. In the past, in the absence of publicly available quality information, consumers assumed that higher prices meant higher product quality (Krishnan, 2022); currently, an abundance of online reviews are available to help navigate consumer decisions (Davidaviciene, 2021), seemingly offering a solution to the lemon problem. However, fake online reviews have also proliferated, and their estimated proportion ranges from approximately 10% to 30%, depending on the platform being studied (Wu et al., 2020). Notably, consumer reviews are not only valuable to buyers. With the help of artificial intelligence and natural

language processing (Shivaprasad, 2017), the analysis of these reviews has become faster and more accurate, helping firms base decisions on them (Praveen et al., 2024). In the context of online reviews, Zhang & Tian (2024) proposed that pricing, quality, and quantity decisions related to production can be optimized. In addition, the processing of online feedback could be linked with product performance (Li, 2022) and can also serve as a good starting point for product development (Goldberg, 2022), but the analysis of such perspectives is beyond the scope of this article.

Returning to solutions for the lemon market, Muthoo & Mutuswami (2011), using the second-best solution mechanism, suggested that in a market with one buyer and a finite number of sellers offering two possible qualities, the surplus of each quality affects the market outcome. If the surplus of the higher quality good is larger, the market outcome may differ from Akerlof's original model, provided that the number of buyers is smaller than the number of sellers. Other authors focused on the supply side when proposing partial solutions. Kahneman et al. (1986) reported that for long-term profits and reputation, firms must behave fairly in the setting of prices and wages. Qi & Xianfeng (2003) suggested that spreading information quickly and widely could help sellers build a good reputation for their products and that free samples could also help maintain a favourable image and push back against inferior competitors. Additionally, the presence of authorized information evaluation agents could also decrease the level of asymmetry. Bai (2021) conducted an actual field experiment in Chinese watermelon markets to investigate the effects of seller reputation building. The study involved applying either simple-looking or laser-cut stickers to watermelons and reported that using the latter induced sellers to provide higher product quality and led to higher profits, but consumers were slow to adapt their evaluations on the basis of stickers, and the extra cost of labelling technology resulted in overall loss of exercise. Economic modelling, including most of the works cited thus far, is based on utility-maximizing rational choice. However, the behaviour of consumers and suppliers is influenced not only by price signals or profit motives but also by psychological factors (Aumann, 2019). The research of Hofstede et al. (2019), which was conducted in more than 70 countries, demonstrated the impact of culture on negotiation processes, emphasizing the role of trust and transparency and the shift from economic to relational rationality in influencing the behaviour of players in negotiations. These insights serve as warnings that economic research must expand its models to better incorporate the ways in which real people make decisions (Tomer, 2007) and rely on the study of human research subjects from various cultures (Henrich et al., 2005).

2.2. Classroom experiments

Classroom experiments have been introduced into the teaching of economics, as the importance of experimental studies in understanding market behaviour was emphasized by Smith (1989). For example, Brauer & Delemeester (2001) reported that games such as The Lemon Market help teach basic economic concepts in college, although they are not sufficient to build a comprehensive macroeconomics curriculum. Another study (Isaac et al., 2001) showed that experimental economics can be used effectively in large undergraduate classes to help students understand economic decision-making through practical exercises.

Akerlof's (1970) model of the lemon market was adapted into a classroom game by Holt and Sherman (1999), which was later expanded by Wolf & Myerscough (2007). In the game, sellers can bring goods of three quality grades to the market under three conditions: symmetrical information, asymmetric information, and asymmetric information with consumer feedback (see the Methodology section). The game helps students realize the difficulties of trade in the absence of information on the quality of goods being sold, especially when sellers know more about the quality of the products than buyers do. The results from earlier runs of the game suggest three main lessons: first, in the symmetric phase of the game, the market will settle at the quality grade of the good that provides the highest total surplus, meaning the collective optimum (Holt & Sherman, 1999). Second, in the asymmetric phase with no feedback, the market collapses since it settles on the lowest quality grade (Holt & Sherman, 1999), and exchanges might "stop […] or [are] severely diminished" (Wolf & Myerscough, 2007). Third, in the phase of asymmetric information with customer feedback, "the number of trades quickly improves and […] sellers are able to sell higher quality items" (Wolf & Myerscough, 2007).

Tsao et al. (2009) expanded upon Holt & Sherman's (1999) original experiment to include specific brands of products. The results revealed that the existence of brands served as a quality indicator and helped reduce the perceived risk of consumers. Additionally, Staveley-O'Carroll & Gai (2023) designed a classroom game that simulated a health insurance market in which providers of the product faced the problem of incomplete information (concerning customers' health status).

2.3. Hypotheses

Having reviewed the literature on the theoretical and empirical importance of lemon markets and the possibilities of classroom simulation games, the following hypotheses were formed:

H1. Under symmetric information, a simulated market performs in the collectively optimal way.

H2a. Under asymmetric information, sellers will offer goods of lower quality but at higher or comparable prices than in the symmetric condition.

H2b. Under asymmetric information, the level of trade (i.e., the number of transactions completed) greatly diminishes.

H3a. In the case of consumer feedback, sellers will once again offer better quality products at prices similar to those seen in the case of symmetrical information.

H3b. In the case of consumer feedback, the level of trade will rebound to levels similar to those under symmetrical information.

3. Methodology and research methods. Data were obtained from a classroom experiment conducted in 11 seminar groups of a "Basics of Economics" course at Budapest Business University with students majoring in business information technology. In all, 294 students, virtually all in the first semester of their first year, participated (76% male). The classroom experiment closely followed the one described by Holt and Sherman (1999), including the addition devised by Wolf & Myerscough (2007). The performance of the classroom experiment has two advantages. First, it serves as an educational tool to help students gain insight into the effects of asymmetric information in markets. Second, it was considered a useful research instrument because it combines the advantages of a simple theoretical model (i.e., few rules and few rule changes in the game) with the participation of actual human beings (instead of a postulated "rational actor").

The game can be described concisely as follows. Small groups of two to four students participate as buyers (producers) or sellers (consumers, customers) in a market. Sellers can choose a name for their "company", which might be viewed as a "brand"; although the good being sold is not specified, it is just a generalized "product", and no difference in utility is supposed to exist between goods bought from different sellers, apart from perhaps some affective value. In each round, producers can bring one or two goods of one of three quality grades, at a price they set, to the market. Sellers' offers are collected and shown together to buyers. Buyers can then decide whether to purchase exactly one good from a seller or to pass. The aim of both parties is to make a "profit": sellers must earn revenues that cover their production costs, whereas buyers should purchase below their willingness to pay (WTP). Table 1 displays the production costs and WTP values for each quality grade of the good. The values used in the experiment described herein were shown to students in euros, but the numbers are the same as the original dollar values in Holt and Sherman's (1999) study, i.e., only ten times higher. Notably, for sellers, producing a second unit costs 10 euros more than the first unit does. Producers do not incur costs on unsold units (it is as if they did not exist at all). Buyers are not aware of sellers' production costs, and sellers are not aware of buyers' WTP values. Notably, the largest total surplus (i.e., the surplus of buyers and sellers added together, which is a measure of a socially desirable outcome) can be achieved if the Grade 2 quality product dominates the market and if other goods are suboptimal. The games played in all 11 seminar groups began with a warm-up round to acquaint students with the mechanics of the game. The first phase of the experiment had symmetric information, meaning that both the quality and price of goods offered by sellers were shown to buyers before the latter made their decisions. . In this first phase, three rounds were played. After that came the second phase of the game, in accordance with Holt and Sherman (1999): only prices but not the qualities of goods offered were shown to buyers. After the products were purchased, their qualities were revealed. Three rounds were played under such rules. Finally, in the third phase of the other three rounds, following the addition made to the game by Wolf & Myerscough (2007), information about product quality was still concealed, but buyers were given the opportunity to provide feedback on their purchases. Starting from the seventh round, feedback information was recorded alongside the name of each seller and displayed for the rest of the game, which meant that dishonest sellers risked having their bad reviews shown. Notably, within the game, faking such reviews was not an option for sellers.

Table 1. Production costs and WTP values for quality grades of goods

Quality grade	The production cost of sellers		WTP of buyers
	1st unit	2nd unit	
Grade 1 (Q1)	€14	€24	€40
Grade 2 (Q2)	€46	€56	€88
Grade 3 (Q3)	€110	€120	€136

Sources: Developed by the authors on the basis of Holt & Sherman (1999).

The data used for analysis were recorded by the teacher holding each seminar. The data table contained the names of the sellers; the quantity, quality, and number of goods each offered for sale in each round of the game; how many of the goods were purchased; and what reviews the sellers received (if any, starting from round seven). Data from all 11 seminar groups (markets) were combined and analysed together, forming the basis of the results presented below.

4. Results. The main aim of the present article is to describe changes in seller behaviour, i.e., the supply side of the market, in response to rule changes in the game, and the results are presented accordingly. The results presented below describe, in a summarized way, the results from 11 classes, i.e., 11 markets in which the game unfolded. Data from the warm-up rounds are not included. While the purpose of the warm-up round was to demonstrate the game to students, it is also true that it provided a first insight to participants into offers of competing sellers or preferences of buyers. Thus, it served as an anchor (cf. Furnham & Boo, 2011) to which behaviour could be adjusted in the first rounds, just as previous rounds also served as anchors even after rule changes. Otherwise, only three outlier values were excluded (instances of the Q3 good being offered above 300 euros; see Table 3).

Table 2. Quantities of goods offered by sellers in all 11 markets combined

Game rounds and phases	Quality grade		
	Q1 (lowest)	**Q2 (middle)**	**Q3 (highest)**
Round 1	15	59	22
Round 2	17	57	19
Round 3	16	69	12
Phase 1 total: symmetrical information	**48**	**185**	**53**
Round 4	83	17	2
Round 5	67	18	9
Round 6	69	19	4
Phase 2 total: asymmetric information	**219**	**54**	**15**
Round 7	38	45	14
Round 8	46	41	12
Round 9	73	19	2
Phase 3 total: asymmetric information with buyer feedback	**157**	**105**	**28**

Sources: Developed by the authors on the basis of research results.

Table 2 summarizes the amount of goods from each quality grade offered by sellers round by round. Overall, the "textbook" results can be observed. By the end of the first phase, the Q2 good dominates the market (71% of all offers in round 3), whereas in the second phase, Q1 is overwhelmingly offered (76% of all offers in phase 2 overall). Notably, no period of learning is required for that adjustment since round 4 (the first one with asymmetric information) already results in the dominance of Q1. Similarly, the addition of customer feedback in round 7 induces a change in seller behaviour by itself, without feedback having to be given: in round 7, Q2 regains a plurality of offers (46%). It must be highlighted, however, that in round 8, Q1 dominates slightly among offers, and the last round of the game displays an enormous "endgame effect" (Selten & Stoecker, 1986): sellers, knowing that buyers cannot retaliate anymore by giving negative feedback, return to offering Q1 overwhelmingly (78% of all offers in the round). Overall, Q1 dominated the feedback phase of the game (54% of all offers as opposed to Q2's 36%) in addition to the asymmetric phase.

Table 3 illustrates the various price levels at which goods were offered in the three different phases of the game. Notably, for the Q2 good, the modal and median prices remained consistent at €60, indicating that producers quickly settled on a price slightly above production costs and maintained it. A similar pattern is observed for Q3, with mode and median prices consistently in the €120--€125 range. Conversely, prices for the lowest grade, Q1, display a different trend. First, it is notable that both the minimum and modal prices for the good are lower in the second and third phases of the game than in the first, suggesting that information asymmetry, with or without feedback, made the market for the good more competitive (as shown by the amounts offered as well). However, it must also be noted that this information gap leads to a significant rise in both median and average prices, exemplifying the "lemon market" phenomenon: sellers make bold yet deceptive offers even at lower prices (approximately €50) than in the optimal state of the market (at €60 for Q2 goods).

Table 3. Data on offered prices for each quality grade of goods and phases of the game

Game rounds and phases	Price levels offered by sellers				
	Minimum	**Maximum**	**Mode**	**Median**	**Average**
Phase 1: symmetrical information					
Q1	20	55	30 and 35	32	34.00
Q2	49	98	60	60	62.79
Q3	105	169[a]	125	125	129.55
Phase 2: asymmetric information					
Q1	15	130	25	50	50.19
Q2	50	120	60	60	70.26
Q3	65	140	124	120	106.93
Phase 3: asymmetric information with buyer feedback					
Q1	18	170	26	52	59.05
Q2	39	115	60	60	61.86
Q3	30	135[b]	120	120	108.61

[a]: Two values, one of 300 and one of 69420, were excluded.
[b]: One value, of 777, was excluded.

Sources: Developed by the authors on the basis of research results.

Furthermore, it can be observed that in the phases involving information asymmetry, some sellers decided to offer some products below their production cost, mostly in the case of the Q3 good (in phase 2, five such offers were made; in phase 3, eight). During discussions of the game, some of those sellers said they were aiming to build trust with consumers by making those offers, suggesting that even in the asymmetric condition, the presence of repeated interactions could lead to a budding corrective mechanism.

Seller behaviour is further described by estimations of supply curves for each quality grade of the good, separately for each phase of the game (Figure 1).

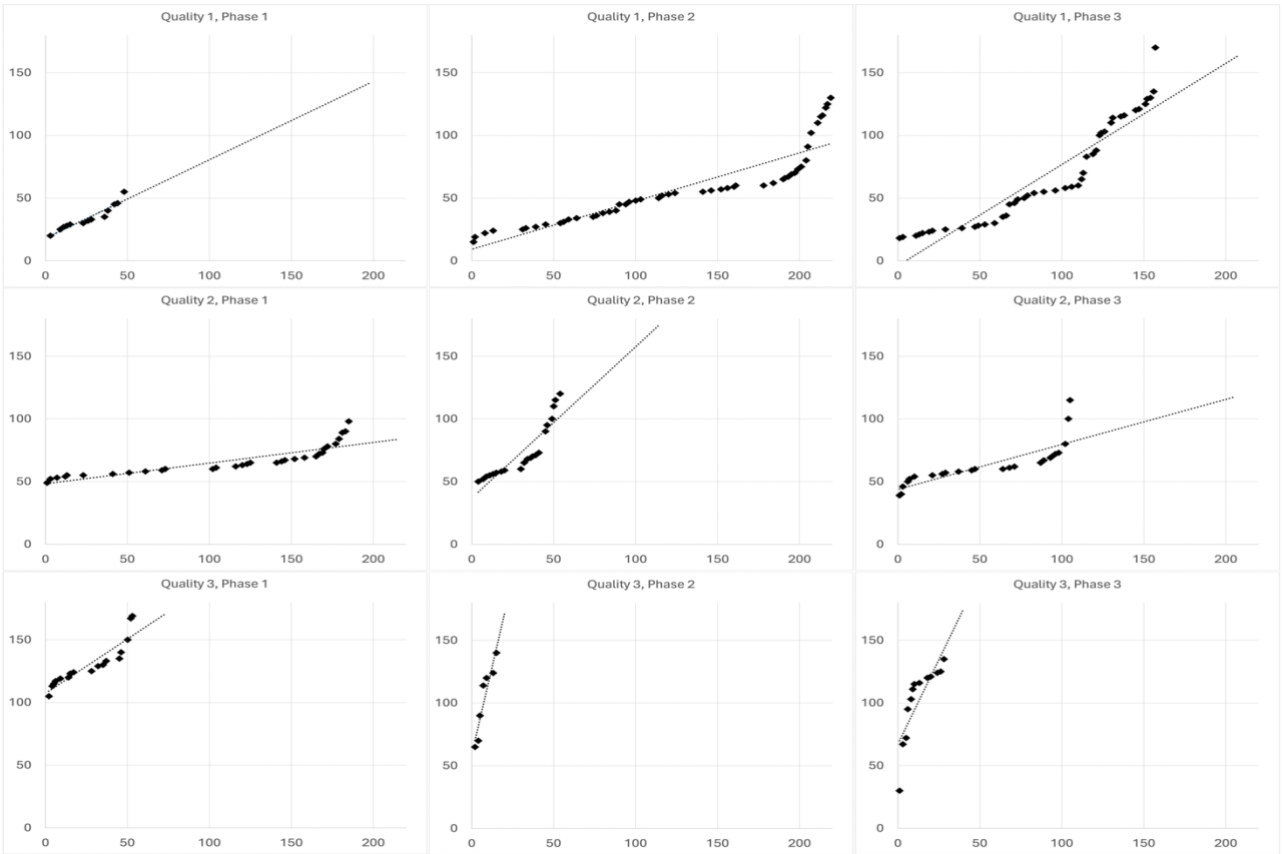

Figure 1. Estimated supply curves for each quality grade of goods in each round
Sources: Developed by the authors on the basis of research results.

These supply curves are ordinary least-square linear estimations over a scatter plot, where each point has price (P) and quantity (Q) coordinates. Price coordinates represent the distinctive price levels at which individual goods were offered by any given seller within the market during a given phase. The quantity coordinates are the cumulative amounts of the goods offered at and below the given price point in the market, again for the whole period. The two variables (namely, the market price and quantity) are strongly related to each other; thus, regression analysis can be conducted (Table 4).

Table 4. Estimated supply curves for each quality grade of goods

	Intercept	**Slope**	**R-squared**
	Phase 1: symmetrical information		
Q1	18.068	0.6253	0.9021
Q2	48.332	0.1645	0.7552
Q3	107.24	0.8688	0.8223
	Phase 2: asymmetric information		
Q1	9.2228	0.3845	0.8052
	Intercept	**Slope**	**R-squared**
Q2	36.784	1.2083	0.7891
Q3	59.12	5.6211	0.8787
	Phase 3: asymmetric information with buyer feedback		
Q1	-3.8166	0.8063	0.8792
Q2	43.809	0.3588	0.6714
Q3	67.2	2.6924	0.6817

Sources: Developed by the authors on the basis of research results.

In this case, a so-called linear estimation was used on the basis of the findings of Kolnhofer-Derecskei et al. (2022). Several observations can be made about supply curves. First, in the case of the Q2 and Q3 goods, the curves are the least steep in the first phase, indicating that the market for these goods was the most competitive under symmetrical information. In fact, the gentlest curve of all is that of Q2, the "optimal" good, in the first phase, demonstrating that perfect information leads to a very competitive and presumably efficient market. Not surprisingly, in phase 2, the supply curves for higher-quality goods become steeper, but for Q1, the dominating quality grade, it is the gentlest of all three phases, meaning that for the lowest-quality goods, the market was the most competitive in the condition of information asymmetry.

The slopes of the estimated supply curves in Phase 3 are closer to those in Phase 1 than those in Phase 2 (except for Q3, which played a very minor role in the market throughout), suggesting a restoration of the order established under the condition of perfect information owing to the option of customer feedback. However, intercept estimates for the curves in phase 3 are decidedly lower than those in phase 1, mostly because several offers are made at high price points (which give rise to higher slopes of the estimated curves), suggesting that markets for the Q1 and Q2 goods were still more volatile despite the presence of feedback than in the case of symmetric information. The series of dots (which represent the offers) also shows which quality was offered in each round (Figure 1).

The intercept in the case of a linear supply curve represents the price where the quantity supplied is zero. In the game, such intercepts should be around the production costs. In the first or symmetric phase, that can indeed be observed. Later, the slopes of the curves changed, which led to a less predictable cost analysis. The price elasticity measure (Mankiw, 2017) is reflected in the appearance of the supply curves. As the elasticity increases, the curve becomes flatter. Here, the elasticity decreases, which may reflect the limited periods of each round, so the sellers may have a short-term, more profit-oriented strategy.

The estimated supply curves represent the intended behaviour of sellers: how many goods they were willing to bring to the market at certain price points? Admittedly, for a full understanding, demand curves should also be estimated. However, the data obtained from the game did not capture the intended behaviour of buyers because they were not allowed to make counteroffers, only a decision to buy or pass. Therefore, the only way to take consumer behaviour into account is to look at the number of goods that were actually sold, as shown in Table 5. The theoretical maximum number of goods sold in one round is 66 (there were six buyers in each of the 11 markets). Phase 1 of the game comes very close to that in each round, which is not surprising for a market with perfect information. In the first round with asymmetric information, only 49 goods were sold, which is a 23% decrease from the previous round.

Table 5. The number of goods sold in all 11 markets combined, by quality grade

Rounds and phases	Quality grades			
	Q1	Q2	Q3	All
Round 1	7	46	10	63
Round 2	7	50	7	64
Round 3	4	54	6	64
Phase 1: symmetrical information, summarized	**18**	**150**	**23**	**191**
Round 4	39	10	0	49
Round 5	43	8	2	53
Round 6	48	10	2	60
Phase 2: asymmetric information, summarized	**130**	**28**	**4**	**162**
Round 7	29	21	6	56
Round 8	29	25	6	60
Round 9	37	8	2	47
Phase 3: asymmetric information with buyer feedback, summarized	**95**	**54**	**14**	**163**

Sources: Developed by the authors on the basis of research results.

Interestingly, in the next two rounds under the same conditions, trade intensified and reached a level less than 10% below the previous maximum (60 sales in round 6). The addition of customer feedback overall did not intensify trade, and in fact, the very last round of the game was the one where the fewest goods were sold, probably because buyers sensed the danger of the "endgame effect". However, notably, in the rounds where customer feedback truly mattered, i.e., rounds 7 and 8, the volume of trade was comparable to that in the latter rounds of the second phase, with the major difference being the greater share of the Q2 good.

5. Discussion. As shown in the literature review, lemon markets have often been treated by way of modelling, which implies deductive reasoning and assumes rational choice by actors. Empirical studies are rare, and in the case of classroom experiments, which are not real-life examples of lemon markets but at least involve human decision makers, authors typically describe their results mainly qualitatively, presenting "market data" from only one (Holt & Sherman 1999) or two (Wolf & Myerscough, 2007) classes of students. The addition of the present article to the body of evidence is a more detailed and quantified description of how simulated markets (11 of them combined) work in the game, as well as offering results that are more than fifteen years newer than what had been available, hinting at possible changes in the way students perceive the game and its core problem.

The discussion revisits the hypotheses one by one. Hypotheses are investigated with reference to quantitative metrics, but formal statistical testing is not performed. This is because the present study did not use random sampling from a larger population with the eventual aim of making generalized claims; rather, it is a case study offering insights into certain patterns of behaviour.

H1. Under symmetric information, a simulated market performs in the collectively optimal way. This hypothesis is strongly supported by the data. Under the condition of symmetric information, markets were dominated by the optimal Q2 quality grade of the good, accounting for 71% of the goods offered (Table 2) and 84% of those bought (Table 5) in round 3. Additionally, a modal and median price for the Q2 grade was established in this phase, which was carried out unchanged into later ones. The results illustrate the well-known ability of markets under perfect information to converge on a socially optimal solution and are in line with earlier findings from the same game (Holt & Sherman, 1999; Wolf & Myerscough, 2007).

H2a. Under asymmetric information, sellers will offer goods of lower quality but at higher or comparable prices than in the symmetric condition. The hypothesis is strongly supported by the data. Information asymmetry in rounds 4--6 of the game led to a number of unsurprising results. First, the lowest quality good (Q1) became dominant, making up 76% of offers (Table 2) and 80% of actual transactions (Table 5). While the market of the Q1 good became more competitive, signalled by lower entry prices than in the first phase, its median and modal prices also increased, indicating that several deceptive offers were made by sellers (where the Q1 good was priced "as if" it was a Q2 good). All of that, again, is in line with what the theoretical model of lemon markets suggests.

H2b. Under asymmetric information, the level of trade (i.e., the number of transactions completed) greatly diminishes. This hypothesis, suggested by the literature, was not entirely supported by results from the experiment. The first round with asymmetry indeed resulted in a 23% drop in the number of goods sold, but by round 6, the number of sales rebounded to a level only 9% below the previous maximum (see Table 5),

probably because both buyers and sellers adapted to the new situation and knew what they could get away with the offering (in terms of price) and what they could expect to buy (mainly, only the Q1 grade). Naturally, the dominance of Q1 is a further reminder that markets veered far from the collective optimum in this phase and illustrates the theoretical model of the "market for lemons" well. Obviously, such a realignment would be a serious shock in any real-life market. However, earlier assertions by Holt and Sherman (1999) and Wolf & Myerscough (2007) about a general "collapse" of trade are contradicted by the rebound in the number of goods sold in rounds 5 and 6 of the game (Table 5).

A number of tentative explanations can be offered because markets did not cease to function even under information asymmetry. Two things can ensure continued operation: first, sellers have to offer low-quality goods at low prices, which probably seems to be the rational strategy for participants (as opposed to making offers at higher prices that consumers might consider fraudulent, even if product quality is good), and they act accordingly. Second, consumers must be willing to risk buying "lemons". There are a number of reasons why they do so. First, students, as real-life decision makers, are not strictly rational (Jones, 1999). Indeed, during the game, it seemed that participants did not necessarily look for the absolute best option but merely tried to "go along" with the game and needed some time and one or two bad decisions to fully become acquainted with the incentives under which they had to operate. Another possible explanation is a low level of loss aversion, which, as noted by Baharad & Kliger (2013), could help alleviate the lemon problem in markets. Indeed, previous studies have shown that risk-taking is highest in late adolescence (Duell et al., 2018), which corresponds to the age of first-year university students, with males showing higher levels of risk-taking in the financial domain than females do (Rolison et al., 2014), and the sample here was male dominated. Furthermore, the result could be explained by the fact that it comes from a Hungarian cultural context, while earlier runs of the experiment were conducted at American universities; however, such an explanation is not very likely because Hungarian society typically displays lower levels of generalized trust than the United States (Our World in Data, online). Finally, one more possible explanation for the stronger-than-expected market activity in the second phase is that students do not view the decision to purchase a good as something final or serious, possibly because they are accustomed to "right to return" policies. Although such an option was not part of the game, it exists in real life, and according to Pei & Paswan (2018), consumers rely on it lightly, sometimes up to the point of fraud. It is possible that students who participated in the same game one or two decades ago had different attitudes toward the act of making a purchase decision.

H3a. In the case of consumer feedback, sellers will once again offer better quality products at prices similar to those seen in the case of symmetrical information. The option of buyer feedback was claimed to have the power to solve the problem of lemon markets, both in theory (e.g., Thierer et al., 2015) and in the case of the classroom game (Holt & Sherman, 1999; Wolf & Myerscough, 2007). The feedback option did show remedial effects to the extent that in rounds 7 and 8, the number and proportion of Q2 goods offered increased from levels seen in the simple asymmetric phase (to 46% and 41%, respectively; see Table 2). However, the "endgame effect" of the last round washed those gains away. Notably, the modal and median offered prices for Q2 corresponded to those established under symmetrical information, but the price range of all offers in the third phase was larger. Additionally, Q1 played a substantial role in the market under feedback conditions, with sellers' offered prices strongly mirroring those of the simple asymmetric phase (see Table 3). Overall, contrary to expectations, feedback did not restore the "textbook optimal" universe of the first phase, as implied by Wolf & Myerscough (2007) earlier, but rather created a halfway state between the worlds of the first two phases.

H3b. In the case of consumer feedback, the level of trade will rebound to levels similar to those under symmetrical information. As seen in the results in Table 5, the hypothesis did not receive unqualified support. The level of trade (i.e., the number of goods sold) in the third phase was almost identical to that seen in the asymmetric condition and fell short of that in the first phase of symmetric information. However, that might also have been due to the strong "endgame effect" observed in the last round, which made buyers cautious. A game run longer could have demonstrated a stronger remedial effect of consumer feedback.

6. Conclusions. The article concerned itself with a classroom experimental model of a "lemon market" and its dynamics, focusing mainly on the supply side. Some of the results are aligned with earlier literature: markets operate better, both in terms of individual utility and collective surplus, when information about product quality is symmetrically known to producers and customers. When only producers are aware of product quality, low-quality goods largely drive out better goods from the market, while the volume of trade diminishes, leading to reduced welfare both individually and collectively. The introduction of a customer

feedback mechanism helps in restoring some of that lost utility but does not eliminate the problem entirely. As soon as producers see the chance to mislead buyers without punishment, they jump on the opportunity.

Policy implications are relevant to markets where information about product quality is missing or uncertain. The results from the game indicated that a feedback mechanism helped steer the market back toward the social optimum, which suggests that such feedback mechanisms should be strengthened in real life. Indeed, the rating systems that are self-evidently present in any online store, or even on the websites of offline businesses, not to mention centralized solutions such as Google reviews, are meant to perform that function. However, the danger of fake reviews has been mentioned above (Wu et al., 2020), and firms often find ways to deceive customers and circumvent consumer protection laws (Meskic et al., 2022). Thus, it seems likely that the danger of lemons entering markets will endure, although consumers can act collectively to protect themselves, and producers can also use branding and reputation building to differentiate themselves if those efforts are not too costly (Bai, 2021).

The fact that the results come from a classroom experiment with students that was run for symbolic rewards (simply the distinction of having made the highest profits as a seller or buyer) is an obvious limitation of this research. It is possible that some results arose only from indifference to taking risks in a game without any real stakes. Furthermore, the "feedback" phase of the game might have been too short to fully drive back markets toward a better outcome and should have been run longer.

Many findings deserve more attention in further research. As has been proven in our previous experiments (Kolnhofer-Derecskei & Csongradi, 2022), the simple wording of a message (framing) may impact subjects' reference price. Interviewing participants about their approach and thought process can shed more light on why sellers and buyers behave in the way they do. A longer feedback period can help reveal whether the mechanism is strong enough to fully restore a healthy market. Playing the game in different contexts, e.g., with students who have known each other for longer, or with participants belonging to specific demographics, or who have different cultural backgrounds, might reveal whether there are factors such as social capital, generational attitudes or others that influence behaviour in the game. Finally, the possible change in attitudes toward the act of making a consumer purchase (whether it is something that is done much more lightly by younger generations or simply in comparison with earlier decades) is worthy of further study.

As Akerlof said in his Nobel prize lecture: "Economics is a far richer field with more interesting, realistic, and detailed models than when I first entered the profession" (Akerlof, 2001). Therefore, it is crucial to investigate and teach interdisciplinary mainstream economic models. Our research achieved its goal: the students were able to learn the economic rules of the market through learning by doing and learning about asymmetrical markets. In addition, this research can offer a more detailed and quantified picture of the results from an experiment that was first performed decades beforehand and offer tentative explanations for why the results obtained herein differ from earlier ones.

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Вплив зворотного зв'язку споживачів на функціонування ринку в умовах асиметрії інформації: результати експерименту в аудиторії

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У статті розглянуто проблематику так званих "ринків лимонів", вперше описаних Джорджем Акерлофом, де інформаційна асиметрія щодо якості товарів призводить до негативних наслідків, таких як зниження середньої якості продукції, зменшення обсягів торгівлі та загальне зниження колективного добробуту. У сучасну епоху онлайн-комерції ця проблема набуває особливої актуальності, оскільки споживачі купують набагато більше товарів, не маючи особистого досвіду користування, ніж будь-коли раніше. У наукових дослідженнях запропоновані можливі рішення цієї проблеми, зокрема формування репутації виробників та покращення доступності інформації для споживачів, наприклад, за допомогою відкритих відгуків (хоча такі відгуки можуть бути сфальсифіковані продавцями). У цій статті представлені результати експерименту в аудиторії, який моделював "ринок лимонів". Перевагою проведення експериментів у навчальній аудиторії є можливість відтворити ринок на основі чітко визначених правил і стимулів відповідно до економічних моделей, залучивши реальних учасників, які приймають рішення, демонструючи відхилення реальної людської поведінки від теоретичної моделі "раціонального вибору". У дослідженні взяли участь 294 студентів, що навчаються за спеціальністю бізнес-інформаційні технології, які створили 11 симульованих ринків. Результати зосереджені на стороні пропозиції, зокрема на обсягах і цінах запропонованих товарів, а також на оцінці дев'яти кривих пропозиції (для трьох рівнів якості товарів на трьох етапах гри). Дослідження показує, що за умов повної інформації ринок працює ефективно. У випадку, коли лише продавці, але не покупці мають інформацію про якість товару, обсяги торгівлі зменшуються, але не так різко, як це зазначалося в попередніх дослідженнях. Ринок демонструє ознаки відновлення, хоча й досягає субоптимальної рівноваги. Після введення механізму зворотного зв'язку від споживачів ринок продовжує рухатися в напрямку соціально оптимального стану. Результати підтверджують, що зворотний зв'язок від споживачів відіграє важливу роль у заповненні інформаційної прогалини в умовах невизначеності якості товарів, проте сам по собі він не здатний повністю вирішити проблему "ринку лимонів". Авторами систематизовано важливі фактори, що впливають на поведінку споживачів в умовах невизначеності, серед яких ризикованість, зміна ставлення до онлайн-покупок і культурні особливості.

Ключові слова: поведінкова економіка; експеримент в аудиторії; зворотний зв'язок споживачів; асиметрія інформації; ринок лимонів.