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Classroom Games: Trading in a Pit Market 2.0

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**CLASSROOM GAMES:
TRADING IN A PIT MARKET 2.0**

September 2016

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Classroom Games: Trading in a Pit Market 2.0*

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Abstract

We have developed a computerized version of Charles Holt's classical market game that can be used even in classes with a large audience. The Pit market game gives students intuitive access to the interaction of supply and demand in real-world markets. Even though trade can take place at non-uniform prices in the classroom game, the average price and the quantity traded are usually very close to the equilibrium values predicted by supply and demand curves. The classroom game can also be used for a lively discussion about the efficiency of markets or to show the consequences of taxes and regulatory interventions.

JEL classification: A22; C88; D01; D40

Keywords: Pit Market; Market Game; Classroom Game; Economic Education; Supply and Demand

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IN the old days, setting up a Pit Market game in the classroom was complicated, time consuming, and limited to small classes. “With larger classes, it is better to use the students near the aisles and let the others watch.” (Holt, Charles A., 1996, p. 196). Fortunately, times have changed! In the digital age, students do not have to sit still and just watch anymore. Currently, students can play an active role in a lecture. We have developed a computerized version of the Pit Market game that can be played and evaluated in large groups, such as those often found in Principles of Economics classes. This teaching method can increase interest in and may reduce skepticism about economic theory.

The Pit Market game is a classical game developed by Charles A. Holt to give students intuitive access to the interaction of supply and demand in real-world markets. In Holt’s classroom game, playing cards are distributed among students. Each student receives one playing card. Students who receive a “black” card (clubs or spades) are sellers; students who receive “red” cards (hearts or diamonds) are buyers. The value number on the card informs the student about his or her cost (seller) or willingness to pay (buyer). Buyers can make a profit if they find a seller who is willing to sell for a price below the buyer’s willingness to pay. Conversely, profitable deals for a seller require finding a trading partner who is willing to accept a price above the seller’s cost. Students try to negotiate mutually profitable deals in front of the classroom (the pit). All successful deals are recorded and immediately published on the blackboard. Each player can trade only once and the game ends when no more profitable deals can be made. When the game is over, the market outcome is discussed in class.

As simple as it is, the game contains some exciting features for introducing market equilibrium in introductory courses. The game does not require a central (Walrasian) auctioneer, but the outcome is generated by decentralized price setting. Even though trade can take place at non-uniform prices, the outcome is usually very close to what our workhorse model of supply and demand predicts, in particular, when the game is played in several rounds. Students who are critical of the concept of supply and demand in the beginning are often quite surprised to see how well the model predicts the outcome in a seemingly chaotic market process where dozens of players on each side of the market interact.

For our purposes, the classical Pit market had one major disadvantage: we could not play it in our typical introductory courses with several hundred students. Therefore, we designed a computerized version of the Pit Market game that can be used even in classes with a large audience. The software, which was written in Java, can be used on most commonly used operating systems (OS); the software and the accompanying manual are in the public domain.¹ We stick as closely as possible to the original Pit Market game. The classroom is randomly divided into sellers and buyers who are supposed to strike the best deals. For obvious reasons, we do not hand out playing cards but use printed tickets. In addition to the information on the player’s willingness to pay or the cost (as in Holt’s version), the tickets also contain an individual player ID. Players who have found a trading partner note the deal on a contract, which includes the players’ IDs and the negotiated price. The contracts are typed into computers provided in the classroom, where the history of prices is immediately displayed on a chart on the classroom’s main screen.

While in the original game, players knew that cost and willingness to play are limited to the numbers 2, 3, ..., 9, and 10 (because of the playing cards), no such information is available to the players in our version. Each player has only the information displayed on his/her own ticket. Despite the complete lack of information a priori and the seemingly chaotic bargaining

¹ The software was developed in a joint seminar project with first-year students at the Faculty of Informatics at TU Dresden. We are grateful for the enormous enthusiasm of the students, who invested several hours to make the software “ready for the market”. A detailed user documentation (Kretschmar et al., 2016) as well as the software itself is available free of charge from the authors of this article. If you are interested in using the software, please send an email to one of the authors of this article, and we will provide you with a download link to the most current version.

Figure 1: Pit Market at TU Dresden on November 24, 2015 © Yvonne Bludau



process involving several hundred students, the outcome is quite surprising for most students. Once the trading has come to a halt, we show the supply and demand curves which result from the distributed tickets. The average price and the quantity traded are usually very close to the equilibrium values predicted by supply and demand curves. The classroom game can also be used for a lively discussion about the efficiency of markets or to show the consequences of taxes and regulatory interventions.

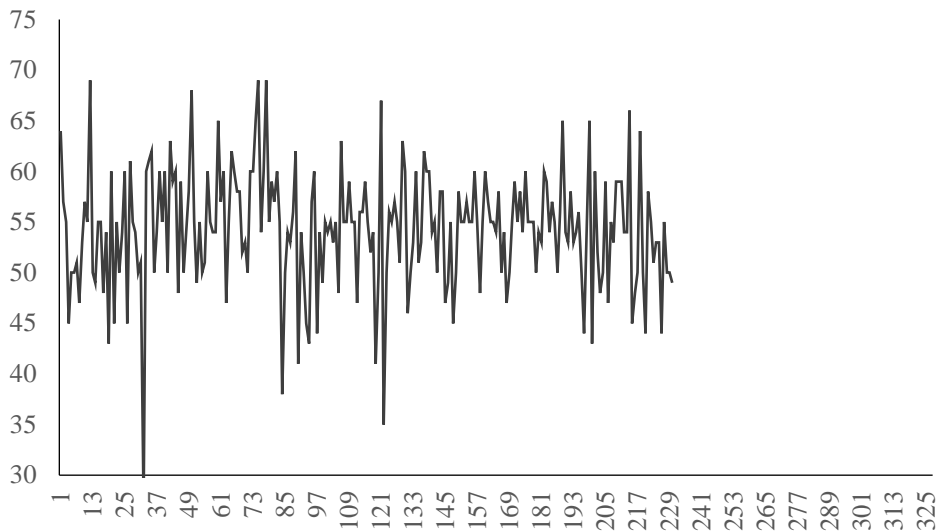
In the following paper, we first describe the typical procedure during the classroom game in more detail. We then show the outcome of the game when it was played at TU Dresden. We use these examples to highlight which features of a market can be discussed with the students in the wake of the classroom game. Then, we discuss alternative variants for playing the game in a classroom setting. Finally, we briefly describe the preparations necessary to play the game.

Setting Up a Pit Market 2.0

We usually play this game in the Principles of Economics course, after the concepts of supply, demand and market equilibrium have been introduced. Therefore, students are familiar with the basic concepts but are often somewhat skeptical that real-world markets indeed work that way. In particular, they see little resemblance between their experience of markets where trades take place at all times and our textbook description of a market equilibrium, where trade only takes place once supply and demand are equalized.

Before the class starts, we set up the computer equipment.² The software runs on the instructor's laptop, which is connected to a projector. In addition, we have a number of "satellite" laptops, which are used to enter the contracts; they are connected via Wi-Fi to the instructor's laptop. When the class starts, we explain that we are going to simulate a simple market in class to see how well our theoretical model fits reality. Students are told that the class will be divided into sellers and buyers. Each student will receive a ticket with an ID and the information of whether he/she is a seller or buyer. A seller's ticket also contains the information on her/his cost of producing widget. A buyer's ticket states the maximum willingness to pay for a widget. Each player is allowed to make only one deal; hence, individual supply or demand is perfectly inelastic. It is particularly important to thoroughly explain the two different views of suppliers and consumers. We also show a numerical example to illustrate that no deals with negative rents should be made; instead of making

² The necessary preparations are described in more detail in the last section.

Figure 2: Chart during session

losses, it is always better to strike no deal at all and exit the game with zero rents. To give students an additional incentive to maximize the individual rent (willingness to pay minus price for buyers and price minus costs for sellers), we announce a raffle at the end where the partners of one randomly selected deal are paid their individual rents in Euros. It is essential that everyone understands the basic rules of the game. Therefore, we allow for a round of questions. However, we do not reveal any information on the distribution of costs and willingness to pay.

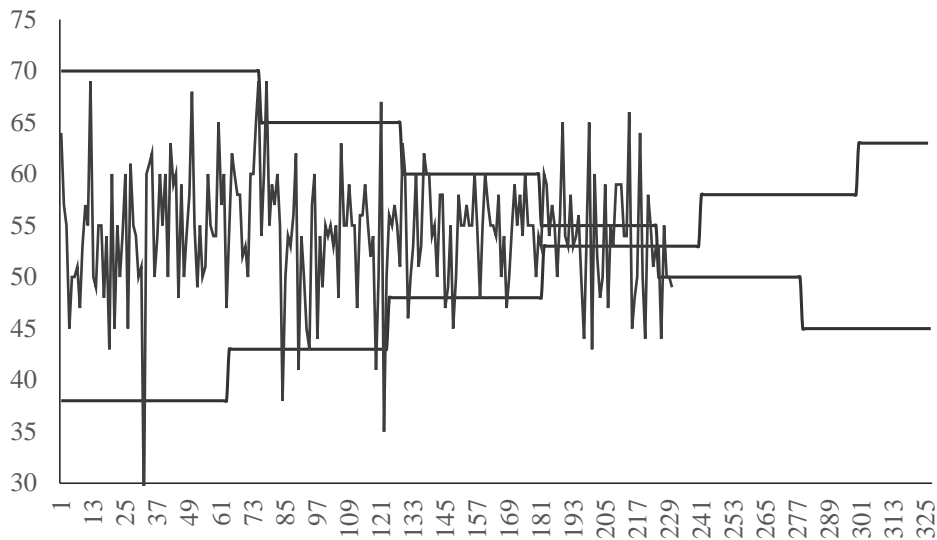
Once all questions are resolved, we ask students to get up, obtain one ticket each from the teaching assistants (TAs), and come to the front of the classroom to start negotiations.³ For a lively interaction, it is important that there is some space so that students can walk around and search for a suitable trading partner. This is usually a lively and often noisy period of the game. While some students bargain quietly and in private, we have experienced students shouting their offers as if they are in a bazaar. Once, a student even picked up the microphone and announced his offer via the PA system. Figure 1 gives an impression of the trading period when we ran the classroom game with 650 students at TU Dresden on November 24, 2015.

If two students agree on a mutually acceptable price, they fill out a “contract”, which states the two IDs and the price agreed upon. They hand over the contract to one of the TAs at the satellite laptops. The contract is entered and automatically transmitted to the instructor’s laptop. The chart containing all deals so far is continuously updated and is made visible for all students via the projector (see Figure 2). The prices displayed on the vertical axis of the chart can be used by all remaining players to update their information on the range of likely deals.

Usually, the deals come in very slowly at the beginning as students try to figure out the range of opportunities. But after 5 or 10 minutes, people energetically try to ensure that they find a trading partner, and deals are at their peak. Then, the flow of new deals gradually runs dry. The game is stopped when no further deals are in sight, and the students are asked to return to their seats for the game’s assessment.

³ We do not distribute the tickets earlier as we want the students to get moving. If they obtain the tickets while sitting in class, they might simply strike a deal with the neighbor.

Figure 3: Evaluation of the outcome



Before the assessment, you can also repeat the game. The volatility of prices will typically decrease quite substantially in the second round. As the one-shot game already takes about 30–45 minutes, depending on class size, we usually abstain from a repetition. Instead, we discuss the likely consequences of iterated markets in the subsequent exchange in class.

Interpreting the Outcome

We start the discussion in class with an open question about the students' assessment of the price formation in the game. They usually report their different strategies, for example, monitoring the price chart, listening in to other bargaining parties, mutually disclosing the tickets and splitting the difference, etc. Even though the price formation itself is not at the core of the game, it is quite illuminative to discuss the various strategies.

By clicking on a button, the software allows us to superimpose the demand and supply curves as well as some summary statistics (see Figure 3).⁴ For the first time, the students are now able to see the actual supply and demand curves that were derived from the distributed tickets. The chart in Figure 3 stems from the classroom game at TU Dresden on November 24, 2015. We had distributed 653 tickets, and 231 deals were made. Therefore, 462 students could find a trading partner; 191 left the trading floor without a deal. The costs ranged from 38 to 63, and the willingness to pay ranged from 45 to 70.⁵ The average price was 54, while the (uniform) equilibrium price would have been 53. Also, the quantities match nicely. In a market equilibrium with a uniform price, we should see 224 units to be traded. Actually, we had 231 contracts. So we had only a slight “overshooting” – we will come back to that point later. However, given the lack of any prior information on both sides of the market and the large price volatility, the outcome is fairly close to what a standard model of supply and demand would predict.

The chart usually raises a number of questions among students. We found that these “puzzles” discussed in class have a long-lasting didactic effect on students.

⁴ The software also produces a CSV file, which contains the entire history of deals (IDs and prices). It can be used for a more detailed analysis, for example, the highest rent or the number of deals with a negative rent.

⁵ This is the standard configuration. The software allows the user to adjust supply and demand as desired.

Do prices above the demand curve and below the supply curve necessarily reflect players' mistakes?

Not necessarily. The supply and demand curves tell us nothing about the cost and willingness to pay of an individual trade depicted by the chart. Supply and demand curves are constructed by sorting players according to their willingness to pay (descending) and costs (ascending). The ordering in the trading chart, in contrast, simply reflects the sequence of deals. From inspection of the chart, we can just say that deals with a price above the highest willingness to pay or below the lowest costs certainly generated a negative rent for one party involved. In Figure 3, deal number 32 with a price of 27 and deal number 122 with a price of 35 obviously caused losses for the sellers. For all other deals, loss-making deals can only be identified by inspecting the history of deals. In our case, 15 of the 462 students who were able to strike a deal made a loss.⁶

Why do we observe overshooting?

With a Walrasian auctioneer, trade only takes place at the equilibrium price. Hence, only sellers with cost below the equilibrium price and buyers with a willingness to pay above the equilibrium price will make a deal. In our pit market, prices are individually bargained. Especially in the beginning, it often happens that deals are made that generate a profit for the two parties involved but that would not occur at equilibrium prices. In deal 12, for instance, the players settled on a high price of 69. As the buyer's willingness to pay was 70 and the seller's cost 63, both made a small profit. Of course, the buyer would have never bought from such an expensive source if he or she had known that much better deals were available.⁷

Can we maximize the number of deals by matching low cost and low willingness-to-pay players?

The previous discussion often inspires some students to suggest, "inverting" the supply curve. Hence, players with the highest willingness to pay buy from sellers with the highest costs. Players with the second highest willingness to pay purchase from the sources with the second highest costs and so on. Such an allocation scheme would increase the number of traded goods above the equilibrium value. This is a good occasion to discuss the difference between the maximization of transactions and the surplus maximization. Even if total surplus as a measure of welfare have not yet been introduced in class, one can easily provide an example of Pareto improving deals by starting from an allocation that maximizes the number of transactions. Players with a high willingness to pay and a low cost can compensate a high-cost producer and a consumer with a low willingness to pay for abstaining, and they will still be better off in terms of rents.⁸

Will price volatility go down with repeated interactions?

Yes. Even if the game is repeated without prior assessment of the first round, students will figure out the "typical" price. Extreme prices will vanish, price volatility will decline, and the prices will gradually converge toward the equilibrium value.

Once the discussion is settled, we play a raffle. The software allows us to randomly select one deal (identified by the players' IDs). The lucky students receive the rents of their deal in Euros. In our case, the maximum rent is 32 which is achieved when a consumer with a willingness to pay of 70 strikes a deal with a producer who has costs of 38. In most raffles,

⁶ Toward the end of the game, there were two deals in which both the seller and the buyer made losses. It seems that some students were very eager to trade even though they were told that the outside option (not trading) avoids any losses. This information can be obtained by inspecting a file that is generated by the software and which contains information on the cost, the willingness to pay, and the price for each deal.

⁷ As most students try to maximize their profits, only some of these deals occur. Our fairly flat supply and demand curves slightly favor those deals. The software allows the user to manipulate the cost and willingness to pay structure. For instance, making the supply curve very steep around the equilibrium, with costs of the additional suppliers above the maximum willingness to pay, would obviously remove this type of deal (but also eliminate a source of lively discussion in class).

⁸ We will return to the welfare analysis below when we discuss variants of the Pit Market game.

however, we had to pay out just a few Euros. We also announce at the beginning that, if a student who is selected in the raffle has made a deal with negative rents, we will charge the students for the loss. Fortunately, we never had to follow through on this claim.

Further Topics

We use the game to illustrate that the outcome in chaotic markets, where no Walrasian auctioneer balances supply and demand before any trade is made, is very close to the allocation predicted by our workhorse model of supply and demand. Hence, we play the game once the students have become acquainted with the concept of market equilibrium. However, you may also want to make use of the classroom game earlier to introduce supply and demand. In this case, students have to figure out in the discussion following the classroom game that, after some repetitions, the price will adjust so that the quantities supplied and demanded are balanced. In this case, it is preferable to play the Pit Market game in several rounds.

Alternatively, one can also introduce the game later in the schedule of a typical introductory course when interventions in markets are analyzed. If the equilibrium price is reached in the first or second round, for instance, the teacher can introduce a tax levied on all sales.⁹ This should lower the quantity traded, increase gross prices, and lower net prices. Alternatively, one can introduce a binding price ceiling, which should lower the quantity traded. (In this case, you may even find some students trying to establish a shadow economy.)

Finally, one can use the game to illustrate the welfare properties of markets. Welfare is simply measured by the sum of rents generated by the deals (Kaldor-Hicks). If students are already familiar with the welfare concept, the software allows us to calculate the actual sum of rents and the maximum feasible rent. The maximum feasible rent is the area between the supply and demand curve; in our case, the maximum surplus amounted to 4198. The actual sum of rents is calculated by summing up willingness to pay minus the cost for all contracts; the classroom game depicted in Figure 3 generated 3600 of rents. So our market, where trade occurred at non-uniform prices, exploited 86% of all potential rents.

Preparing Pit Market 2.0

Before the game can be played in the classroom, some preparations are necessary. The detailed description for the setup can be found in Kretzschmar et al. (2016). Only the basic steps are described here.

In the first step, the basic parameters must be determined. In particular, the software requires the maximum number of players that are expected to attend the course at the day of the game. You also have the opportunity to adjust the distribution of costs and willingness to pay; the classroom game depicted in Figure 3 was played with the standard configuration. The software then generates a PDF file for the tickets, which inform each student of his or her cost or willingness to pay. You have to print these tickets and sort them into packages. We use two differently colored papers for buyers and sellers; this makes it much easier for students to find suitable partners from the other side of the market during the game. Finally, you have to print the “contracts”, where the students can note their IDs and the negotiated price.

In class, the software has to run on the instructor’s laptop. Then, the additional “satellite” laptops, which are used to enter the contracts, are connected to the instructor’s laptop via Wi-Fi. For our game with 650 students, we used three satellite laptops that were operated by two TAs each. Having two TAs at each satellite laptop is helpful when trades are at their peak. One TA accepts the contracts and dictates IDs and prices to the other TA.

⁹ This feature is not implemented in the software, but the predicted outcome can easily be derived.

When the students understand the rules of the game, the tickets are distributed to the students. Usually, not all of the printed tickets are distributed as some enrolled students may not be present. For an accurate picture of supply and demand, the software has to know which tickets were not distributed. At this point, the ordering of the tickets in packages is crucial. For each package, the ID of the first ticket that was not distributed has to be entered into the screen form on the instructor's laptop. Then, the game can be started, and the screen shows the chart with the negotiated prices as soon as the first price is entered into the system.

We hope that some colleagues teaching Principles of Economics courses find this software helpful. If you use Pit Market 2.0 in class, let us know where it was played, with how many students, and with what outcome. We are also grateful for any suggestions for improving or extending the software.

Acknowledgments

The game and its software implementation would have never been completed without the inspiration and support from many colleagues. The inspiration for playing the game in large classes came from Klaus Schmidt, who introduced a paper and pencil version in his Microeconomic Principles course at the University of Munich. The software was written by Timon Kretzschmar, Justus Paulick, Lukas Jähn, Dominik Weinrich, and Xinyu Yang. Full of energy and with great ideas, they developed the software as part of a practical seminar at the Faculty of Informatics, TU Dresden. Many thanks also to their supervisors, Jan Falkenberg and Barbara Speck, who made this possible and who helped to structure the project. We are also grateful to the numerous colleagues and TAs at our faculty, who came up with many very helpful suggestions for improving the game. Ronnie Schöb kindly allowed us to test our game in his principles class at FU Berlin. Last but not least, we thank the (mostly first-year) students at TU Dresden and FU Berlin who played the Pit Market with such a great enthusiasm.

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