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An Application of Experimental Economics to Agricultural Policies: The Case of U.S. Dairy Deregulation on Farm-Level Markets

by

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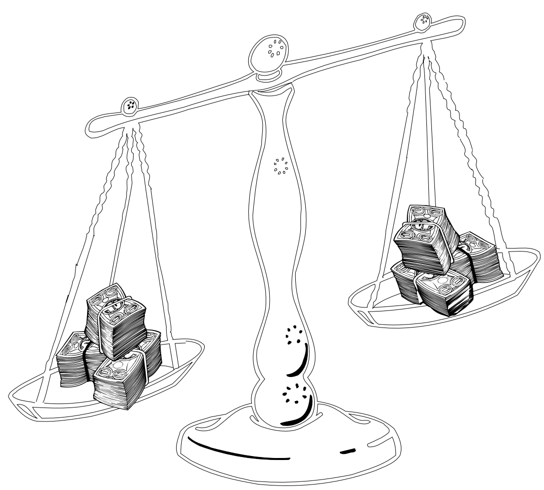

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PREFACE

This paper is based on the research conducted by Maurice Doyon for his Ph.D. dissertation. Dr. Doyon is presently an economist with the Groupe de recherche en economie et politique agricoles at Laval University in Quebec. Andrew Novakovic is the E.V. Baker Professor of Agricultural Economics at Cornell University.

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ABSTRACT

Current dairy regulations in the U.S. are the result of over 80 years of regulatory activities. Through the 1920s and 1930s the U.S. government passed various acts designed to increase the share of market surplus captured by sellers, which at the time was judged insufficient. Lately, budget constraints and commitments to freer trade agreement have let the government and some dairy sector leaders contemplate different levels of dairy deregulation. The elimination of the Federal Milk Marketing Orders (FMMOs), a cornerstone of U.S. dairy regulation, has emerged as a possibility.

The thought of eliminating the FMMOs was particularly disturbing to milk producers because of uncertainty regarding what might happen to the farm price, the volume of raw milk supplied, market stability and price efficiency, and to the distribution of market surplus between dairy farmers and dairy processing plants.

These particular questions have not been extensively studied before due to data availability problems. Data from the era prior to the establishment of FMMOs would be difficult to obtain, and probably not meaningful because FMMOs have been around since the late-1930s.

Experimental economics is used to simulate U.S. dairy market conditions and the effect of the elimination of FMMOs. The experimental task is a simple 2 X 2 matrix laboratory game. The treatments are oligopsony and regulation. Perishability is represented by an advance production decision with no carry-over and is kept constant across the experiments. Experimental sessions comprised 12 periods and a practice period. Sellers made production decisions and received a pool price, while buyers made a price (bid) and quantity decision. The allocation of units produced is made by the monitor on a highest bid basis. The game is computer assisted.

Experimental results indicate that, in the absence of regulation, buyers are successful in reducing market price below the perfectly competitive price and in capturing a larger share of market surplus than a competitive solution predicts. Regulation reduced the market power of buyers and the price fluctuation of raw milk, in an oligopsonistic market, and had no significant impact on the overall price efficiency of the market.

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I INTRODUCTION

As is the case in most industrialized countries, the U.S. dairy sector is heavily regulated. The current dairy regulations in the U.S. are the result of over 80 years of regulatory activities. In the early 1900s, the growth of cities, combined with improvements in transportation technology and infrastructure encouraged dairy farms to specialize their operations. Similarly, dairy processing and distribution activities became more specialized and concentrated. This resulted in a few large organized buyers with some degree of market power buying a perishable product from many small, unorganized producers.

Through the 1920s and 1930s the U.S. government passed various acts designed to increase the share of market surplus captured by sellers. The Capper-Volstead Act of 1921 gave the right for farmers to collude and participate in price-setting behavior in a way which otherwise would have been a prima facie violation of existing antitrust laws. The formation of collective bargaining units (cooperatives) by dairy farmers resulted in mitigated success. Later, in the midst of the Great Depression, the federal government passed the Agricultural Marketing Agreement Act of 1937. This Act enabled the creation of the Federal Milk Marketing Orders (FMMOs), which allow for classified pricing, location price differentials and pooling of revenues from milk sales.

Lately, budget constraints and commitments to freer trade agreements have let the government and some dairy sector leaders contemplate different levels of dairy deregulation. The elimination of FMMOs (deregulation) has emerged as a real possibility.

The thought of eliminating FMMOs was particularly disturbing for the dairy industry because of uncertainty regarding what might happen to the farm price, the volume of raw milk supplied, market stability, and the distribution of market surplus between dairy farmers and dairy processing plants.

These particular questions have not been extensively studied before due to data availability problems. Data from the era prior to the establishment of FMMOs would be difficult to obtain and would probably not be meaningful because FMMOs have been around since the late-1930s. Moreover, dairy experts have been unable to entirely agree on the direction and magnitude of the price changes due to deregulation. Some think that the market is fairly competitive or would become competitive as cooperatives grew, thus farmers on average should receive a price close to, perhaps a bit less than the current regulated price. Others believe that buyers are in a situation of oligopsony that cooperatives action cannot mitigate, and thus buyers will have market power, pushing farm prices significantly lower.

This paper uses experimental economics to simulate the effects of the elimination of FMMOs on farm price, on the volume of raw milk supplied, on the distribution of market surplus between dairy farmers (sellers) and dairy processing plants (buyers), on market price efficiency, and to some extent, on market stability. The experimental task is a simple 2 X 2 matrix laboratory game. The treatments are oligopsony and regulation. Perishability is represented by advance production decision with no carry-over, and is kept constant across the experiments. Perishability is hypothesized to be an important element that impacts the outcome of the market, but it exceeds the reach of this research to study it as a treatment. Similarly, the organization of sellers into producer cooperatives is not taken into account in the experiment. Each experimental session comprised 12 periods and a practice period. Sellers make production decisions and receive a pool price, while buyers make a price (bid) and quantity decision. The allocation of the unit produced is made by the monitor on a highest bid basis. The game is computer assisted.

Experimental results indicate that in the absence of regulation, buyers are successful in reducing the market price below the perfectly competitive price and in capturing a larger share of market surplus than a competitive solution predicts. Regulation reduces the market power of buyers in an oligopsonistic market, has no significant impact on the overall price efficiency of the market, and decreases the price fluctuation of raw milk in an oligopsonistic market. Although U.S. dairy regulation is an amalgam of different tools and rules, this paper focuses only on the elimination of a cornerstone of the U.S. dairy policy, namely the classified pricing and pooling scheme used in FMMOs.

The paper is organized as follows. The second section briefly discusses U.S. dairy policies, previous studies, the model used, and the hypotheses that are going to be tested. Then, the third section translates the real world problem into an experimental market. Finally, a discussion of the results of the experiment is followed by the conclusions.

II. THE DAIRY INDUSTRY

2.1. U.S. Dairy Policies

The dairy policies enacted in the 1930s remain largely intact today. The foundation of the U.S. dairy program is the support price, FMMOs, and a quota on imports. The government does not directly subsidize dairy farmers or support farm prices. Instead, the government sets purchase prices for surplus butter, skim milk powder and cheddar cheese. These purchase prices include a margin to cover the cost of processing milk so that, on average, dairy farmers should receive at least the support price. Price targets under the Dairy Price Support Program have been set low enough since 1988 so as to be largely ineffective. The program is presently scheduled to be terminated in 1999.

In the U.S. there are two grades of milk: grade A (fluid grade milk) and grade B (manufacturing grade milk). FMMOs regulate only grade A milk. Today, more than 70 percent of all milk sold to plants and dealers in the U.S. is regulated under Federal Orders and another 25% is regulated under similar state programs. Given that only 35% of milk sold is needed for fluid use in these markets, a significant amount of grade A milk is being used in manufactured products (Figure 2.1).

The pricing mechanisms in FMMOs set the minimum prices that regulated plants must pay for milk, based on how it is used. So, producers who sell their milk to a plant regulated by an FMMO all get the same minimum price for their milk through the pooling of receipts[1]. The blend price (minimum price) is a weighted average of the class prices. The weights are based on how the milk is used by processors during the month. The final payment that a farmer receives is affected by deductions for transportation costs and promotion, and by premiums

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[1] Variations are allowed for milk composition and transportation costs. In addition, an exception exists for members of a cooperative. The rationale is that coops offer services, and thus can offer a price below the blend price.

related to milk components and quality. It should be noted that in the last few years, the market price for class III milk has been higher than the support price.

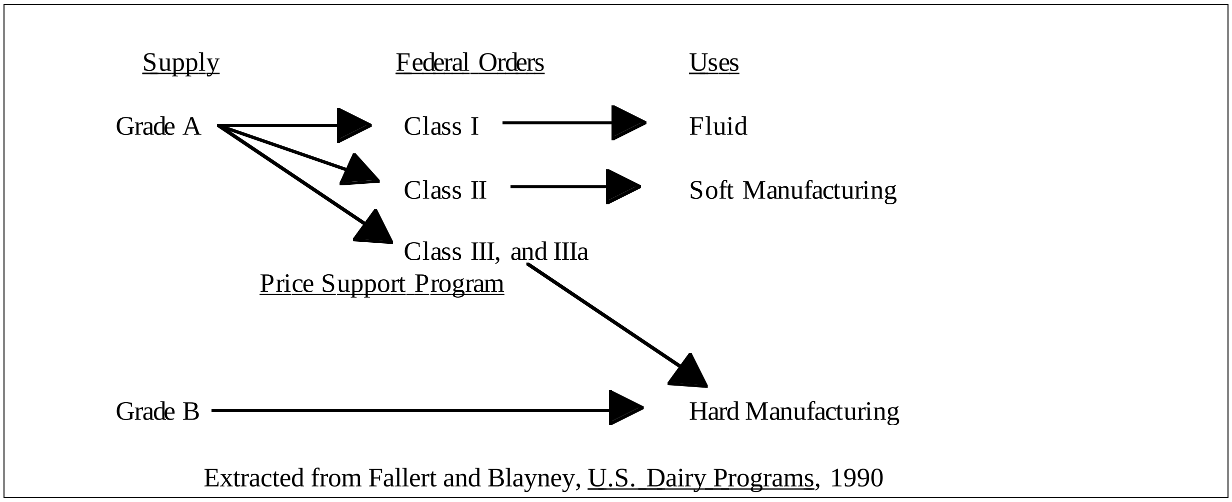

Figure 2.1 Federal Marketing Orders Categorize Milk According to Use

The regulated monthly price that a class III plant must pay is a base price, equal to the so-called Basic Formula Price (BFP) that is announced a month after the transaction month. Similarly, a class II plant would pay the BFP + 30¢ per hundredweight. The BFP employed in class II pricing is the one calculated two months prior to the current month. Finally, a class I plant would pay the two months old BFP plus its regional class I differential (Figure 2.2). Class IIIa milk refers to skim milk used to make skim milk powder. The class IIIa price is calculated by a formula largely based on a benchmark wholesale price for bulk skim milk powder.

Given that the support price has not played an important role in dairy regulation in the last few years, how would the elimination of FMMOs affect milk price?

Because more than 85% of the milk produced in the U.S. is sold through coops, even after the elimination of FMMOs it is likely that cooperative will attempt to maintain pooling or some form of price equalization across members. However, the mandatory 30¢ over class III price, and the mandatory class I price differential would not exist anymore, and it is far from clear whether cooperatives would be able to maintain price differentials in these markets. These new conditions are likely to affect milk prices and the distribution of market surplus between sellers and buyers of raw milk.

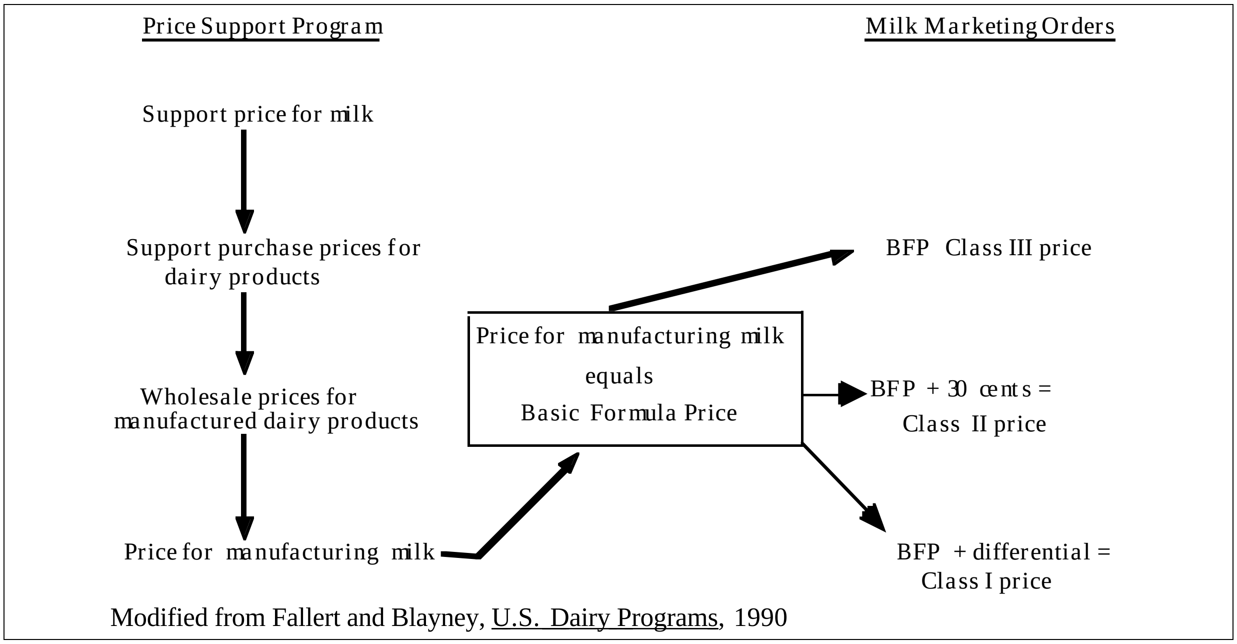

Figure 2.2 The Basic Formula Price Links the Price Support Program and Marketing Orders

2.2 Literature Review

A short review of literature shows that even though the U.S. dairy sector has been extensively studied, no study that looks directly at the impact of deregulation on the market price of milk and on the market surplus distribution between plants and farmers was found. Most related studies have taken a look at the cost of regulation, at the possible structure of an unregulated market, or at cases of sellers market power within the regulatory environment.

The Food and Agricultural Policy Research Institute (FAPRI) estimated the impact of the elimination of all dairy programs on the dairy sector. Their model comprises over 70 behavioral equations and identities plus an additional 100 equations that provide regional dairy cost of production estimates. However, price surfaces that would exist without FMMO and that are necessary to conduct their analysis came from a panel of dairy experts. According to FAPRI, their analysis is extremely sensitive to the exogenous milk prices needed for their analysis. *"These assumptions are extremely important in setting the stage for the subsequent analysis. If a different set of differentials were assumed to exist, the regional differences that show up under this run would be different"* (FAPRI, April 1995). The expert panel believed price differentials would decline, consequently FAPRI results show a significant decrease of milk price at the farm, a lower level of production and a sharp decrease in the number of dairy cows.

MacAvoy (1977) reports the result of a study made by the Department of Justice Antitrust Division staff on a phased deregulation of milk marketing. A computer simulation of dairy deregulation resulted in a price decrease (3%) of farm milk used for fluid and a price increase (5%) of farm milk used for manufacture. However, the study assumes a perfectly competitive deregulated market for raw milk.

Ippolito and Masson (1978) estimated the costs and efficiencies of dairy regulation using a price equilibrium model. According to their study, dairy regulations create many inefficiencies and are rather costly. The study did not clearly estimate the benefits of regulation. Moreover, they implicitly assume that unregulated markets are perfect; hence a regulated market by definition must be sub-optimal.

Suzuki *et al.,* (1993) built an econometric model of imperfect competition which, according to the authors, better estimated the effects of deregulation than the models of perfect competition economists traditionally use. However, this study did not assess the level of competitiveness between farmers and buyers. Instead, the demonstration, through comparison of alternative models, has been made that a state of perfect competition will not exist in an unregulated market.

From the literature it seems that dairy economists agree on the fact that the current structure of the U.S. dairy market is not perfectly competitive. However, disagreements on the source or type of imperfect competition have been observed. According to Masson and DeBrock (1980) "*The milk industry ... is far from competitive ... due in part to locational factors and in part to a vast network of federal and state governmental regulations and control* ." From this citation it can be inferred that regulations move the dairy industry away from perfect competition. However, in testimony on federal dairy policy Novakovic (1995) wrote "*Farm level milk markets are not models of perfect competition. They are inherently oligopsonistic in nature, meaning buyers generally have the ability to dictate price.*" If an unregulated dairy market is oligopsonistic, it can be inferred that regulation tries to correct market imperfection inherent to the sector. On the other hand, if an unregulated market behaves close to the model of pure competition, regulation then only creates market distortions to the detriment of buyers.

A laboratory experiment allows for the collection of data in a controlled environment. Thus, the use of exogenous and subjective data into models is avoided. The effects of interrelated variables and confounding extraneous factors that plague econometric analyses are also reduced to a minimum. Given the long history of regulation and the numerous structural shocks that characterized the dairy sector, experimental economics appears to be appropriate to study the impact of deregulation on farm price, on the volume of raw milk supplied, on the distribution of market surplus between dairy farmers and dairy processing plants, and on market price efficiency.

2.3 Theory and Hypotheses

In this sub-section, general theoretical concepts are briefly reviewed. Then, based on these concepts a simple dairy market model is developed, followed by a description of the hypotheses that were tested in the experiment.

2.3.1 Theory

The model of pure competition is defined by the following four characteristics (Millman, 1996):

1- Many firms and many consumers;
2- No single firm is big enough to affect price;
3- Standardized product;
4- Easy entry and exit of firms.

The model of pure competition is important not because it describes much of the real world, but because it is a normative model of efficiency and equity. Agricultural markets are often cited in textbooks as being near to pure competition.

The market for raw milk is not likely to be one of pure competition. First, the condition of many sellers (dairy farmers) and many buyers (dairy processing plants) is violated. In the U.S. there are roughly 100 dairy farms for each processing dairy plant, and this ratio has generally increased over time. Even when coops are taken into account, the number of sellers still far outweighs the number of plants at the national level[2]. This is all the more true when one recognizes that many plants have the same owners. Another point that affects the market for raw milk and that is not explicitly stated in the conditions of pure competition is the high degree of perishability of raw milk. Because a firm faces a total loss if units produced are not sold or consumed in a given period of time, that firm is more at the mercy of buyers than a firm that could store its output, at little cost, and offer it at a more opportune time.

Thus, perishability and the oligopsonistic characteristic of the raw milk market probably give dairy processors a certain degree of market power. Market power is broadly defined as the ability to influence the price of a product or a resource. In game theory terms, equilibrium market power exists if there is a non-cooperative equilibrium that results in supra-competitive price.

2.3.2 Dairy Market Model

In a simplified way, the U.S. dairy market contains two types of demand for raw milk. A demand for raw milk used in the processing of milk beverage and cream (herein called Type I demand), and a demand for raw milk used in the processing of manufactured dairy products such as cheese, ice cream, yogurt, butter and powder (Type II). Type I demand is presumed relatively inelastic, while Type II demand is less inelastic than Type I demand. The “type” categorization used for this research obviously relates to the classes used in federal orders. It has been taken for granted in dairy markets that consumer demand for beverage milk (class I) is more inelastic than the demand for manufactured products (classe II, III, and IIIa), and numerous studies suggest this (Ippolito and Masson, 1978). Moreover, price discrimination in federal orders would fail to enhance producer prices if this were not true. The difference in elasticity is mostly explained by the different degree of perishability of the two product categories. Contrary to manufactured dairy products, milk beverages have to be consumed within a few days after their exit from the plant. Therefore, milk beverage processing plants have a more inelastic demand for raw milk than manufactured dairy product plants. The supply curve for raw milk is inelastic. This inelasticity stems from the fixed asset structure of dairy farms, and the high degree of perishability of raw milk. In a situation of pure or perfect competition, the summation of Type I demand (DI) and Type II demand (DII) would make up the total demand (Dt) (Figure 2.3). It is the intersection of the supply curve (S) and the total demand curve that will result in the perfectly competitive equilibrium price (P*) and quantity (Qt*), assuming no additional, confounding transaction costs (Figure 2.3). Although, the model of pure competition might not be perfectly appropriate to describe the raw milk market, it is nevertheless an important benchmark in terms of price, quantity, and price efficiency.

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[2] Although concentration of producer cooperatives at the national level is not extremely high, concentration in some local markets is.

FMMOs affect the market of raw milk by price discriminating between Type I and Type II demand. Type I buyers are asked to pay a higher price for raw milk than Type II buyers. A pooled price is returned to all the farmers in the following way:

$$P' = \frac{PIQ_1 + PIIQ_2}{Q_1 + Q_2}$$

where P' is the pooled price. PI and PII are Type I and Type II buyer's price, respectively. Q_1 and Q_2 are the quantities of raw milk sold at the Type I price and Type II price, respectively.

It can be observed from Figure 2.3 that classified pricing creates a new demand curve (average revenue) Dp. Dp is at the right of the total demand curve of the model of pure competition (Dt) as long as DI is more inelastic than DII. The effect is a higher equilibrium price P'>P* and a larger equilibrium quantity Qt'>Qt*. The difference between PI and PII is called the differential (DF). The major role of the orders is to ensure that the differential is respected by the plants.

By their price discrimination scheme, FMMOs are subsidizing the Type II buyers to the detriment of the Type I buyers. In the process, a larger share of the perfectly competitive total surplus is transferred to sellers. Thus, if one believe that the unregulated raw milk market is close to the model of pure competition, regulation then acts as a device that transfers wealth from the buyers to the sellers without any economic justification. In a sense, it confers monopoly power to the seller. On the other hand, if one believes that buyers have a sufficient degree of market power to permit oligopsonistic behavior, then regulation could be seen as a corrective device that ensures that sellers and buyers get a surplus share more consistent with pure competition.

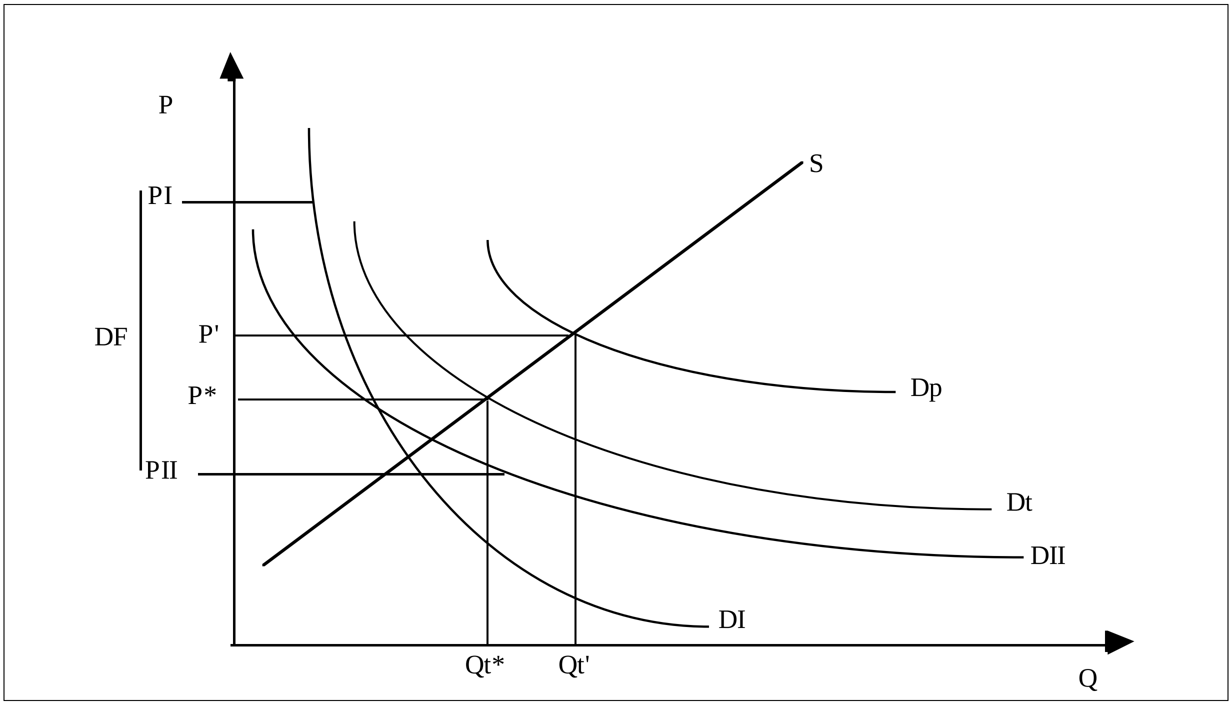


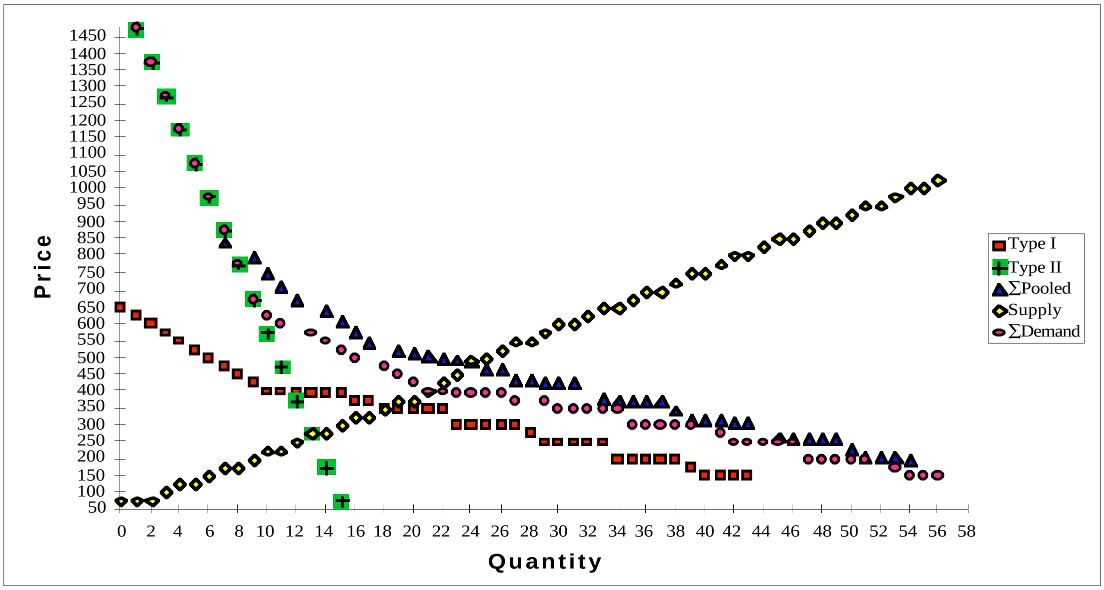
Figure 2.3 Illustration of the Regulated Market for Raw Milk

In order to shed some light on the effect of regulation on the surplus allocation between sellers and buyers, two demand curves and a supply curve were constructed for the purpose of the experiment (Figure 2.4). Following the methodology used in many experiments, discrete curves were used.

In the experiments, the same industry supply and demand curves are kept constant. The supply curve is allocated among sellers in a way such that each seller has a similar marginal cost curve. The Type I (less inelastic) and Type II (inelastic) demand curves are similarly allocated between Type I and Type II buyers[3]. In the model of pure competition the summation of the two demand curves would result in the industry demand curve (∑Demand). The industry demand and supply curves intersect at a price of 400 francs and at 21 units[4].

In the regulated environment, the use of a differential of 266 francs results in a regulated demand curve (∑Pooled). The supply curve intersects the regulated demand curve at a price of 495 francs and at 24 units.

To assess the impact of the treatment variables (regulation and oligopsony), the model of pure competition is often used as a benchmark. Although the model of pure competition does not make any distinction between storable and perishable goods, previous studies such as Mestelman, and Welland (1988 and 1990) show evidence that market price efficiency and the distribution of surplus among sellers and buyers is affected by the presence of perishability. In general, these results suggest that sellers are disadvantaged when perishability exists. Note that perishability is present and constant across all treatments of the experiment. This is expected to impact the outcomes, but it is not specifically measured as a treatment.



TType I: Demand for low value buyers | Type II: Demand for high value buyers
∑Demand: Total demand without regulation | Supply: Supply curve
∑Pooled: Total demand with presence of regulation

Figure 2.4 Experiment's Supply and Demand Step Functions

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3 Note that Type I buyers in the experiment represent Type II buyers in the FMMOs, and vice versa. The change was made at the request of subjects in experimental pretests.

4 In the experiment, "francs" are used to denote the players' currency.

2.3.3 Hypotheses

From Figure 2.3 it can be seen that regulation shifts the total demand curve to the right (from Dt to Dp). In theory, relative to the perfectly competitive equilibrium, this shift results in higher market price, more unit traded, and a larger share of market surplus for sellers. That leads to the following hypotheses.

H1a: Regulation increases market prices.

H1b: Regulation increases the quantity traded.

H1c: Regulation increases the percentage of the competitive sellers' surplus captured by sellers.

According to economic theory, the presence of oligopsony decreases market prices, the number of units traded, and the percentage of sellers' surplus captured by sellers, all relative to the model of pure competition.

H2a: A reduction in the number of buyers decreases market price

H2b: A reduction in the number of buyers decreases the quantity traded

H2c: A reduction in the number of buyers decreases the percentage of the competitive sellers' surplus captured by sellers

Using the theoretical prediction behind the previous two sets of hypothesis, we see that the oligopsony and the regulation treatments are hypothesized to be diametrically opposed. Does the combination of these two treatments partially cancel each other? In order to shed some light on the more specific question; "Can regulation mitigate the market imperfection of the dairy market?" (assuming the existence of an oligopsonistic market), the following hypotheses are tested.

H3a: Oligopsony has less effect on market prices with the presence of regulation than without regulation.

H3b: Oligopsony has less effect on the percentage of competitive sellers' surplus captured by sellers with the presence of regulation than without regulation.

Economists, in general, believe that most forms of regulation are a hindrance to efficiency (e.g., Ippolito and Masson, 1978). The model of pure competition is, in theory, perfectly efficient. Efficiency will then be measured as the total surplus captured over the total surplus available in the model of pure competition. This leads to a fourth testable hypothesis:

H4: Regulation reduces the overall price efficiency of the market.

One argument often used by dairy regulators to justify their existence is that regulation decreases price variability. "Federal milk orders ... facilitates orderly marketing. Orders …

correct conditions of price instability and needless fluctuations in price." (USDA, 1989). This hypothesis will be tested using the price variance and a measure of price deviation.

H5: Regulation increases market price stability.

III. THE EXPERIMENT

To test the hypotheses previously formulated, an experiment was designed. The experiment allows for variation in the number of buyers (oligopsony) and for the presence or absence of regulation. In this section the nature of the experiment is described, as well as the specific feature of the markets. A discussion of how the experimental design improves the power of the experiment, and minimize the chances that "nuisance variables" might interfere with the interpretation of the results concludes this section.

As a preliminary, the following definitions should be noted. A <u>cohort</u> is a group of ten or seven subjects who participated in the same trading sessions. A <u>period</u> amounts to one trading decision by each player and to the outcome of these decisions. A <u>session</u> is a 50 to 90 minute interval of trading activity and is made up of 12 trading periods plus a practice trading period. The combination of all the sessions makes up the <u>experiment</u>.

3.1 Trader Types

In order to simulate the market for raw milk, subjects in each cohort are randomly assigned to one of the following roles: seller, Type I buyer, or Type II buyer.

Sellers make advance production decisions in each period, and receive the average market price. There is no carry-over for units produced. Thus, if a unit has been produced but is not sold, that unit is lost and the seller still incurs the production cost. This represents the perishability effect inherent to the raw milk market.

Type I buyers are low-value buyers and face an inelastic demand curve. These buyers simulate the manufactured or class III buyers in the market for raw milk. Finally, Type II buyers are high-value buyers and have the means to outbid the Type I buyers at any time. Type II buyers face a highly inelastic demand curve. They are the representation of fluid milk or class I buyers in the market for raw milk.

Buyers (Type I and Type II) have to make a quantity and a bid decision in each period. All the units bought in a single period by a single buyer have to be bought at her bid price.

3.2 Trading Rules

With Regulation

In this simulated market two levels of price classification exist, which is a simplification from the current market for raw milk. Having two levels of price classification instead of three or even four does not alter the results because it maintains the principle of price discrimination between different demand elasticity, which is the core of regulation.

In the regulated market sellers have first to make a production decision based on their own price expectation. Then each Type I buyer (low-value) makes a bid and a quantity decision. A minimum bid for Type II buyers is then computed. The minimum bid is the weighted average of the previous period realized transaction for low-value buyers, plus a constant[5].

The constant represents the class I differential and was chosen to be at 266 francs (an experimental currency) for the experiment[6]. A differential of 266 francs allows for a significant spread in price between treatments, and is within the industry historical range of differential relative to the predicted price.

Type II buyers must then bid at a price greater or equal to the announced minimum bid price. Using a computer program the monitor then makes the allocation for the units that have been produced. Three scenarios can occur: 1- supply equals demand; 2- excess demand; 3- excess supply.

In the first scenario, sellers sell all their production and buyers get all the units asked for at their respective bid. The second scenario implies that sellers sell all their production but that not all buyers get the number of units that they ask for. The allocation is made by the monitor on a highest bid basis. Therefore the buyers with the lowest bid get only a part of the units asked (residual supply), or no unit at all. In the third scenario buyers get all the units that they ask for, but some sellers do not sell all their production. Sellers are randomly chosen to decide who starts selling first. However, to avoid that the random effect plays an important role in the decision process of sellers, sellers sell one unit at the time. This means that the first seller picked sells her first unit first, then the first unit of the second seller picked is allocated, and so on. Then we move to the second unit for the first seller picked, and the process continues until total demand is fulfilled. Sellers who did not sell all their units still incur the cost of producing these units.

The monitor then announces the results of the allocation as well as the final weighted price for the sellers. The final weighted price is the summation of the quantity bought by each buyer multiplied by their bid and divided by the total unit bought in the period. Subjects then enter the information that concerns their decision on their computer and get their net earnings for the period. All sellers get the same price, while buyers pay their individual bid. The trade sequence, although a simplification, contains the major traits of FMMOs.

To reflect the regulatory process, after each period, prices, the bid and quantity decisions of each buyer, the production decision of each seller, as well as the allocation process are displayed on the board, and made common knowledge. However, players know only their own cost or their own value structure. The role of each subject (seller, low-value buyer, high-value buyer) is also common knowledge.

Subjects are also told at the beginning of each experiment that the monitor has the right to refuse a bid if the bid is considered too low. In order to avoid anchoring problems, the floor bid is not divulged to the players. If a bid is too low, the bidder will be asked privately to resubmit a bid, and not to bid below 200 francs. This could be seen as corresponding to the

[5] For the first period the minimum bid is computed using realized transaction of Type I buyers in the practice period.

[6] The use of an experimental currency allows to scale the experiment as needed, while always using round numbers for trading. Francs are converted to U.S $ at the end of each session.

price support level, although 200 francs is an extremely low price (only half of the predicted equilibrium price in pure competition).

Without Regulation

Without regulation the trading rules are the same with the exception that the differential is then 0 and that Type II buyers have no minimum bid constraint. Thus, Type I and Type II buyers bid at the same time and compete directly against one another. Sellers still get a weighted price and buyers pay their bid. The way units are allocated is also the same.

3.3 Subjects and Incentives

Subjects were undergraduate students at the University of Arizona, Tucson. Each subject was part of a cohort and participated in two sessions over two days. A subject could not be in two different cohorts. Subjects in the experiment made different amounts of money based on their market performance, their incentive is therefore to earn the most money they can.

Sellers made money by selling units at a price that was higher than the cost of each unit. Individual low-cost units had to be sold before high-cost ones, thus each seller faced increasing marginal cost (MC). Because sellers made their decision before knowing what the market price was going to be, they had to anticipate the future price based on the history of the game. Sellers should produce where MC = expected price.

Buyers made money by buying units at a price below the value of each unit. Individual high-value units had to be bought before the low-value ones, thus buyers faced decreasing marginal value (MV). Buyers made one bid for all the units that they wanted to buy, therefore buyers should buy at MV = bid.

Each type of player was expected to make an average between $25 and $35 including show-up fees for the two-day experiments (total duration two to 2.5 hours). To convert the francs, the experimental currency used, into U.S. dollars the following exchange rates were used.

	No-oligopsony		Oligopsony	
	Regulation	No-regulation	Regulation	No-regulation
Seller	F * 0.00075	F * 0.00075	F * 0.001	F * 0.001
Buyer I	F * 0.0020	F * 0.0020	F * 0.0009	F * 0.0009
Buyer II	F * 0.00045	F * 0.00045	F * 0.00015	F * 0.00015

Because the role that a subject played could greatly affect her earnings in francs, different exchange rates were allocated for each role. This way, equity relative to potential earnings in U.S. dollars was reestablished between subjects. The same reason explains the differences in exchange rate between the oligopsony and the no-oligopsony sessions. Participants knew their own exchange rate before the start of the game, and were told orally about the equity factor of exchange rates.

3.4 Experimental Design Issues

To conduct the experiment, six groups of ten subjects and six groups of seven subjects were recruited. The groups of ten subjects were assigned to cohorts seven to twelve (C7 to C12), while the groups of seven subjects were assigned to cohorts one to six (C1 to C6). As shown in Figure 3.1, each cohort is assigned to two sessions (over a two-day period), and the two sessions differed in treatment. Moreover, the order in which different cohorts traded was reversed. So, half of the cohort started with one treatment while the other half started with the other treatment.

		OLIGOPSONY YES	OLIGOPSONY NO
REGULATION YES	session I	C11 C21 C31	C71 C81 C91
	session II	C42 C52 C62	C102 C112 C122
REGULATION NO	session I	C41 C51 C61	C101 C111 C121
	session II	C12 C22 C32	C72 C82 C92

Figure 3.1 Experimental Design

Figure 3.2 shows how treatments differ. The oligopsony treatment results from a reduction in the total number of buyers (from six to three). Thus experiments with oligopsony needed only seven subjects instead of the ten subjects. For the regulation treatment the differential (DF) goes from 0 to 266 and Type II buyers are constrained by a minimum bid.

The experimental design (Figure 3.1) serves several purposes. First it controls for differences across cohorts. It is known that different subjects in laboratory markets possess different levels of intelligence, motivation and familiarity with the experimental environment (Kagel and Roth (1995), Davis and Holt (1992)). Such differences can make it more difficult to draw inferences about the effect of a treatment variable if one cohort of subject trades in one setting and another group trades in another setting. In such a case, the treatment might actually reflect differences in the cohorts' skill or motivation, more observation would then be required to isolate the treatment effect. The best way to avoid this problem is to have all subjects trade in every cell of the design. However, in this particular design it would have been difficult to have people come back for four days (instead of two). As an added problem the number of subjects was not perfectly balanced between treatments. The second best solution was to have subjects participate in half of the cells of the design. For example, cohort 1 participates in the oligopsony-regulation cell first (C11), then in the oligopsony-no regulation cell (C12) (Figure 3.1). The number of sessions in each cell was also increased to compensate for the not perfectly repeated design.

		Oligopsony					
		YES			NO		
		# seller	# buyer I	# buyer II	# seller	# buyer I	# buyer II
Regulation	YES DF = 266	4	2	1	4	3	3
	NO DF = 0	4	2	1	4	3	3

DF: Price differential

Figure 3.2 Treatments Design

The design also controls for the order effects. Because laboratory markets are complex, even a single cohort may behave differently in later repetitions of the task than in early repetitions (Forsythe and Lundholm (1990)). This effect is controlled by varying the order in which different cohorts trade. For example, cohorts 1 to 3 trade in the oligopsony-regulation cell, then in the oligopsony-no regulation cell. In contrast, cohorts 4 to 6 trade first in the oligopsony-no regulation cell then in the oligopsony-regulation cell.

IV. EXPERIMENTAL RESULTS

4.1 The Effect of Regulation and Oligopsony on Price and Quantity Traded

By the nature of the market simulated, only one price--the weighted price--is generated in each period of the experiment. The analysis will also concentrate on the total quantity traded.

Panel A of Table 4.1 shows that regulation increases the average market price, which is consistent with H1A. The panel also shows that oligopsony or the reduction in the number of buyers has no effect on price in a regulated world. On the other hand, oligopsony decreases market price in the absence of regulation. This is consistent with H2a and H3a.

To assess the statistical significance of these effects, the dependence of the data must first be addressed. Each period in the experiment gives us one data point for each variable of interest. The 24 sessions that composed the experiment are made of 12 periods, excluding a practice period. This yielded 288 observations for each dependent variable. In order to reduce the impact of the learning effects, only the last six periods of each session were kept[7]. Thus, 144 observations were left.

The 144 observations of the dependent variables are not independent because each subject is assigned to a cohort, which trades in two sessions. This dependance is accounted for by using a "repeated-measures" ANOVA to assess the effects of the experiment treatments. For the purpose of the statistical analysis, a period is considered a repeated treatment, as well as regulation (as defined earlier). Oligopsony is not a repeated-measure in the experiment. A repeated-measures ANOVA compares the explanatory power of each repeated variable to the explanatory power of that variable's interaction with the "cohort" variable. For example, as shown in Panel B of Table 4.1, regulation accounts for a mean sum of squares of 194,628. In contrast, the regulation x cohort interaction explains a sum of squares of only 3,127 (per degree of freedom). Thus, the effect of regulation is robust across cohorts, and therefore is significant at the 0.0001 level. The effect of oligopsony and the regulation x oligopsony interaction are also statistically significant at the 0.0315 and 0.068 levels (one-tail test)[8].

The repeated-measures ANOVA allows for the determination of the degree of statistical significance for the treatment variables, and to look at the different interaction between those variables. However, a contrast analysis is needed to assess the degree of statistical significance between one pair of treatments and another. To perform the contrast analysis, we use two repeated-measures ANOVA wherein each run keeps one of the treatment variables constant at a time. For example, Panel C of Table 4.1 shows that in the absence of oligopsony, the increase in price that results from regulation is significant at the 0.0018 level. Regulation also significantly increases price in the presence of oligopsony. On the other hand, the same panel shows that in a regulated world, a reduction in the number of buyers has no significant impact on price, but has a significant impact in the absence of regulation.

Next, the effects on the quantity of units traded are examined. Panel A of Table 4.2 indicates that regulation increases the number of units traded, as expected from the mathematical model and in accordance with H1b. It also appears that the presence of oligopsony slightly reduces quantity traded, even more so with regulation. According to theory, oligopsony would have the effect of reducing the number of units traded.

Panels B and C of Table 4.2 show that the effects of regulation on quantity traded are statistically significant. In contrast, oligopsony has no statistically significant effect on the number of units traded, which does not support H2b. However, we can see that the results are going in the direction predicted by theory, but we can not say with great certainty (due to low statistical significance) that the decrease in quantity is due to a reduction in the number of buyers.

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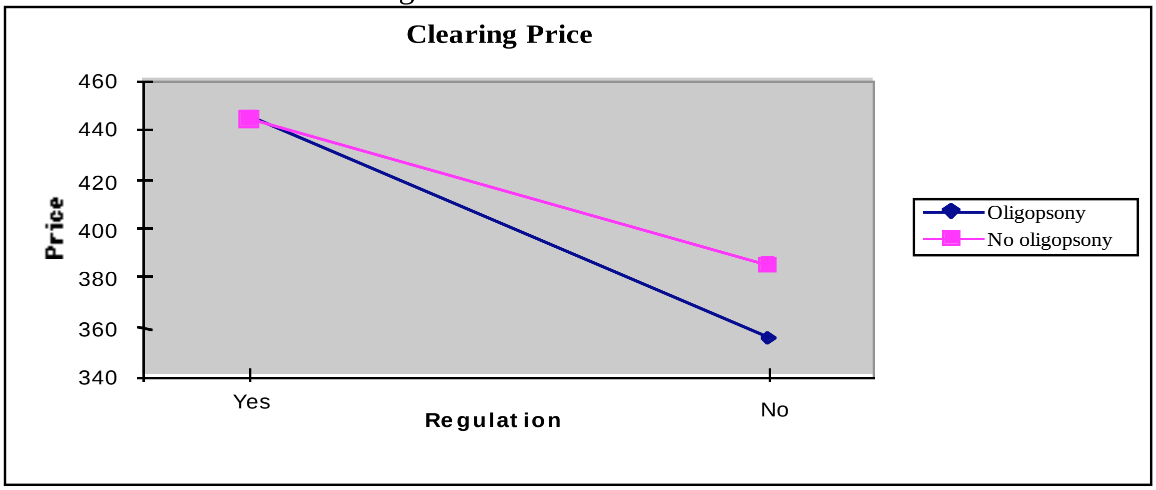
[7] The statistical analysis shows the presence of a "period" or learning effect when all the periods are used. This effect mostly disappeared when the last six periods are used. However, this change does not affect the direction of the results, but statistical significance is improved.

[8] Unless specified otherwise, all statistical tests are two-tailed test. In this case a one-tail test is appropriate because the results are conformed to the hypotheses.

Table 4.1 The Effect of Regulation and Oligopsony on Market Clearing Price

Panel A displays the effect of regulation on market clearing price in oligopsony and no-oligopsony settings. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of Market Clearing Price



Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	7511	7511	4.37	0.0631
Cohort	10	17189	1719		
Regulation	1	194628	194628	62.25	0.0001
Oligopsony*Regulation	1	8220	8220	2.63	0.1360
Regulation*Cohort	10	31265	3127		
Period	5	2954	591	1.02	0.4162
Oligopsony*Period	5	2659	532	0.92	0.4773
Period*Cohort	50	28969	579		
Regulation*Period	5	2506	501	0.45	0.8103
Regulation*Oligopsony*Period	5	7548	1510		
Regulation*Period*Cohort	50	55526	1111		
	143	358975			

Table 4.1 (Continued)

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	36.37	0.0018
Effect of regulation with oligopsony	30.99	0.0026
Effect of oligopsony with regulation	0.00	0.9479
Effect of oligopsony without regulation	5.14	0.0468

Table 4.2 The Effect of Regulation and Oligopsony on Quantity Traded

Panel A displays the effect of regulation on quantity traded in oligopsony and no-oligopsony settings. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of Quantity Traded

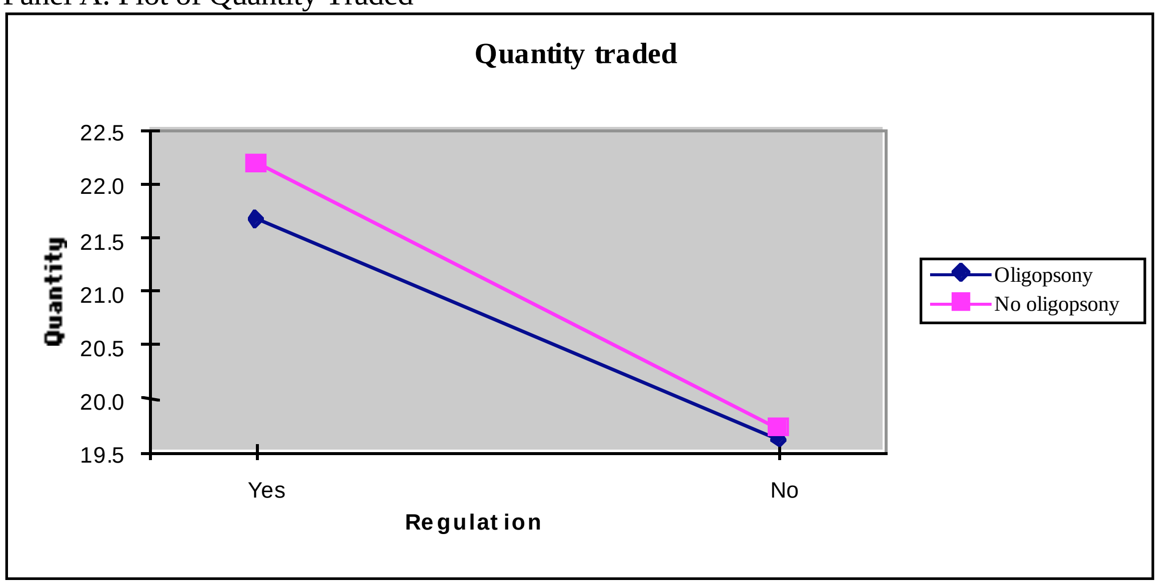


Table 4.2 (Continued)

Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	3.67	3.67	1.96	0.1917
Cohort	10	18.74	1.874		
Regulation	1	184.51	184.51	21.49	0.0009
Oligopsony*Regulation	1	1.56	1.56	0.18	0.6787
Regulation*Cohort	10	85.85	8.585		
Period	5	30.7	6.14	1.72	0.1462
Oligopsony*Period	5	13.53	2.706	0.76	0.5827
Period*Cohort	50	178.01	3.5602		
Regulation*Period	5	24.37	4.874	0.95	0.4544
Regulation*Oligopsony*Period	5	6.98	1.396		
Regulation*Period*Cohort	50	255.24	5.1048		
	143	803.16			

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	13.67	0.0140
Effect of regulation with oligopsony	8.34	0.0343
Effect of oligopsony with regulation	1.22	0.2955
Effect of oligopsony without regulation	0.04	0.8553

4.2 The Effect of Regulation and Oligopsony on Market Price Efficiency and on Surplus Distribution

Market surplus is the summation of the sellers' surplus and the buyers' surplus. The sellers' surplus is the area that is above the supply curve and below the equilibrium price, while the buyers' surplus is the area that is below the demand curve and above the equilibrium price. Price efficiency is defined, for the purpose of the study, as the surplus extracted by the trading agents divided by the maximum possible surplus. The maximum possible surplus extracted is computed using the model of pure competition (Figure 2.4). A measure of market price efficiency is computed for each period.

An important measure of surplus distribution is the percentage of the competitive sellers' surplus captured by sellers (sSurplus%), and the percentage of the competitive buyers' surplus captured by buyers (bSurplus%). However, these measures are not appropriate to make comparisons across sessions because of their correlation with price efficiency. For example, if the level of price efficiency rises in a given period, the sSurplus% and bSurplus% will also increase. In order to eliminate the variation of sSurplus% and bSurplus% due to variation in the level of price efficiency, sSurplus% and bSurplus% are divided by their respective level of price efficiency. The variables obtained are Net Seller Welfare = Surplus%/price efficiency and Net Buyer Welfare = bSurplus%/price efficiency.

It can be seen from Panel A of Table 4.3 that regulation seems to increase market price efficiency, especially with the presence of oligopsony. Oligopsony also appears to reduce price efficiency in the absence of regulation. However, Panel B of Table 4.3 indicates that neither oligopsony nor regulation has a statistically significant effect on market price efficiency. Although Panel A suggests that regulation in an oligopsonistic world and oligopsony in an unregulated world affect market price efficiency, the contrast analysis confirms the lack of statistically significant effects (Panel C, Table 4.3). Thus, H4 is rejected; regulation does not reduce the price efficiency of the market.

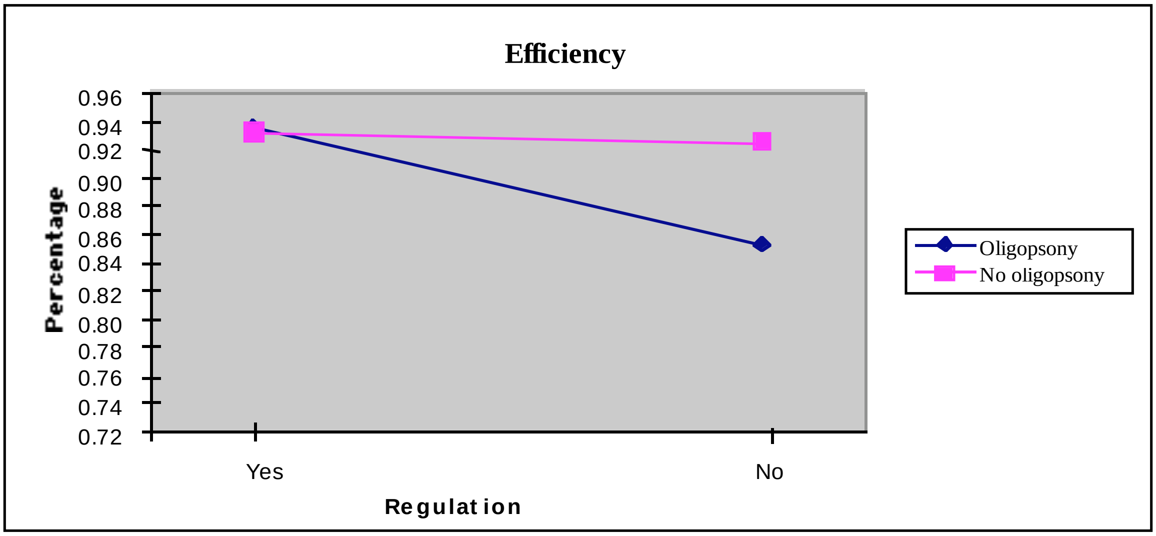
Panel A of Table 4.4 shows that regulation increases Net Seller Welfare (sWelfare), in accordance with H1c. It also shows that the presence of oligopsony reduces sWelfare (H2c) and that the reduction is stronger in the absence of regulation (H3b).

Panel B of Table 4.4 indicates that the effects of regulation and of oligopsony are significant. It also shows a period effect statistically significant at the 0.0755 level. As the session progresses sellers are able to increase sWelfare. This seems to indicate that some learning effects are still taking place for this variable. However, additional analysis suggests that the presence of statistical significance (at the 0.0755 level) reflects peculiar characteristics of the data, rather than the presence of an effect. When the analysis is done over the 12 periods of each session the period effect is rejected for sWelfare. Moreover, if the analysis is done over the last four periods of each session, the period effect is also rejected.

Table 4.3 The Effect of Regulation and Oligopsony on Market Price Efficiency

Panel A displays the effect of regulation on market price efficiency in oligopsony and no-oligopsony settings. Price efficiency is defined as the market surplus extracted by the trading agents divided by the total market surplus[9]. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of Market Price Efficiency



Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	0.0492	0.0492	1.77	0.2127
Cohort	10	0.2779	0.0278		
Regulation	1	0.0672	0.0672	2.07	0.1809
Oligopsony*Regulation	1	0.0564	0.0564	1.74	0.2166
Regulation*Cohort	10	0.3247	0.0325		
Period	5	0.0386	0.0077	0.85	0.5216
Oligopsony*Period	5	0.0157	0.0031	0.35	0.8833
Period*Cohort	50	0.4550	0.0091		
Regulation*Period	5	0.0291	0.0058	0.59	0.7094
Regulation*Oligopsony*Period	5	0.0174	0.0035		
Regulation*Period*Cohort	50	0.4954	0.0099		
	143	1.8266			

[9] Total market surplus is defined by the area that is above the supply curve and below the demand curve.

Table 4.3 (Continued)

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	0.02	0.8958
Effect of regulation with oligopsony	2.34	0.1867
Effect of oligopsony with regulation	0.05	0.8341
Effect of oligopsony without regulation	1.83	0.2055

Table 4.4 The Effect of Regulation and Oligopsony on sWelfare

Panel A displays the effect of regulation on sWelfare in oligopsony and no-oligopsony settings. sWelfare is defined as the percentage of the competitive sellers' surplus captured by sellers divided by market price efficiency. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of sWelfare

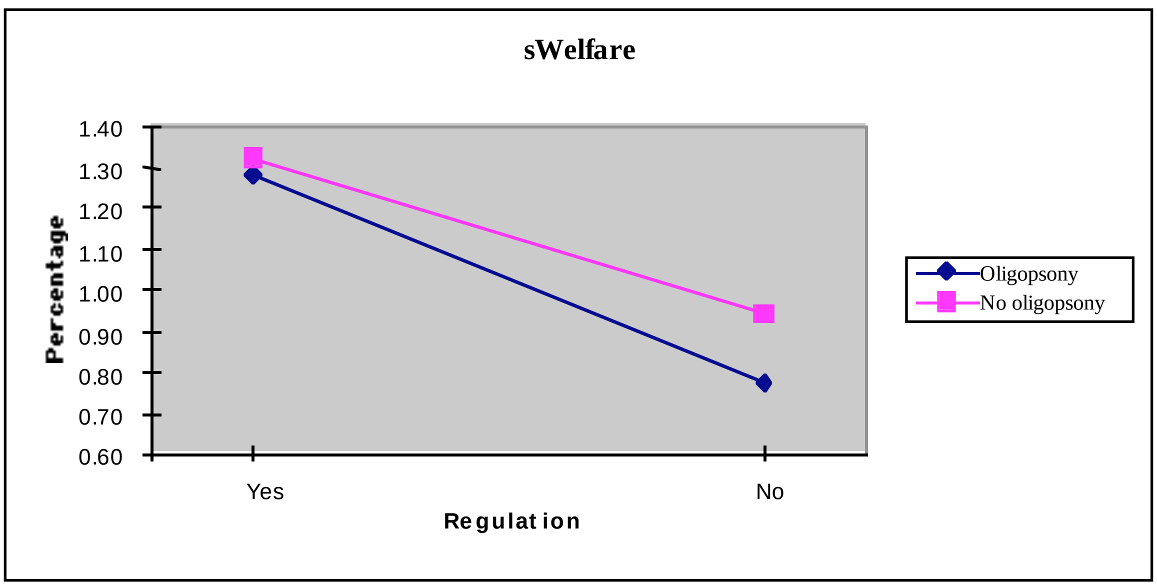


Table 4.4 (Continued)

Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	0.4304	0.4304	5.30	0.0440
Cohort	10	0.8115	0.0812		
Regulation	1	7.1253	7.1253	56.50	0.0001
Oligopsony*Regulation	1	0.1451	0.1451	1.15	0.3086
Regulation*Cohort	10	1.2611	0.1261		
Period	5	0.5425	0.1085	2.14	0.0755
Oligopsony*Period	5	0.2434	0.0487	0.96	0.4505
Period*Cohort	50	2.5323	0.0506		
Regulation*Period	5	0.1436	0.0287	0.30	0.9099
Regulation*Oligopsony*Period	5	0.4441	0.0888		
Regulation*Period*Cohort	50	4.7697	0.0954		
	143	18.4490			

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	50.71	0.0008
Effect of regulation with oligopsony	23.19	0.0048
Effect of oligopsony with regulation	0.45	0.5154
Effect of oligopsony without regulation	4.33	0.0640

The contrast analysis (Panel C of Table 4.4) confirms that in all settings regulation significantly increases sWelfare. Further evidence that regulation mitigates the effects of oligopsony on surplus allocation is given. Thus, with regulation, a reduction in the number of buyers has no statistically significant effect. On the other hand, in the absence of regulation, a reduction in the number of buyers significantly (statistically) reduces sWelfare.

Next, we want to assess the impact of the treatment variables on Net Buyer Welfare (bWelfare). Because we respectively divided sSurplus% and bSurplus% by price efficiency to obtain sWelfare and bWelfare, a loss in sWelfare will be reflected in an equal gain in bWelfare. Thus, Panels B and C of Table 4.5 are identical to their counterpart in Table 4.4, but this time, the effect is in the opposite direction.

Panel A of Table 4.5 shows that regulation decreases bWelfare. It also shows that the presence of oligopsony increases bWelfare, according to H2c, and that the increase is stronger in the absence of regulation (H3b).

Panel B of Table 4.5 indicates that the effects of regulation and of oligopsony are significant. As for Panel B of Table 4.4 a period effect is detected at the 0.0755 level (see the previous discussion). Panel C of Table 4.5 confirms that in all settings regulation significantly decreases bWelfare. With regulation, a reduction in the number of buyers has no statistically significant effect. On the other hand, in the absence of regulation, a reduction in the number of buyers significantly (statistically) increases bWelfare.

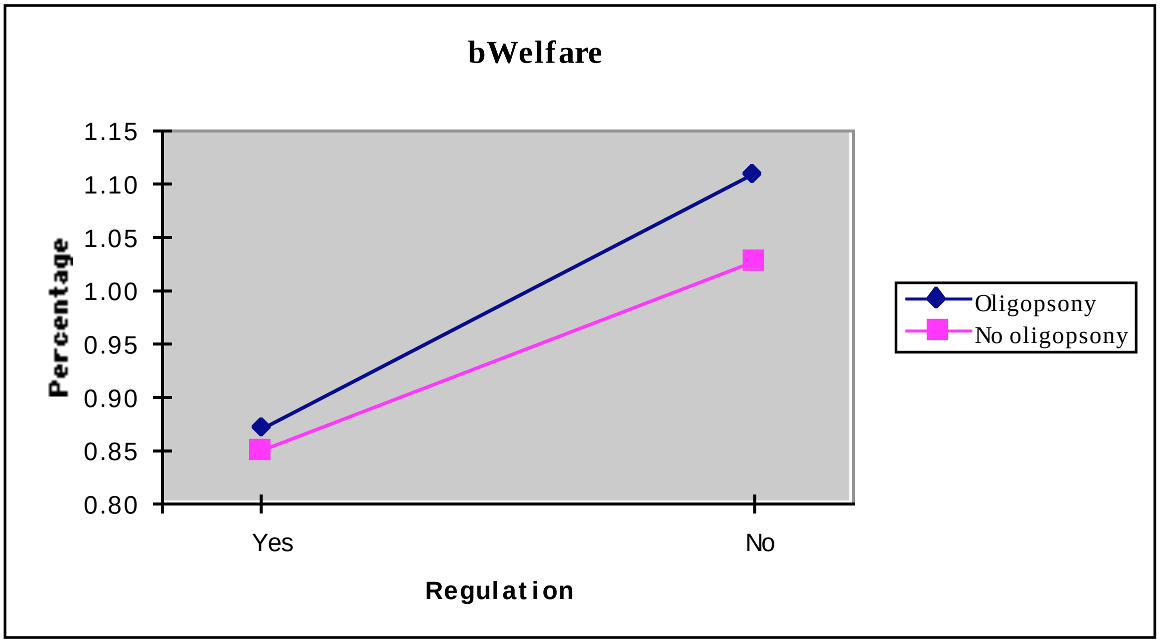
Another way to look at the impact of regulation and oligopsony on the distribution of surplus is to compare the sSurplus% and the bSurplus% in a single cell of the design. One would expect to see no statistically significant difference between sSurplus% and bSurplus% in a perfectly competitive environment. Also, to see regulation significantly (statistically) increases the difference in favor of the sSurplus%, and to see oligopsony significantly (statistically) increases the difference in favor of the bSurplus%. The average sSurplus% and bSurplus% of each session are used to run an ANOVA test.

Panel A of Table 4.6 shows that, as we expected, the combination of treatments No regulation-No oligopsony (pure competition) yields similar levels of sSurplus% and bSurplus%. Panel B of Table 4.6 confirms that the difference is not statistically significant. In comparison to the perfectly competitive treatment, Panel A of Table 4.6 shows that regulation increases sSurplus% (H3B), and slightly reduces bSurplus%. The mean difference between sSurplus% and bSurplus% is statistically significant in the presence of regulation. In contrast, from the perfectly competitive treatment a reduction in the number of buyers does not appear to change the level of bSurplus%, but does reduce the level of sSurplus%. The mean difference between sSurplus% and bSurplus% also becomes statistically significant with a reduction in the number of buyers.

Table 4.5 The Effect of Regulation and Oligopsony on bWelfare

Panel A displays the effect of regulation on bWelfare in oligopsony and no-oligopsony settings. bWelfare is defined as the percentage of the competitive buyers' surplus captured by buyers divided by market price efficiency. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of bWelfare



Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	0.0950	0.0950	5.30	0.0440
Cohort	10	0.1791	0.0179		
Regulation	1	1.5728	1.5728	56.51	0.0001
Oligopsony*Regulation	1	0.0321	0.0321	1.15	0.3083
Regulation*Cohort	10	0.2783	0.0278		
Period	5	0.1198	0.0240	2.14	0.0756
Oligopsony*Period	5	0.0537	0.0107	0.96	0.4509
Period*Cohort	50	0.5590	0.0112		
Regulation*Period	5	0.0317	0.0063	0.30	0.9099
Regulation*Oligopsony*Period	5	0.0981	0.0196		
Regulation*Period*Cohort	50	1.0527	0.0211		
	143	4.0723			

Table 4.5 (Continued)

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	50.72	0.0008
Effect of regulation with oligopsony	23.19	0.0048
Effect of oligopsony with regulation	0.45	0.5158
Effect of oligopsony without regulation	4.34	0.0639

Table 4.6 Comparison of the Percentage of The Competitive Sellers' Surplus Captured by Sellers (sSurplus%) and the Percentage of the Competitive Buyers' Surplus Captured by Buyers (bSurplus%) Within Various Combinations of Treatments

Panel A displays comparisons of the sSurplus% and the bSurplus% for each cell of the experimental design. Panel B reports the two-tailed P-values of an ANOVA that assumes that each session provides a single independent observation.

Panel A: Graph of sSurplus% and bSurplus%

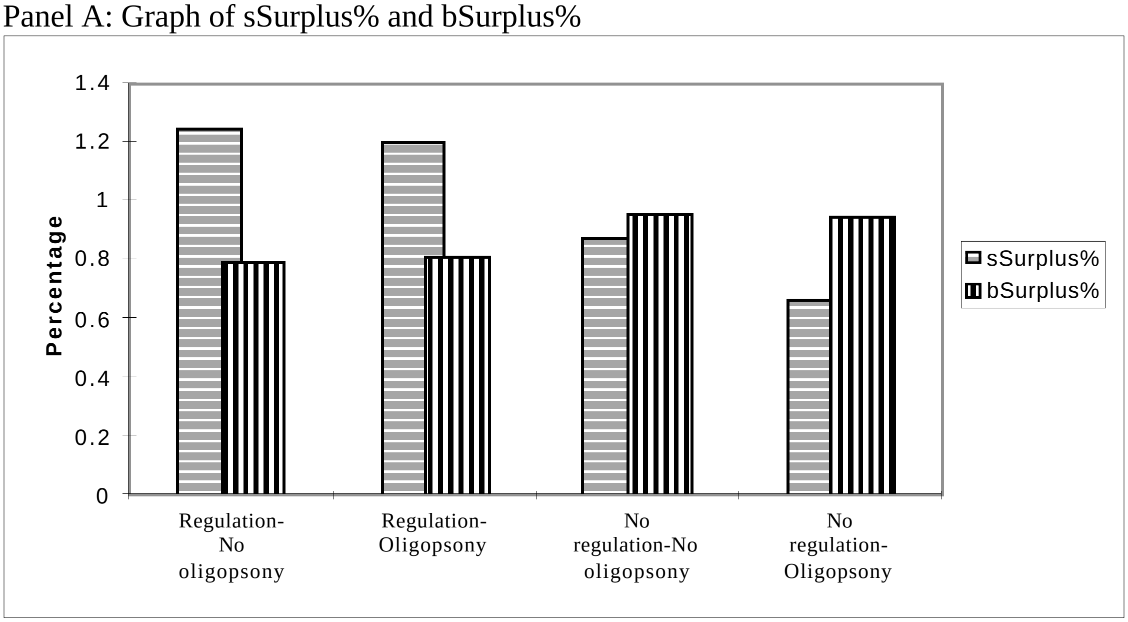


Table 4.6 (Continued)

Panel B: Statistical Results from an ANOVA

	F Value	Prob > F
Regulation-No oligopsony		
sSurplus% vs bSurplus%	120.3	0.0001
Regulation-oligopsony		
sSurplus% vs bSurplus%	36.68	0.0001
No regulation-no oligopsony		
sSurplus% vs bSurplus%	2.24	0.1653
No regulation-oligopsony		
sSurplus% vs bSurplus%	7.17	0.0232

It should be noted that the total surplus available to buyers is roughly twice the total surplus available to sellers (Figure 2.4). That explains why we can sometimes observe an important gain in sSurplus% and a small loss in bSurplus%, without any important change in the level of price efficiency.

4.3 The Effect of Regulation and Oligopsony on Market Price Stability and Deviation

Price variance is used to measure price stability. The sample price variance is a measure of dispersion relative to the mean price. One price variance per session is computed over the last six periods of each session. Thus, 24 observations are available for the statistical analysis. Panel B of Table 4.7 is the result of a Two-Way ANOVA, while Panel C displays the results of paired t-tests and simple ANOVA.

From Panel A of Table 4.7 we can see that the presence of oligopsony increases the price variance, especially in the absence of regulation. On the other hand, regulation seems to reduce price variance a great deal when the number of buyers is reduced, and to slightly increase the price variance in the absence of oligopsony.

Although Panel B of Table 4.7 indicates that the oligopsony and the regulation effects are statistically significant, one has to be careful in the interpretation of these results; because the analysis also shows a strong interaction effect between oligopsony and regulation. The contrast analysis helps to shed some light on the results. From Panel C it can be seen that in the presence of regulation, oligopsony has no statistically significant effect on price variance. However, in the absence of regulation, oligopsony significantly (statistically) increases the price variance. Once again, regulation mitigates the effect of reducing the number of buyers. Similarly, the reduction of the price variance is statistically significant in a regulated world with the presence of oligopsony, in accordance with H5. In contrast, in the absence of oligopsony, regulation significantly (at the 0.08 level) increases price variance.

Next, a coefficient of deviation to the predicted price is computed. The coefficient is computed as follow: Price deviation = $(Pm - Pp)^2$ where Pm is the market price and Pp is the predicted price. The greater the price deviation is, the further away the market price is from the theoretical prediction. The price deviation is computed for each period (excluding the practice round) of each session. For reasons enumerated earlier, only the last six periods of each session were kept for the following statistical analysis. In the regulated sessions, Pm = 495, while Pm = 400 for the unregulated ones.

Panel A of Table 4.8 shows that only in the absence of regulation and oligopsony does the market price come close to the predicted price (low price deviation). In an unregulated world, a reduction in the number of buyers increases the price deviation. The oligopsony treatment seems to have little effect in the presence of regulation. However, the price deviation level is high with regulation.

Table 4.7 The Effect of Regulation and Oligopsony on the Price Variance

Panel A displays the effect of regulation on the price variance in oligopsony and no-oligopsony settings. The price variance is computed by session. Panel B reports the two-tailed P-values of a two-way ANOVA with one repeated-measures (regulation). Panel C reports the two-tailed P-value of the contrast analysis (simple ANOVA or paired t-test).

Panel A: Plot of Price Variance

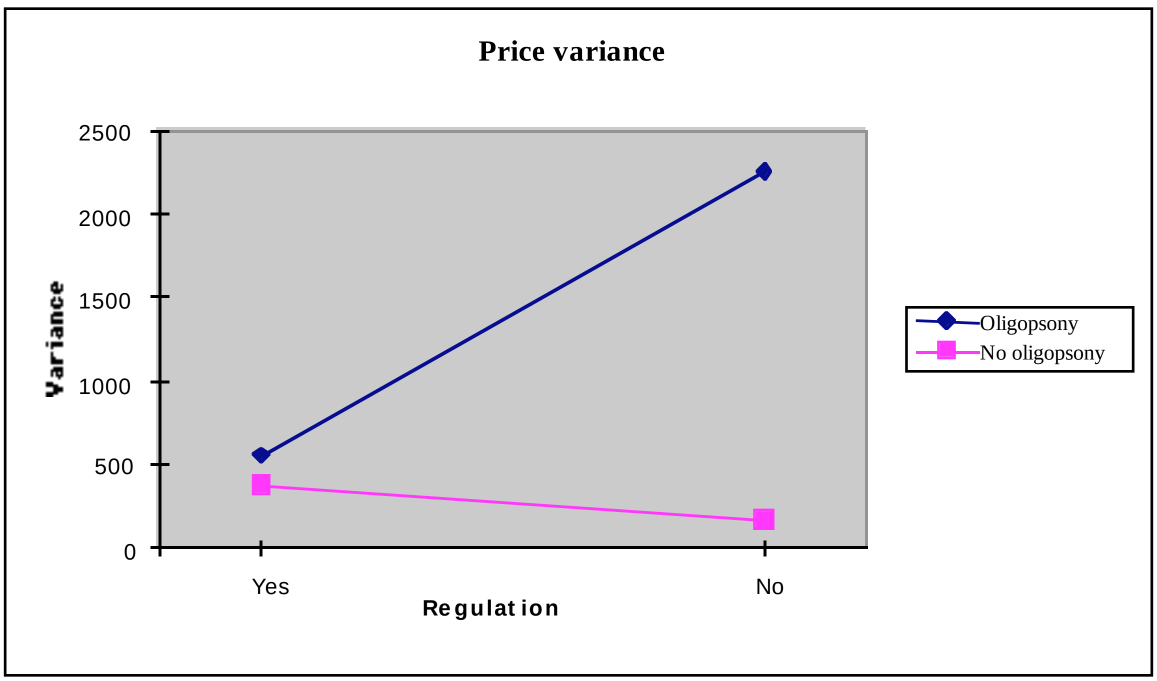


Table 4.7 (Continued)

Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	7709915	7709915	19.31	0.0013
Cohort	10	3993524	399352.4		
Regulation	1	3313482	3313482	7.90	0.0185
Oligopsony*Regulation	1	5449825	5449825	12.99	0.0048
Regulation*Cohort	10	4196359	419635.9		
	23	24663105			

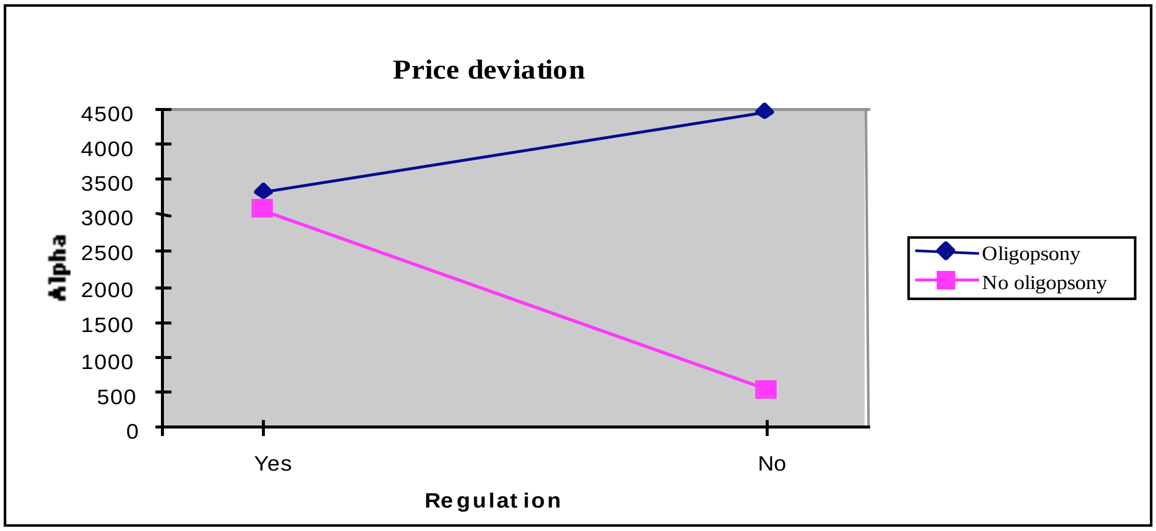
Panel C: Statistical Results from Contrast Analyses

Contrast	F or t Value	Prob > F or t
Effect of regulation without oligopsony	t = 2.18	0.0800
Effect of regulation with oligopsony	t = -3.26	0.0224
Effect of oligopsony with regulation	F = 0.79	0.3946
Effect of oligopsony without regulation	F = 18.78	0.0015

Table 4.8 The Effect of Regulation and Oligopsony on price deviation

Panel A displays the effect of regulation on price deviation in oligopsony and no-oligopsony settings. The price deviation is defined as square of the difference between the observed market price and the predicted market price. Panel B reports the two-tailed P-values of a 3-way ANOVA with repeated-measures on two factors (period and regulation). Panel C reports the two-tailed P-value of the contrast analysis (repeated-measures ANOVA with one treatment variable kept constant at the time).

Panel A: Plot of price deviation



Panel B: Statistical Results from a Repeated-Measures ANOVA

Source	DF	SS	MS	F Value	Prob > F
Oligopsony	1	159441	159441	10.43	0.0090
Cohort	10	152813	15281		
Regulation	1	17889	17889	0.54	0.4774
Oligopsony*Regulation	1	121088	121088	3.69	0.0838
Regulation*Cohort	10	328367	32837		
Period	5	38678	7736	1.58	0.1834
Oligopsony*Period	5	42487	8497	1.73	0.1442
Period*Cohort	50	245091	4902		
Regulation*Period	5	15964	3193	0.28	0.9207
Regulation*Oligopsony*Period	5	50118	10024		
Regulation*Period*Cohort	50	565781	11316		
	143	1737717			

Table 4.8 (Continued)

Panel C: Statistical Results from Contrast Analyses

Contrast	F Value	Prob > F
Effect of regulation without oligopsony	11.41	0.0197
Effect of regulation with oligopsony	0.41	0.5486
Effect of oligopsony with regulation	0.06	0.8162
Effect of oligopsony without regulation	11.17	0.0075

Panel B of Table 4.8 indicates that oligopsony increases price deviation in a statistically significant way, while regulation has no statistical significant effect. However, as for the variance, an interaction effect between regulation and oligopsony is detected. A look at the contrast analysis (Panel C, Table 4.8) demonstrates that in the absence of oligopsony, regulation significantly increases price deviation. However, with the presence of oligopsony, regulation has no statistically significant effect on price deviation. Similarly, in a regulated world, the presence or absence of oligopsony has no significant effect on price deviation. However, in an unregulated environment price deviation significantly increases when the number of sellers is reduced.

It appears that, in general, market prices do not converge to the theoretically predicted price. Our experimental representation of the model of pure competition is the exception, although we still on average have a difference of more than 20 francs with the predicted price. This raises two questions, are the prices converging to a different price than the predicted one, and are those prices higher or lower than the theoretical prediction.

A first step in answering the first question is to look at the relationship between price deviation and the price variance. The experiment average level of price deviation and of the variance is used as a benchmark. A high level of price deviation combined with a large variance indicates that market prices do not converge at all. In contrast, a low level of price deviation combined with a small variance indicates that market prices converge to the predicted price. Finally, a high level of price deviation and a small variance indicates a market price deviation, b ut not to the price predicted by theory.

Table 4.9 offers evidence that in the absence of regulation and oligopsony market prices converge near the theoretically predicted price. In contrast, without regulation and with the presence of oligopsony market prices do not appear to converge at all. In both regulatory cases (with and without oligopsony) evidence suggests that market prices are converging to a price that is not the theoretical predicted price. The average market price (Pm) suggests that the converging prices are lower than the predicted price (Pp).

Table 4.9 Comparison of the Price Deviation and the Price Variance Across Treatment Combinations.

	Pm	Pp	P deviation	%	Variance	%
Regulation-No oligopsony	444	495	3077	1.08	373	0.45
Regulation-Oligopsony	445	495	3348	1.17	553	0.66
No regulation-Oligopsony	356	400	4477	1.57	2250	2.70
No regulation-No oligopsony	385	400	538	0.19	163	0.20
Overall Mean			2860		835	

Where Pm = Average market price Pp = Predicted Price

Price deviation = (Pm-Pp)^2

Note: Price convergence has been computed using each individual observation, and not the mean prices

Although it is not in the scope of this paper, two puzzling observations are worth mentioning. First, prices tend to increase from period to period and then to drop to a low level, then they start to rise again, to eventually fall later. Some sessions have few long cycles, while other have numerous short cycles. A plausible explanation for the price cycles, which needs to be further explored outside the structure of this paper, is the Edgeworth cycle. The absence of a pure Nash strategy (for the buyers) and a capacity constraint (for the sellers) are the primary conditions needed for the Edgeworth cycle (Kruse, Rassenti, Reynolds, and Smith, 1994). These conditions, arguably, are present in this experiment.

Second, market prices are on average significantly lower than predicted. It should be remembered that sellers face advance production with no carry-over decisions in the experiment. In contrast, the theoretical price predictions generally assume production to demand decision. In the general setting, sellers only produce what they can sell (P=MC). In the setting of advance production with no carry-over, sellers face a much more complex decision. Sellers must make their decision before knowing the market price and are penalized for under producing (foregone profit), and for over producing (incur the cost of the unsold units). Are the differences observed the result of learning difficulties? A single-factor ANOVA between the sellers' production decision over the twelve periods of the experiment and the last six periods shows no statistically significant differences (p-value 0.67). So, no learning effect in the production decision was detected over the 12 periods of the experiment.

Moreover, results indicate that in the sessions where sellers on average underproduced (from expected price=MC), the market price was still significantly lower than the predicted price, but higher than the average session market price. This seems to indicate that advance production with no carry-over leads to additional market power to buyers. Again, this needs to be further explored and is beyond the scope of this paper. It should also be noted that it is likely that without the 200 francs floor, the difference between the predicted price and the market price would be even more pronounced. The floor price was bid by at least one buyer 64 times over the 288 sessions that make up the experiment.

V. CONCLUSIONS

Federal Milk Marketing Orders (FMMOs) are the regulation that implements classified pricing and price pooling, which is a major part of the U.S. dairy policy. Twenty-four experimental sessions simulated the effect of the presence or the absence of classified pricing

(FMMO regulation) combined with the presence or absence of oligopsony on various dependent variables. Perishability was also present in the experiment but kept constant across all sessions. The organization of sellers into producer cooperatives as an oligopsony counter measure is not taken into account as a possible treatment in the experiment.

Results indicate that regulation increases market price as well as the quantity traded. It also transfers market surplus from the buyers to the sellers. Hypotheses posed in Chapter II are supported or not supported as follows:

- H1a: Regulation increases market prices.
    - supported
- H1b: Regulation increases the quantity traded.
    - supported
- H1c: Regulation increases the percentage of the competitive sellers' surplus captured by sellers.
    - supported

Results show that when the number of buyers is reduced from six to three (the number of sellers is kept constant at four), in the absence of regulation, buyers gain market power. The gain in market power is measured by a reduction in market price and quantity purchased. In addition, an increase in the percentage of the competitive buyers' surplus captured by buyers (bSurplus%), and a reduction in the percentage of the competitive sellers' surplus captured by sellers (sSurplus%) is observed.

- H2a: A reduction in the number of buyers decreases market price
    - supported
- H2b: A reduction in the number of buyers decreases the quantity traded
    - observed but not statiscally supported
- H2c: A reduction in the number of buyers decreases the percentage of the competitive sellers' surplus captured by sellers
    - supported

However, when regulation is present, a reduction in the number of buyers has no statistically significant effect. Thus, regulation successfully neutralized the oligopsony effects.

- H3a: Oligopsony has less effect on market prices with the presence of regulation than without regulation.
    - supported
- H3b: Oligopsony has less effect on the percentage of the competitive sellers' surplus captured by sellers with the presence of regulation than without regulation.
    - supported

Regulation has no statistically significant impact on market price efficiency, but increases market stability in a oligopsonistic market.

- H4: Regulation reduces the overall price efficiency of the market.
  - not supported
- H5: Regulation increases market price stability.
  - supported

If the U.S. dairy sector is inherently oligopsonistic in the absence of regulation; results indicate that regulation can successfully obtain market results that conforms to those expected in perfect competition. However, the experiment does not explore the possibility that, if FMMOs were eliminated, producer marketing cooperatives might achieve a similar correction in market power between sellers and buyers. Neither does the experiment assess what would be an optimal level of regulation (differential). The possibility that regulation can transfer market surplus to sellers well beyond the perfectly competitive level has not been explored.

Across all the experimental treatments, market prices are significantly lower than the prices predicted by theory. The presence of advance production with no carry-over (perishability) in the experiment may explain much of this effect. Prior research (Mestelman and Welland, 1988) suggests that perishability disadvantages sellers. This hypothesis should be further explored. The presence of a floor price in the experiment is believed to have mitigated the decrease in market price and the market power of buyers. The floor price was bid in 64 periods over the 288 periods of the experiment.

Further research should explore the capability of cooperatives to correct possible oligopsony in the raw milk market. A critical issue is whether individual seller incentives would be consistent with maintaining a collective bargaining strategy among sellers. A better understanding of the market for raw milk could also be achieved by having perishability as a treatment in future experiments. Another promising avenue would be to explore if regulation reestablishes a market equilibrium close to the model of pure competition or if it transfers market surplus to sellers well beyond the perfectly competitive level, and how the magnitude of a price differential relates to this.

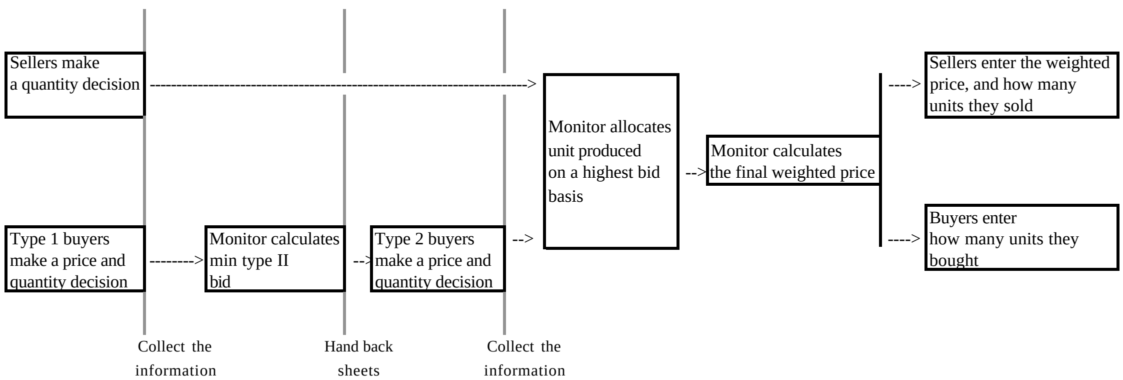
APPENDIX A

Table A.1 Instructions For Sellers With Regulation and No Oligopsony

In this experiment, you will participate in a series of market trading periods. As a participant in the experiment, you will be a seller. Transactions that you will make in each trading period will determine your earnings in "francs", a laboratory currency. Francs will be converted using the following formula, $=0.00075(francs), and will be paid to you at the end of the experiment. Each type of player has a different exchange rate. Your individual decisions will determine your individual earnings. Your earnings are not linked to the other participants' earnings.

After reading the instructions, you will be given a chance to ask any questions you might have. Then we will begin the first trading period.

The chart below gives you the experiment sequence of actions



Instructions for Sellers

Sellers earn money by selling units at prices that are above their costs. Total earnings for a period are computed by subtracting total production costs from total revenues. The information sheet gives sellers information on their costs. The cost of each unit will be the same in each period. **Sellers must make production decisions prior to the start of trading in each period and incur the cost of all units produced, whether or not they are sold**.

Seller decisions and earnings will be recorded on a sheet similar to the Seller Decision Sheet, shown below. Trading periods are designated by separate columns. In this example, a seller may sell up to three units in each trading period. The production decisions are made by entering in the quantity row, prior to the start of trading in each period, how many units the seller wants to produce. The unit column gives the seller its production capacity.

Consider, for example, trades in period 1 of the seller decision sheet. In this case no more than three units can be produced. The first, second and third unit can be produced at a cost of 100, 110 and 120 francs, respectively (information sheet). Suppose a seller decides to produce 3 units, but sells only two units in period 1 at the weighted price of 180 francs (see Decision Sheet).

Table A.1 (Continued)

INFORMATION SHEET FOR SELLER: **1**

Unit Produced	Total Cost	Marginal Cost	Average Cost
0	0	0	0
1	100	100	100
2	210	110	105
3	330	120	110

A Sample Seller Information Sheet

DECISION SHEET FOR SELLER: **1**

		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
	Units Produced	**3**					
	Weighted price	180					
unit	**Units sold**	**2**					
1	selling price	180					
2	selling price	180					
3	selling price						
	total revenue	360					
	total production cost	330					
	total earning for the period	30					
	cumulative earnings	30					

A Sample Seller Decision Sheet

Total revenues are the unit sold multiplied by the weighted price (2*180), while total production costs are the sum of 100 + 110 + 120 (information sheet). Total earnings for the period would be 30 francs (360-330=30). Note that in this example, if the seller had produced 2 units instead of 3 she would have made 150 francs instead of 30 francs. Earnings in this example are for illustrative purposes only; actual earnings might be higher or lower.

Importantly, <u>a seller incurs the cost for all units produced</u>. Thus, if a unit is produced but not sold in a period, that unit will negatively affect your earnings for the period. In the unlikely event that your <u>cumulative earnings</u> (bottom of the seller decision sheet) <u>are negative in the last period</u>, you then only receive your show-up fees.

Trading Rules

All buyers and sellers have identification numbers; your number is given in the upper part of a Decision Sheet that is in your folder. There are two types of buyers, Type I (low-value) and Type II (high-value), for which different trading rules apply, as explained below. First, the monitor will begin each trading period with an announcement that sellers have one minute to make their production decisions, which they will write on their Seller Decision Sheet, (quantity produced row) in the column for the current period. The production decisions of each seller will be collected by the monitor.

Table A.1 (Continued)

Simultaneously, Type I buyers will be asked to write their bids and the number of units that they are willing to buy at their bid price. Remember that each buyer chooses only a single bid, so all transactions that a buyer makes in a period will be at the same price. That information will then be collected and the monitor will announce a minimum bid price at which Type II buyers can start to bid.

Third, Type II buyers will be given 1 minute to write their bids and the number of units that they are willing to buy at their bid price. That information will then be collected and the monitor will announce a weighted price (as defined below) at which sellers will sell.

Each buyer (Type I and Type II) must write down her respective bid and quantities (bid and quantity row, buyer's decision sheet).

Fourth, if supply is greater than demand, sellers will be selected randomly in the following way. Each seller has an identification number at the top of his or her Seller Decision Sheet. The monitor has Ping-Pong balls with seller identification numbers on them in a bingo cage that will be used to draw the balls in sequence (without replacement). Sellers will be selected in this way to establish a selling order. The monitor will then allocate the unit produced, following the selling order, on a highest bid basis among buyers. The first seller selected will sell his or her first unit produced, then the second seller selected will sell his or her first unit produced. When all first units are sold, the process will be repeated with second units produced. The process will continue until there are no more units demanded.

Note that all sellers get the same price for their units (a weighted price) while buyers pay their individual bid. This completes the trading period. We will reopen the market for a new trading period by having sellers make new production decisions, buyers submit new prices and quantities, and the process will be repeated.

To summarize the sequence of trade:

1- Each seller makes a production decision

2- Each Type I buyer makes a price and quantity decision;

3- The monitor announces the minimum bid for Type II buyers;

4-Each Type II buyer makes a price and quantity decision under the minimum bid constraint

5- The monitor announces a weighted price;

6- Sellers sell their produced units at a weighted price.

(For example, suppose that there are two sellers, S1 and S2, two Type I buyers B1 and B2, and two Type II buyers B3 and B4.

Table A.1 (Continued)

1 a- <u>Sellers have 1 minute to make a production decision:</u>
Say S1 and S2 decide to produce 3 unit each.

b- <u>Type I buyers have 1 min. to make price and quantity decisions:</u>
B1 and B2 submit bids of 150 and 120 for 2 and 1 unit, respectively.

2- <u>The monitor then announces a minimum bid for Type II buyers:</u>
*The minimum bid is the weighted average of the previous period realized transaction for low-value buyers plus a constant. In this case the minimum bid for the next period would be computed as follow **(**(150+150+120)/3 units + **100)**=240, assuming that B1 and B2 bought all the units wanted. Where **100** (the constant), in the example, was arbitrarily picked by the monitor and kept constant over the experiment. For simplicity, let's assume that the minimum bid from the previous period is 240 francs as well.*

3 -<u>Type II buyers have 1 minute to make quantity and price decisions (price must be > or = to 240).</u>
*Assume that B3 and B4 each bid a unit at the price of 280 and 240, respectively. That would yield the following weighted price **(**(280+240+150+150+120)/5 units**)**=188.*

4- <u>The monitor announces a weighted price.</u>
The weighted price is 188. Thus, the weighted price announced would be 188 in this example.

5- S<u>upply is greater than demand: Sellers are randomly picked and sell their production at the weighted price.</u>
Suppose that S2 is selected first. The monitor will then allocate seller S2 first unit to buyer B3, and seller S1 first unit to buyer B4. The monitor will then start allocating second units at the best available bid, so seller S2 second unit to buyer B1, seller S1 second unit to buyer B1. Finally, seller S2 third unit is allocated to buyer B2. Because demand is satisfied, seller S1 is left with a unit unsold. The blackboard would appear as follows:

Buyer	B1	B2	B3	B4
Bid	150	120	280	240
Quantity	2	1	1	1
Weighted Price	188	......	......	......
Seller	S2	S2	S2	S1
Seller	S1			

To calculate their earnings, sellers use the weighted price, while buyers use their own bid.

The period ends and sellers and buyers are then given 1 minute to make production, bid and quantity decisions for the next period)

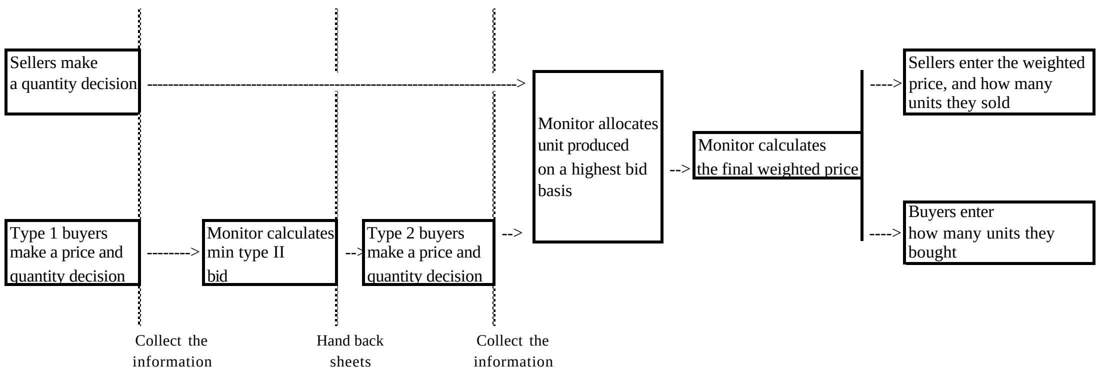
Except for interaction with the monitor, no other talking is permitted. Any questions?

Table A.2   Instructions For Buyers With Regulation and No Oligopsony

In this experiment, you will participate in a series of market trading periods. As a participant in the experiment, you will be a buyer. Transactions that you will make in each trading period will determine your earnings in "francs", a laboratory currency. Francs will be converted using the following formula, $=0.00045(francs), and will be paid to you at the end of the experiment. Each type of player has a different exchange rate. Your individual decisions will determine your individual earnings. Your earnings are not linked to the other participants' earnings.

After reading the instructions, you will be given a chance to ask any questions you might have. Then we will begin the first trading period.

The chart below gives you the experiment sequence of actions



Instructions for Buyers

Buyers earn money by purchasing units at prices that are below their values. Earnings from the purchase of each unit are computed by taking the difference between the value of the units and the purchase price. Total earnings for the period are computed by adding up the earnings on all units purchased that period.

Buyer decisions and earnings will be recorded on a Buyer Decision Sheet, shown below. In this example, a buyer may purchase up to two units in each trading period. For the first unit that may be bought during a period, the buyer receives the amount listed in row 1, labeled “value of 1st unit.” If a second unit is purchased during the same period, the buyer receives the additional amount listed in row 3, labeled “value of 2nd unit.” Note that buyers can make only one bid per trading period, and if they trade, all the units bought in a period are purchased at their bid price.

Consider, for example, purchases in period 1 of the Buyer Decision Sheet. In this practice period, the value of the first unit is 200 and the value of the second unit is 180, as shown in rows 1 and 3. Suppose a buyer bids 150 for two units Earnings on the purchase of the first unit are obtained by subtracting the purchase price (bid), which is 150, from the value in row 1, which is 200. The difference of 50 is entered in row 2. Next, the earnings from the purchase of the second unit are entered in row 4. Total earnings for the period are the sum of 50 (on the first unit purchased) and 30 (on second unit purchased). The sum of 80 francs is then entered in row 5. Earnings in this example are for illustrative purposes only; actual earnings could be higher or lower.

Table A.2 (Continued)

BUYER DECISION SHEET FOR BUYER:		**B2**						
			Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
		Bid	150					
unit	row	**Quantity**	2					
1st	1	value of 1st unit	200	200				
unit	2	earnings	50					
2nd	3	value of 2nd unit	180	180				
unit	4	earnings	30					
	5	total earning for the period	80					
	6	allocation plus cumulative earnings	80					

A

Sample Buyer Decision Sheet

A buyer makes only one bid for the units he or she is willing to buy in a period, and does not receive the value for a unit unless the unit is purchased. Thus, earnings for each unit not purchased in a period are zero. At the end of a period, your earnings will be recorded in row 5 of your decision sheet. Earnings for subsequent periods will be calculated similarly. In the unlikely event that your cumulative earnings (bottom of the buyer decision sheet) are negative in the last period, you then only receive your show-up fees.

Trading Rules

All buyers and sellers have identification numbers; your number is given in the upper part of a Decision Sheet that is in your folder. There are two types of buyers, Type I (low-value) and Type II (high-value), for which different trading rules apply, as explained below. First, the monitor will begin each trading period with an announcement that sellers have one minute to make their production decisions, which they will write on their Seller Decision Sheet, (quantity produced row) in the column for the current period. The production decisions of each seller will be collected by the monitor.

Simultaneously, Type I buyers will be asked to write their bids and the number of units that they are willing to buy at their bid price. Remember that each buyer chooses only a single bid, so all transactions that a buyer makes in a period will be at the same price. That information will then be collected and the monitor will announce a minimum bid price at which Type II buyers can start to bid.

Third, Type II buyers will be given 1 minute to write their bids and the number of units that they are willing to buy at their bid price. That information will then be collected and the monitor will announce a weighted price (as defined below) at which sellers will sell.

Each buyer (Type I and Type II) must write down her respective bid and quantities (bid and quantity row, buyer's decision sheet).

Table A.2 (Continued)

Fourth, if supply is greater than demand, sellers will be selected randomly in the following way. Each seller has an identification number at the top of his or her Seller Decision Sheet. The monitor has Ping-Pong balls with seller identification numbers on them in a bingo cage that will be used to draw the balls in sequence (without replacement). Sellers will be selected in this way to establish a selling order. The monitor will then allocate the unit produced, following the selling order, on a highest bid basis among buyers. The first seller selected will sell his or her first unit produced, then the second seller selected will sell his or her first unit produced. When all first units are sold, the process will be repeated with second units produced. The process will continue until there are no more units demanded.

Note that <u>all sellers get the same price for their units (a weighted price) while buyers pay their individual bid</u>. This completes the trading period. We will reopen the market for a new trading period by having sellers make new production decisions, buyers submit new prices and quantities, and the process will be repeated.

To summarize the sequence of trade:

1- Each seller makes a production decision

2- Each Type I buyer makes a price and quantity decision;

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5- The monitor announces a weighted price;

6- Sellers sell their produced units at a weighted price.

(For example, suppose that there are two sellers, S1 and S2, two Type I buyers B1 and B2, and two Type II buyers B3 and B4.

1 a- <u>Sellers have 1 minute to make a production decision:</u>
Say S1 and S2 decide to produce 3 unit each.

b- <u>Type I buyers have 1 min. to make price and quantity decisions:</u>
B1 and B2 submit bids of 150 and 120 for 2 and 1 unit, respectively.

2- <u>The monitor then announces a minimum bid for Type II buyers:</u>

*The minimum bid is the weighted average of the previous period realized transaction for low-value buyers plus a constant. In this case the minimum bid for the next period would be computed as follow **(**(150+150+120)/3 units + **100)**=240, assuming that B1 and B2 bought all the units wanted. Where **100** (the constant), in the example, was arbitrarily picked by the monitor and kept constant over the experiment. For simplicity, let's assume that the minimum bid from the previous period is 240 francs as well.*

Table A.2 (Continued)

3- <u>Type II buyers have 1 minute to make quantity and price decisions (price must be > or = to 240).</u>

*Assume that B3 and B4 each bid a unit at the price of 280 and 240, respectively. That would yield the following weighted price **(**(280+240+150+150+120)/5 units**)**=188.*

4- <u>The monitor announces a weighted price.</u>

The weighted price is 188. Thus, the weighted price announced would be 188 in this example.

5- S<u>upply is greater than demand: Sellers are randomly picked and sell their production at the weighted price.</u>

Suppose that S2 is selected first. The monitor will then allocate seller S2 first unit to buyer B3, and seller S1 first unit to buyer B4. The monitor will then start allocating second units at the best available bid, so seller S2 second unit to buyer B1, seller S1 second unit to buyer B1. Finally, seller S2 third unit is allocated to buyer B2. Because demand is satisfied, seller S1 is left with a unit unsold. The blackboard would appear as follows:

Buyer	B1	B2	B3	B4
Bid	150	120	280	240
Quantity	2	1	1	1
Weighted Price	188	......	......	......
Seller	S2	S2	S2	S1
Seller	S1			

To calculate their earnings, sellers use the weighted price, while buyers use their own bid.

The period ends and sellers and buyers are then given 1 minute to make production, bid and quantity decisions for the next period.)

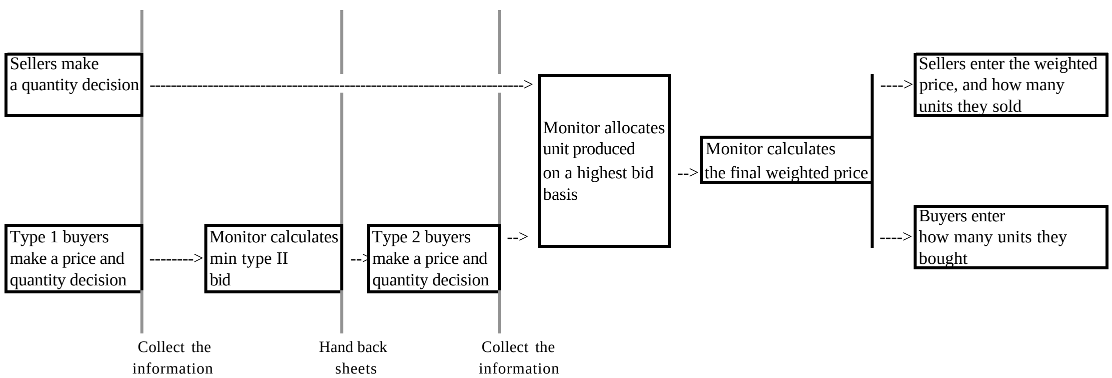
Except for interaction with the monitor, no other talking is permitted. Any questions?

Table A.3 Instructions for Sellers with Regulation and Oligopsony

In this experiment, you will participate in a series of market trading periods. As a participant in the experiment, you will be a seller. Transactions that you will make in each trading period will determine your earnings in "francs", a laboratory currency. Francs will be converted using the following formula, $=0.001(francs), and will be paid to you at the end of the experiment. Each type of player has a different exchange rate. Your individual decisions will determine your individual earnings. Your earnings are not linked to the other participants' earnings.

After reading the instructions, you will be given a chance to ask any questions you might have. Then we will begin the first trading period.

The chart below gives you the experiment sequence of actions



Instructions for Sellers

Sellers earn money by selling units at prices that are above their costs. Total earnings for a period are computed by subtracting total production costs from total revenues. The information sheet gives sellers information on their costs. The cost of each unit will be the same in each period. **Sellers must make production decisions prior to the start of trading in each period and incur the cost of all units produced, whether or not they are sold**.

Seller decisions and earnings will be recorded on a sheet similar to the Seller Decision Sheet, shown below. Trading periods are designated by separate columns. In this example, a seller may sell up to three units in each trading period. The production decisions are made by entering in the quantity row, prior to the start of trading in each period, how many units the seller wants to produce. The unit column gives the seller its production capacity.

Consider, for example, trades in period 1 of the seller decision sheet. In this case no more than three units can be produced. The first, second and third unit can be produced at a cost of 100, 110 and 120 francs, respectively (information sheet). Suppose a seller decides to produce 3 units, but sells only two units in period 1 at the weighted price of 180 francs (see Decision Sheet).

Table A.3 (Continued)

INFORMATION SHEET FOR SELLER: 1

Unit Produced	Total Cost	Marginal Cost	Average Cost
0	0	0	0
1	100	100	100
2	210	110	105
3	330	120	110

A Sample Seller Information Sheet

DECISION SHEET FOR SELLER: 1

		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
	Units Produced	**3**					
	Weighted price	180					
unit	**Units sold**	**2**					
1	selling price	180					
2	selling price	180					
3	selling price						
	total revenue	360					
	total production cost	330					
	total earning for the period	30					
	cumulative earnings	30					

A Sample Seller Decision Sheet

Total revenues are the unit sold multiplied by the weighted price (2*180), while total production costs are the sum of 100 + 110 + 120 (information sheet). Total earnings for the period would be 30 francs (360-330=30). Note that in this example, if the seller had produced 2 units instead of 3 she would have made 150 francs instead of 30 francs. Earnings in this example are for illustrative purposes only; actual earnings might be higher or lower.

Importantly, a seller incurs the cost for all units produced. Thus, if a unit is produced but not sold in a period, that unit will negatively affect your earnings for the period. In the unlikely event that your cumulative earnings (bottom of the seller decision sheet) are negative in the last period, you then only receive your show-up fees.

Trading Rules

All buyers and sellers have identification numbers; your number is given in the upper part of a Decision Sheet that is in your folder. There are two types of buyers, Type I (low-value) and Type II (high-value), for which different trading rules apply, as explained below. First, the monitor will begin each trading period with an announcement that sellers have one minute to make their production decisions, which they will write on their Seller Decision Sheet, (quantity produced row) in the column for the current period. The production decisions of each seller will be collected by the monitor.

Table A.3 (Continued)

Simultaneously, Type I buyers will be asked to write their bids and the number of units that they are willing to buy at their bid price. Remember that each buyer chooses only a single bid, so all transactions that a buyer makes in a period will be at the same price. That information will then be collected and the monitor will announce a minimum bid price at which Type II buyers can start to bid.

Third, Type II buyers will be given 1 minute to write their bids and the number of units that they are willing to buy at their bid price. That information will then be collected and the monitor will announce a weighted price (as defined below) at which sellers will sell.

Each buyer (Type I and Type II) must write down her respective bid and quantities (bid and quantity row, buyer's decision sheet).

Fourth, if supply is greater than demand, sellers will be selected randomly in the following way. Each seller has an identification number at the top of his or her Seller Decision Sheet. The monitor has Ping-Pong balls with seller identification numbers on them in a bingo cage that will be used to draw the balls in sequence (without replacement). Sellers will be selected in this way to establish a selling order. The monitor will then allocate the unit produced, following the selling order, on a highest bid basis among buyers. The first seller selected will sell his or her first unit produced, then the second seller selected will sell his or her first unit produced. When all first units are sold, the process will be repeated with second units produced. The process will continue until there are no more units demanded.

Note that all sellers get the same price for their units (a weighted price) while buyers pay their individual bid. This completes the trading period. We will reopen the market for a new trading period by having sellers make new production decisions, buyers submit new prices and quantities, and the process will be repeated.

To summarize the sequence of trade:

1- Each seller makes a production decision

2- Each Type I buyer makes a price and quantity decision;

3- The monitor announces the minimum bid for Type II buyers;

4-Each Type II buyer makes a price and quantity decision under the bid constraint;

5- The monitor announces a weighted price;

6- Sellers sell their produced units at a weighted price.

(For example, suppose that there are two sellers, S1 and S2, two Type I buyers B1 and B2, and two Type II buyers B3 and B4.

1 a- Sellers have 1 minute to make a production decision:
Say S1 and S2 decide to produce 3 unit each.

b- Type I buyers have 1 min. to make price and quantity decisions:
B1 and B2 submit bids of 150 and 120 for 2 and 1 unit, respectively.

Table A.3 (Continued)

2- <u>The monitor then announces a minimum bid for Type II buyers:</u>

*The minimum bid is the weighted average of the previous period realized transaction for low-value buyers plus a constant. In this case the minimum bid for the next period would be computed as follow **(**(150+150+120)/3 units + **100)**=240, assuming that B1 and B2 bought all the units wanted. Where **100** (the constant), in the example, was arbitrarily picked by the monitor and kept constant over the experiment. For simplicity, let's assume that the minimum bid from the previous period is 240 francs as well.*

3- <u>Type II buyers have 1 minute to make quantity and price decisions (price must be > or = to 240).</u>

*Assume that B3 and B4 each bid a unit at the price of 280 and 240, respectively. That would yield the following weighted price **(**(280+240+150+150+120)/5 units**)**=188.*

4- <u>The monitor announces a weighted price.</u>

The weighted price is 188. Thus, the weighted price announced would be 188 in this example.

5- S<u>upply is greater than demand: Sellers are randomly picked and sell their production at the weighted price.</u>

Suppose that S2 is selected first. The monitor will then allocate seller S2 first unit to buyer B3, and seller S1 first unit to buyer B4. The monitor will then start allocating second units at the best available bid, so seller S2 second unit to buyer B1, seller S1 second unit to buyer B1. Finally, seller S2 third unit is allocated to buyer B2. Because demand is satisfied, seller S1 is left with a unit unsold. The blackboard would appear as follows:

Buyer	B1	B2	B3	B4
Bid	150	120	280	240
Quantity	2	1	1	1
Weighted Price	188	......	......	......
Seller	S2	S2	S2	S1
Seller	S1			

To calculate their earnings, sellers use the weighted price, while buyers use their own bid.

The period ends and sellers and buyers are then given 1 minute to make production, bid and quantity decisions for the next period.

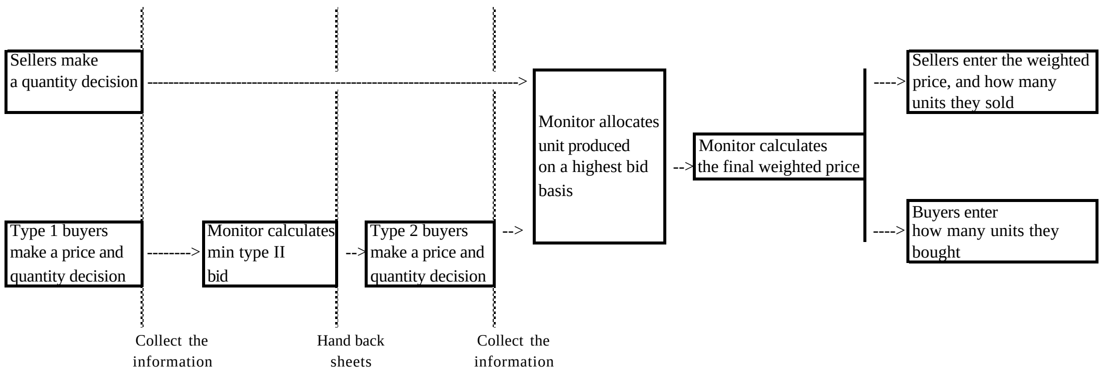
Except for interaction with the monitor, no other talking is permitted. Any questions?

Table A.4 Instructions for Buyers with Regulation and Oligopsony

In this experiment, you will participate in a series of market trading periods. As a participant in the experiment, you will be a buyer. Transactions that you will make in each trading period will determine your earnings in "francs", a laboratory currency. Francs will be converted using the following formula, $=0.00015(francs), and will be paid to you at the end of the experiment. Each type of player has a different exchange rate. Your individual decisions will determine your individual earnings. Your earnings are not linked to the other participants' earnings.

After reading the instructions, you will be given a chance to ask any questions you might have. Then we will begin the first trading period.

The chart below gives you the experiment sequence of actions



Instructions for Buyers

Buyers earn money by purchasing units at prices that are below their values. Earnings from the purchase of each unit are computed by taking the difference between the value of the units and the purchase price. Total earnings for the period are computed by adding up the earnings on all units purchased that period.

Buyer decisions and earnings will be recorded on a Buyer Decision Sheet, shown below. In this example, a buyer may purchase up to two units in each trading period. For the first unit that may be bought during a period, the buyer receives the amount listed in row 1, labeled "value of 1st unit." If a second unit is purchased during the same period, the buyer receives the additional amount listed in row 3, labeled "value of 2nd unit." Note that buyers can make only one bid per trading period, and if they trade, all the units bought in a period are purchased at their bid price.

Consider, for example, purchases in period 1 of the Buyer Decision Sheet. In this practice period, the value of the first unit is 200 and the value of the second unit is 180, as shown in rows 1 and 3. Suppose a buyer bids 150 for two units Earnings on the purchase of the first unit are obtained by subtracting the purchase price (bid), which is 150, from the value in row 1, which is 200. The difference of 50 is entered in row 2. Next, the earnings from the purchase of the second unit are entered in row 4. Total earnings for the period are the sum of 50 (on the first unit purchased) and 30 (on second unit purchased). The sum of 80 francs is then entered in row 5. Earnings in this example are for illustrative purposes only; actual earnings could be higher or lower.

Table A.4 (Continued)

BUYER DECISION SHEET FOR BUYER: **B2**

unit	row		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
		Bid	150					
		Quantity	2					
1st unit	1	value of 1st unit	200	200				
	2	earnings	50					
2nd unit	3	value of 2nd unit	180	180				
	4	earnings	30					
	5	total earning for the period	80					
	6	allocation plus cumulative earnings	80					

A

Sample Buyer Decision Sheet

A buyer makes only one bid for the units he or she is willing to buy in a period, and does not receive the value for a unit unless the unit is purchased. Thus, earnings for each unit not purchased in a period are zero. At the end of a period, your earnings will be recorded in row 5 of your decision sheet. Earnings for subsequent periods will be calculated similarly. In the unlikely event that your cumulative earnings (bottom of the buyer decision sheet) are negative in the last period, you then only receive your show-up fees.

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