# INDIVIDUAL VALUE-DRIVEN RENT DISSIPATION IN LIMITED-ENTRY FISHERIES: EXPERIMENTAL EVIDENCE

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## ABSTRACT

Economists have devoted considerable attention to rent-dissipation in limited-entry fisheries as a result of excessive use of capital inputs, or "capital stuffing." We may refer to this mechanism of rent dissipation as "cost-driven rent dissipation." An alternative potential mechanism of rent dissipation, which we refer to as "value-driven rent dissipation," may occur if limited-entry management causes fishermen to receive a lower price for their fish than would be possible under an alternative management system. In theory, value-driven rent dissipation may occur if the marginal value to a fisherman from fishing differently (for example, more slowly to take better care of the fish and improve quality) is positive but less than the marginal cost from a reduced catch share. This paper describes an economic experiment to study value-driven rent dissipation in a limited entry fishery. Following an approach developed by Knapp and Murphy (2010), subjects "fish" competitively for beans by scooping them out of a large bowl and "delivering" them to a pitcher. Given the choice of delivering to a pitcher placed close by for a lower price or a pitcher placed farther away for a higher price, unless the price differential is sufficiently high, subjects choose the closer but lower-priced pitcher. With the introduction of an individual quota to replace the competitive fishery, value dissipation ends as subjects choose the higher-priced pitcher. This simple experiment provides a powerful demonstration of a less-appreciated mechanism of rent dissipation, which is useful for both research and teaching.

**Keywords:** fisheries, experiment, rent dissipation, limited entry, derby

## INTRODUCTION

### Rent Dissipation in Fisheries

Rent dissipation in fisheries can occur in several forms. *Resource-driven* rent dissipation is caused by over-exploitation of a fishery, reducing biomass to an economically inefficient level. As managers implement regulations in an attempt to control fisheries harvests to prevent overexploitation, incentives arise that can cause other forms of rent dissipation to occur.

*Cost-driven* rent dissipation occurs when management of a fishery creates incentives for fishermen to overcapitalize in an effort to gain a larger share of the TAC. While attempting to control for over-exploitation of a fishery resource, policymakers typically focus on the biology of the fishery first, and the economics second (Gordon, 1954). Policies that focus on the health of the biomass as the only management concern can create incentives that encourage fishermen to increase fishing effort and intensity, leading to a competitive “race for fish” and over capitalization. Cost driven rent dissipation can be a direct result of fisheries management and is typically regarded as one of the side effects of limited entry management systems, such as that of Alaska’s Bristol Bay salmon fishery.

Limited entry management restricts the number of participants in a fishery through the issuance of permits. This management technique may be effective at limiting the growth of some inputs in a fishery. However, a limited entry system does not eliminate the incentive for harvesters to compete against one another for the available fish. As fishermen increase the amount of effort to catch as many fish as

possible, the amount of capital invested will often increase until the cost of harvesting is equal to the revenue produced by the resource, thus dissipating rents produced by the fishery.

*Value-driven* rent dissipation occurs when fishermen receive a lower price for their product that that which the market could potentially support. While the more explicit consequences of the much-researched cost-driven rent dissipation are readily observable, the implicit nature of value driven dissipation causes rents to be more ambiguously dissipated through markets. Previous research on the subject of value-driven rent dissipation shows that regardless of its obscure nature, rent dissipation and distortions on the marketing side of the ledger may be as important as distortions on the production or cost side of the ledger (Homans and Wilen 2005).

Value-driven rent dissipation may be *aggregate* or *individual*. Aggregate value-driven rent dissipation occurs as the result of the combined choices of individuals. Aggregate choices such as a short harvesting season can create market instability and hinder the development of new and fresh markets. Individual value-driven rent dissipation is the result individual choices, such as harvesting practices which result in low quality fish.

### Scope and Purpose

This paper describes an experiment in which we attempt to isolate the elements contributing to individual value-driven rent dissipation. By holding cost and total allowable catch (TAC) factors constant, we are able to observe some of the incentives created by competitive fishing which may lead to individual value-driven rent dissipation. In addition to examining the incentives that cause individual value-driven rent dissipation, our experimental design also allows for the measurement of the quantity of dissipation; providing insight into the potential significance of individual value driven rent dissipation in fisheries.

## EXPERIMENTAL DESIGN

### Methodology

The methodology used in this research is a modified version of a methodology developed by Knapp and Murphy (2010) that models some of the key characteristics of the Bristol Bay salmon fishery. The Knapp and Murphy experiment was designed to measure cost-driven rent dissipation by using a methodology that holds all other factors constant. The experiment is a social dilemma game that uses the physical act of scooping beans from a large bowl to represent harvesting fish. The advantage of this design is that, like a competitive fishery, information regarding competitors' choices as well as the consequences of one's own choices is immediately available.

Like the previous experiment designed by Knapp and Murphy (2010), this experiment intends to replicate a limited-entry fishery. Six subjects, standing around a round table, use scoops to "fish" for beans from a large bowl placed on the table. They "deliver" the beans into pitchers placed on the floor. They are paid based on the amount of beans they deliver to their pitchers. Subjects can choose between delivering to a "near" pitcher or a "far" pitcher. They get paid a higher price for beans delivered to the far pitcher. But because it takes longer they won't catch as much if they deliver to the far pitcher.

The earlier Knapp and Murphy experiment investigated cost-driven rent dissipation by allowing subjects to choose between scoops of different sizes and costs. In this experiment, the element of scoop choice is removed: all participants use the same ¼ cup sized scoop. Instead, the experiment investigates value-driven rent dissipation by allowing subjects to choose between pitchers for which they are paid different prices.

Motivation for the current experimental design resulted from the observation of the earlier experiment, where a large amount of beans were spilled onto the floor during the experiment. This suggested that the methodology might be used to examine individual value-driven rent dissipation in competitive fisheries.

Eight experiments were conducted using six participants for each experiment. Additionally, three pilots were conducted to fine tune the experimental parameters and receive feedback. Post-experiment surveys were also provided to subjects to identify characteristics that may have influenced their performance in the experiment.

Subjects are positioned around a circular table placed in the center of the room and are provided with two pitchers into which they can place their harvested beans. On the table was a common bowl that participants harvest from simultaneously. Pitchers are placed in equal but opposing locations in the room. Near pitchers are equally spaced around the table where the subjects harvest their beans. Far pitchers are located approximately ten feet from the near pitchers. The orientation of the pitchers is such that subjects should not perceive a comparative advantage among other participants to harvest greater quantities. See figure one for pitcher orientation. Figure two shows the harvesting scoops, harvesting bowl and a delivery pitcher.

Figure 1.

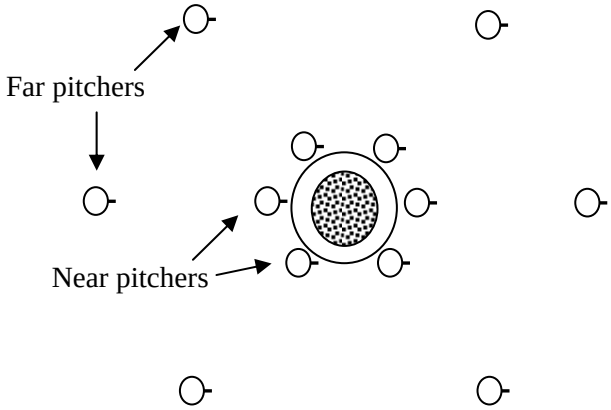



Figure 2.

Participants receive a “low” constant price for each cup delivered to the near pitcher and a “high” but variable price for each cup delivered to the far pitcher. However, delivering to the far pitcher also requires more time to deliver the harvest. Thus, participants face a trade-off between capturing a larger catch-share by delivering to the near pitcher, or earning a higher return on their harvest by delivering to the far

pitcher. It is expected that participants will deliver to the far pitcher when they perceive the opportunity costs associated with travelling to the higher priced pitcher to be less than the marginal benefits received from capturing a larger catch-share. Furthermore, it is expected that the change in prices of the far pitcher will result in observable changes in strategy amongst participants.

Harvests are measured by weighing pitchers after each round. Weight of the harvest is then converted to cups using the ratio of 190 grams of beans per cup. A projection screen is used to display harvesting data and current pitcher prices to participants throughout the experiment. Prices for the far pitcher and the amount each player harvested during previous rounds are shown so subjects can make profit maximizing decisions. Additionally, subjects can observe their earnings for each round in experimental dollars and their cumulative earnings in U.S. dollars.

**Subjects**

Subjects in this experiment were recruited through the UAA Experimental Economics Lab database. Each participant agrees to receive e-mails about upcoming experiments and sign up on an online forum. Space is allotted for ten participants to attend to ensure an adequate sample size for each experiment. Additional subjects who show up for the experiment but are not needed are provided $5.00 for their time and allowed to return for a later experiment. Subjects are only allowed to participate in this experiment once to mitigate the possibility of skewed results.

Subject's earnings are proportional to the amount of beans successfully harvested. The ratio of earnings per harvest, however, depends on each subject's pitcher choice. Participants receive experimental dollars with an exchange rate of E$1 = US$ 0.50. The exchange from experimental dollars to USD is demonstrated before the skill treatment. Average payment was $27.59 and subjects were individually awarded their payments in a closed envelope at the conclusion of the experiment.

**Treatments**

Each experiment consists of three treatments with varying numbers of rounds, for a total of 17 rounds. Table 1 provides an overview of the rules and purpose of each round. The treatments are described below in greater detail.

Table 1.

| Rounds | Price for far pitcher | Instructions | Purpose |
|---|---|---|---|
| 1-6 "Skill treatment" | $1.00 | Some subjects required to deliver to near pitcher, others required to deliver to far pitcher, varied between rounds | Give subjects practice in delivering to near and far pitchers; test subjects' relative skill in harvesting and delivery |
| 7-16 "Choice treatment" | Varied each round: $1.25, $1.50, $1.75, $3.00 | Subjects allowed to choose between delivering to near or far pitcher | Observe subjects' deliveries to each pitcher with different prices for far pitcher |
| 17 "Quota treatment" | $1.75 | All subjects harvests limited to equal quota shares<br><br>Subjects allowed to choose between delivering to near or far pitcher | Observe subjects' deliveries to each pitcher with quota shares |

*Skill:* The skill treatment consists of six rounds (1-6) and is used to establish a baseline for each subject and to test for differences between subjects' harvesting abilities. This treatment is also necessary to provide subjects with information regarding their respective change in harvest share by delivering to the far pitcher. Subjects are instructed to deliver their harvest to either the near pitcher or the far pitcher. In any given round during this treatment half of the participants deliver near, while the other half deliver far. Subjects are arranged each round to ensure they deliver to both near and far pitchers an equal number of times.

*Derby:* The derby treatment consists of ten rounds (7-16), and is the main phase of the experiment. The rules for the derby treatment change such that, rather than be assigned a particular pitcher to deliver their beans, subjects can now choose where to deliver. Additionally, the price of the far pitcher is now a randomized variable and is provided to participants before each round. The price range for the far pitcher consists of five prices (1.25, 1.50, 1.75, 2.00, 3.00) and each is repeated twice throughout the treatment.

*Quota:* The quota treatment occurs in the final round of the experiment. The choice system from the derby treatment remains unchanged, with a regulatory difference. Participants can deliver to whichever of their pitchers they desire, but can only harvest 2.5 cups of beans. This stage is used to identify changes in behavior when a regulated quota system comes into effect. For this treatment, the price of the near pitcher remains at $1.00 and the far pitcher is priced at $1.75. Participants are provided scales to weigh their harvest. Although the pitchers cannot be moved, participants can move the scale back and forth as they see fit to ensure the proper amount of beans is harvested.

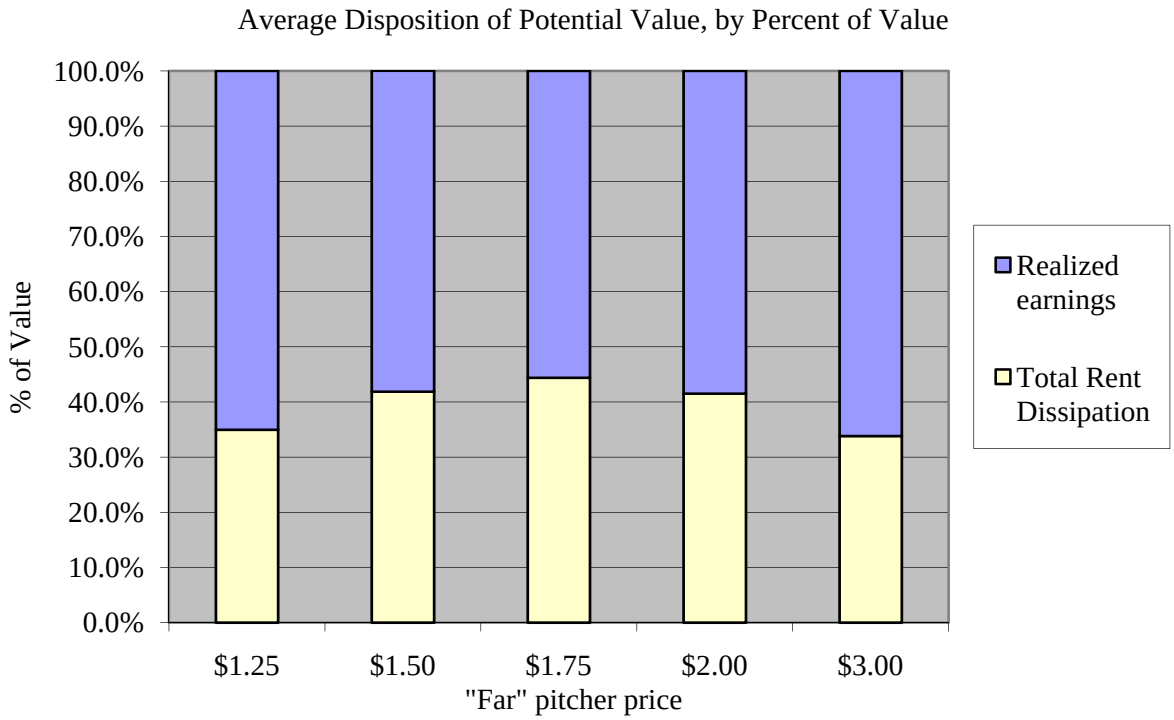
Prior to beginning each experiment, instructions are provided to each subject and read aloud to ensure comprehension. Rules contained within the instructions prevent subjects from interacting with one another during the experiment. After reading the instructions, a demonstration is conducted so subjects can observe the instructions in the experiment. Finally, subjects apply the instructions in a practice round for no monetary gain. The practice round is not recorded.

**RESULTS**

There are two ways in which value driven rent dissipation occurs in this experiment: beans spilled onto the floor during harvesting and beans delivered to the near pitcher. The difference between these sources is that while beans delivered to the near pitcher do have value, the decision to deliver to the lower value pitcher is a deliberate choice to dissipate value. Ultimately, any bean that is not successfully delivered to the far pitcher is considered analogous to poor quality fish and thus dissipated value.

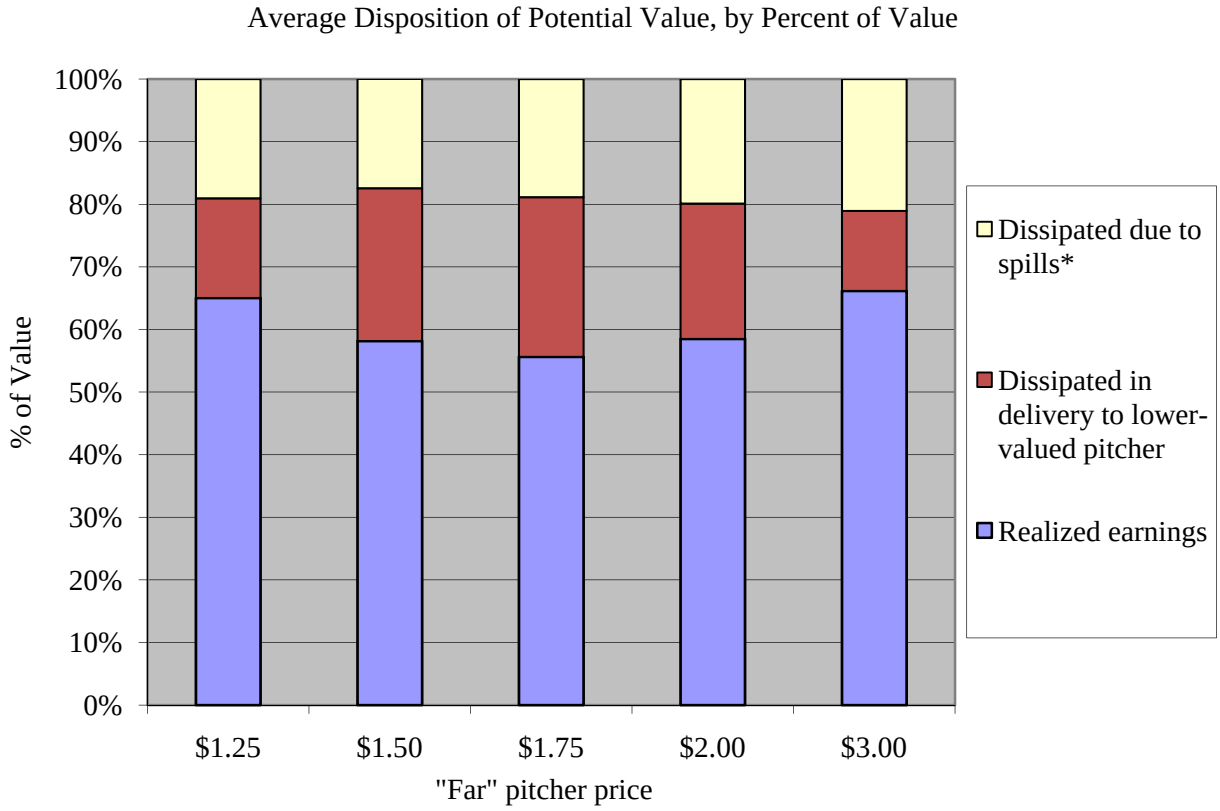
The results show that significant individual value-driven rent dissipation occurs: Average individual value-driven rent dissipation in competitive rounds ranged between 33% and 44% of total harvest value as indicated in graph 1.

Graph 1.



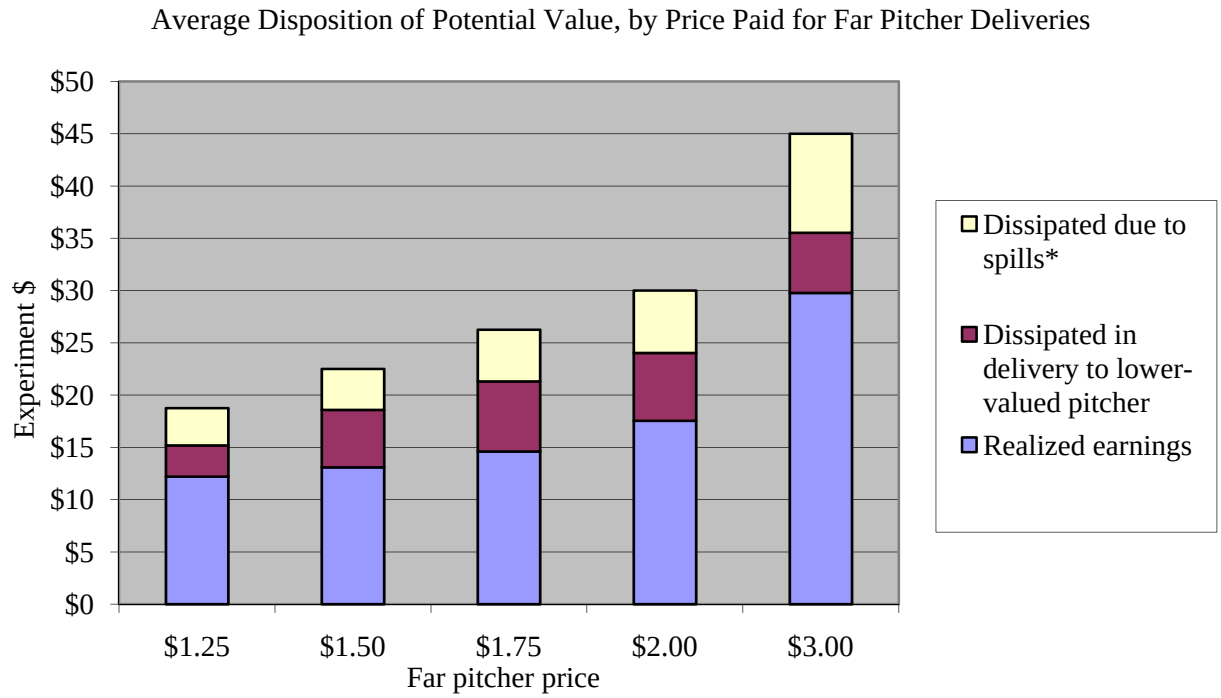

Our second observation produced by the data is that individual value-driven rent dissipation is greatest at intermediate prices, specifically at the far pitcher price of $1.75. The reason for this is that while all prices above $1 represent potential to increase value, the tradeoff between increased value and decreased catch share prevents subjects from delivering to the far pitcher. As the far pitcher price continues to rise, more subjects deliver beans to the far pitcher and are less sensitive to the choices of the other subjects. This is shown in graph 2 where, as the amount of individual value-driven rent dissipation as a result of spills remains relatively constant (in volume); the amount attributable to near pitcher choices is greatest at intermediate prices and least at the lowest and highest prices for the far pitcher. Intuitively this can be seen as a direct result of competition, where a reduction in competitive behavior (and a corresponding increase in certainty of catch share) would provide incentive for all subjects to deliver beans to the higher value far pitcher.

Graph 2.



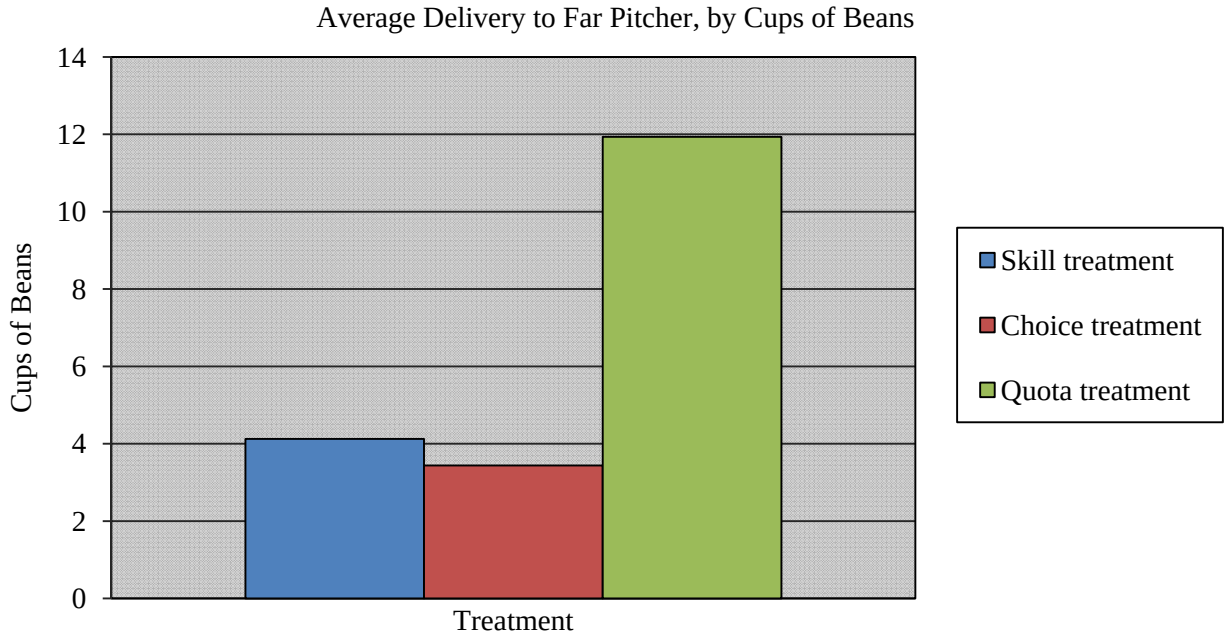

Graph 3 illustrates the disposition of value in experimental dollars. As the price paid for the far pitcher increases, we observe changes in the total value of beans. The reason for this is that as subjects increase deliveries to the far pitcher in response to a higher price, the value and volume of beans delivered to the far pitcher increases. The result is an increase in total value which has the further effect of increasing individual value-driven rent dissipation in the form of beans spilled on the floor. While the volume of beans spilled remains more or less constant throughout each experiment, and is perceived to be a result of any amount of competition present, the value of spilled beans increases with price paid for far pitcher deliveries. An interesting conclusion to this observation is that, as the price paid for the far pitcher increases, subjects make the decision to dissipate less rents by delivering to the higher priced pitcher, but actually dissipate the same amount of rents due to the increase in value of the beans and the constant amount of spillage. It can therefore be reasoned that subjects, while making a rational decision by attempting to maximize value, are simply trading one form of individual value driven rent dissipation for another.

Graph 3.




The implementation of a quota system as the final treatment in our experiment affected behavior to drastically change the harvesting practices of the subjects. Once the quota system was introduced, harvesting time increased on average, from 31 seconds to 120 seconds, and subjects demonstrated a dramatic shift in behavior. As can be seen in graph 3, with the reduction of competition subjects delivered almost all beans to the far pitcher.

Graph 4.



## CONCLUSIONS

This experiment demonstrates that individual value-driven rent dissipation is a significant and measureable phenomenon. In a competitive fishing situation, subjects gained significantly less value from the beans that they harvested than they could have, and significantly less value than they actually received in a non-competitive (quota) fishery. Subjects dissipated value both by spilling beans (failing to deliver harvested beans to either pitcher) and by delivering beans to lower-value near pitchers.

This experiment shows that the extent of individual value-driven rent dissipation is greatest at intermediate prices: where the additional potential value from delivering to a far pitcher is high enough to be significant, but not high enough to induce subjects to deliver to the far pitcher. Subjects are aware that value could be increased but perceive that the opportunity cost of forgone catch share is too great. The effect of competitive fishing is that subjects gain significantly less value from the fishery than they do when they are not competing for shares of the resource.

Establishing property rights by introducing a harvesting quota drastically changes behavior. By virtually eliminating competition, value is increased. This phenomenon can be seen in many fisheries that have adopted rights based management systems.

Value driven rent dissipation is an implicit form of rent dissipation that is often obscure in nature. While rent dissipation on the cost side has been extensively researched, relatively little attention has been given to the mechanisms by which management may affect value. The results of this experiment suggest that further research into the phenomenon of value-driven rent dissipation is needed.

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