

THESES CANADIENNES SUR MICROFICHE



National Library of Canada
Collections Development Branch

Canadian Theses on
Microfiche Service

Ottawa, Canada
K1A 0N4

Bibliothèque nationale du Canada
Direction du développement des collections

Service des thèses canadiennes
sur microfiche

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

22

0-310-18041-2



National Library of Canada

Bibliothèque nationale du Canada

CANADIAN THESES ON MICROFICHE

THÈSES CANADIENNES SUR MICROFICHE

65950

NAME OF AUTHOR/NOM DE L'AUTEUR Kelly Busche

TITLE OF THESIS/TITRE DE LA THÈSE Toward a Theory of Repeating Dutch Auctions

UNIVERSITY/UNIVERSITÉ Simon Fraser University

DEGREE FOR WHICH THESIS WAS PRESENTED/ GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE Doctor of Philosophy

YEAR THIS DEGREE CONFERRED/ANNÉE D'OBTENTION DE CE GRADE 1984

NAME OF SUPERVISOR/NOM DU DIRECTEUR DE THÈSE Dr. John F. Chant

Permission is hereby granted to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈQUE NATIONALE DU CANADA de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

L'auteur se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans l'autorisation écrite de l'auteur.

DATED/DATE August 17, 1984 SIGNED/SIGNÉ _____

PERMANENT ADDRESS/RÉSIDENCE FIXE



TOWARD A THEORY OF
REPEATING DUTCH AUCTIONS

by

Kelly Busche

B.A., University of Waterloo, (1978)

M.A., Simon Fraser University, (1980)

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
in the Department
of
Economics

(C) Kelly Busche 1984

SIMON FRASER UNIVERSITY

August 1984

All rights reserved. This thesis may not be
reproduced in whole or in part, by photocopy
or other means, without permission of the author.

APPROVAL

Name: Kelly Busche
Degree: Doctor of Philosophy
Title of Thesis: Toward a Theory of Repeating Dutch Auctions

Examining Committee:

Chairman: Kenji Okuda

John Chant
Senior Supervisor

Thomas Bofcherding

Christopher Hall

Clyde Reed

Donald Gordon
External Examiner
Director of Research
Bernard Baruch College
City University of New York

Date Approved: Aug. 13, 1984

PARTIAL COPYRIGHT LICENSE

I hereby grant to Simon Fraser University the right to lend my thesis, project or extended essay (the title of which is shown below) to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users. I further agree that permission for multiple copying of this work for scholarly purposes may be granted by me or the Dean of Graduate Studies. It is understood that copying or publication of this work for financial gain shall not be allowed without my written permission.

Title of Thesis/Project/Extended Essay

Toward a Theory of Repeating Dutch Auctions

Author: _____

(signature)

Kelly Busche

(name)

August 17, 1984

(date)

ABSTRACT

Typically, research in economics has been directed toward explaining changes in prices and outputs under the implicit assumption that transactions are conducted through either a formal market or some other institutional arrangement. Until recently, little attention has been paid to the questions of how and under what circumstances these markets or institutions have arisen. In this thesis, I analyze a particular market institution - a repeating Dutch auction for flowers - and generate refutable propositions which are capable of explaining the existence of and the rules within this particular institution.

While virtually all current auction theory analyzes prices and outputs taking the auction form as exogenously determined or determined by monopoly sellers, the theory I propose derives the form of the auction as an endogenous, joint-gains-from-trade response to certain underlying informational characteristics of the market in question. The endogeneity assumption is important because it

emphasizes that alternative forms of economic organization could have been chosen in lieu of the repeating Dutch auction. By examining the auction as the survivor institution, the thesis develops a theory of the Dutch auction in the tradition of the Coasian theory of the firm.

From the theory presented, several refutable propositions capable of explaining the rules of the Dutch auction are derived. These propositions are tested against data representing more than sixty thousand transactions taken from a repeating Dutch flower auction in Vancouver, British Columbia. No proposition is rejected by the data.

To my father

Acknowledgements

In the hope that they will not be too embarrassed by being connected with the present work, I would like to acknowledge assistance of the following people.

My advisory committee was composed of John Chant, Thomas Borcharding, and Christopher Hall; Chant's contribution was pervasive and to him I owe a very large debt; Tom Borcharding had left Simon Fraser in the early stages of this thesis but even from long distance his assistance was gratefully received; Chris Hall first provided me with the idea that Dutch auctions might provide price discounts for revelation of information, and was closely involved in the subsequent refining of that idea. Stephen Easton acted as an unofficial but very welcome member of that committee. In addition, I would like to record my appreciation to a former teacher, Arthur De Vany, who taught me much about what constitutes an economic question.

Others to whom a note of thanks for assistance of various kinds is appropriate include: Clyde Reed, Larry Boland, David Hammes, Don Reddick (who collected much of the data), Michael Walker, Janet Walker, Donna Popovic, and Gladys Ellen Durksen.

This work could not have been accomplished without the assistance of Mr. Tom Mulleder, general manager of the United Flower Growers' Cooperative and the staff who provided access to the data on the flower auction. Their help is most gratefully acknowledged.

TABLE OF CONTENTS

	<u>Page</u>
Title Page	
Approval Page	ii
Abstract	iii
Dedication	iv
Acknowledgements	v
Table of Contents	vii
List of Tables	x
List of Figures	xi
Introduction	1
Notes to Introduction	5
Chapter 1	6
A Selective History of Auctions and Bidding Sales	6
Overview	6
Slave Auctions	7
Handshake Auctions	9
Whispered Bid Auctions	10
Agricultural Product Auctions	11
Auctions for Financial Instruments and Gold	12
Tax Farming by Auctions	13
Miscellaneous Auctions	13
A Final Auction	14
Summary	15
Notes to Chapter 1	17
Chapter 2	19
Literature Survey	19

	<u>Page</u>
Chapter 2	
Overview	19
The Theoretical Literature	21
The Vickrey Model	22
Extension to sales where more than one item is for sale	25
Discriminatory vs. Competitive Rule Auctions	26
Auctions with Bidders who have Asymmetric Information	31
The Winner's Curse	34
Reserve-Price and Entrance-Fee Auctions	37
Optimal Auction Design	38
Summary of Theoretical Literature	39
The Experimental Literature	41
Summary	46
Notes to Chapter 2	47
Chapter 3	48
An Alternative Strategy	48
The Experimental Microeconomic System	50
Rejection of Parallelism by the Survivorship Principle	51
Evidence "from the field" to reject Parallelism	56
Sufficiently General Analysis	57
The Alternative Strategy	62
Notes to Chapter 3	64
Chapter 4	65
The Economics of a Repeating Dutch Auction	65
The Importance of Information	66
Information Production in Firms	67
Information Production Within Auctions	70
Information Production in Different Forms of Auctions	72

Chapter 4

	<u>Page</u>
What Information is Involved?	74
How is Information Paid For?	75
Summary of the Approach	78
A Note on the Data	79
The Repeating Dutch Auction for Flowers	79
Dutch Rules	80
The Grouping of Flowers	81
The Order of Sales	82
The Order of Sales - Cut Flowers versus Potted Plants	86
Option to Purchase Entire Wagon	91
Minimum Size of Wagon Rule	96
Variance of Prices	97
The Double Zero Rule	100
Notes to Chapter 4	102
Chapter 5	103
Conclusions	103
Appendix	107
A Note on the Data	107
References	109

LIST OF TABLES

	<u>Page</u>
Table 1	90
Table 2a	94
Table 2b	94
Table 3	95

LIST OF FIGURES

	<u>Page</u>
Figure 1	28
Figure 2	89

INTRODUCTION

Typically, research in economics has been directed toward explaining changes in prices and outputs under the implicit assumption that transactions are conducted through either a formal market or some other institutional arrangement. Until recently, little attention has been paid to the questions of how and under what circumstances these markets or institutions have arisen.¹ In this thesis, I analyze a particular market institution - a repeating Dutch auction for flowers - and generate refutable propositions which are capable of explaining the circumstances which give rise to the institution and the rules within the institution.

While virtually all current auction theory analyzes prices and outputs taking the auction form as exogenously determined or determined by monopoly sellers,² the theory I propose derives the form of the auction as an endogenous response to certain underlying informational characteristics of the market in question. The endogeneity assumption is important because it emphasizes that alternative forms of economic organization could have been chosen in lieu of the repeating Dutch auction. By examining the auction as the survivor institution, the thesis develops a theory of the Dutch auction in the tradition of the Coasian theory of the

firm.³

This work should be viewed as both substantially different from and complementary to the traditional auction literature. It is different from traditional work insofar as it focuses on a different set of questions. While the available literature concentrates on the determination of prices and outputs of specific auction forms and simultaneously derives appropriate bidding strategies, the present work is concerned with the way in which particular organizational forms are chosen. The particular auction form is derived as a solution to the problem of encouraging the appropriate acquisition and revelation of information.

The work also complements traditional auction research: theorists and experimentalists both impose specific auction rules on markets and agents in an attempt to determine the impact of different rules on the resulting prices and allocations. In this thesis, I argue that only certain environments can support specific organizational forms so that the imposition of specific rules on arbitrary environments may lead to inappropriate conclusions. By identifying some of the important determinants of particular auction forms, this work will allow theorists and experimentalists to develop models which will more accurately mimic nature in the sense that the institutional arrangements imposed on markets and agents in theoretical or

experimental settings could more likely survive and thus be observed in nature.

In order to test whether important determinants have been identified, refutable propositions which are derived from the theory are tested against data representing more than sixty thousand transactions taken from a repeating Dutch flower auction in Vancouver, British Columbia.

The thesis is organized as follows: in Chapter 1, a brief history of some auctions is presented. The chapter focuses on the systematic use of certain auction mechanisms for specific goods, independent of the historical or cultural settings in which they are found. I argue that the observation that certain auction forms are associated in a systematic way with certain goods, independent of historical or other factors, supports the contention that at least for certain questions, theories of auctions will be incomplete or misleading if the characteristics of the relevant markets are ignored.

Chapter 2 is a survey of the relevant auction literature. Included is the theoretical work starting with Vickrey (1961), experimental work associated primarily with Vernon Smith (1962 etc.) and more recently Charles Plott (1978 etc.), and some recent work on the design of auctions (e.g. Riley and Samuelson (1981), Harris and Raviv (1981), and Milgrom and Weber (1982)).

In Chapter 3, I explain the reasons which suggest that at least for some questions, it is inappropriate to specify auction forms without a theory which suggests that the particular form could be supported by the particular market environment. By examining auction forms in environments which could not support them, we run the risk of examining phenomena which do not exist.

As an alternative to this strategy, Chapter 4 presents a theory of auctions in which informational characteristics of the market determine, in part, the appropriate type of auction. The theory produces specific refutable propositions which are tested against the data from the repeating Dutch flower auction.

Conclusions and extensions to the theory are contained in the final Chapter.

(2)

NOTES TO INTRODUCTION

- 1) Exceptions include works by Marschak (1955), Hurwicz (1959, 1973), Goldberg (1977) and Gould (1978). In a more general vein, this idea is found in much work labelled "law and economics"; for a recent example, see Klein and Kenney(1983). Also, endogenous institutions is a feature in work by economists of the Austrian school, for example, see Israel Kirzner (ed.), Method, Process, and Austrian Economics: Essays in Honor of Ludwig von Mises (1982).
- 2) Vickrey's (1961) seminal article actually derives the auction as a solution to a specific problem but then concludes that all auctions are equivalent. Recent examples where exogenous auctions are equivalent are found in the survey by Engelbrecht-Wiggans (1980) and articles by Harris and Raviv (1981), Riley and Samuelson (1981), and Milgrom and Weber (1982). While most research is conducted in an environment where the auction form is chosen exogenously, a few models employ monopoly sellers who choose the auction form which maximizes their revenue. Maximization of net gains from trade is not a motivation in these models.
- 3) I take the Coasian tradition to be manifest in the view that contractual organizational forms arise as alternatives to "pure price" allocation mechanisms. Works in this tradition include Alchian and Demsetz (1972), McManus (1975), Barzel (1982), Umbeck(1982), Cheung (1983) and Klein and Kenney(1983).

CHAPTER 1

A SELECTIVE HISTORY OF AUCTIONS AND BIDDING SALES

Overview

Almost all of the economic literature on auctions treats the form of the auction and the rules within as exogenous variables; that is, the literature maintains the standard approach of considering the determination of prices and resource allocation as invariant to the institutional arrangements. This approach implicitly assumes that the factors which determine the choice of institution do not influence observed prices and/or allocations. But if the choice of institution does not influence prices or allocations, why do different institutions exist? The only answer available from the auction literature relies on the existence of monopoly power on the part of the seller. However, even monopolist sellers who attempt to maximize revenue cannot by themselves support the existence of particular auction forms. A necessary (but unstated) assumption in the monopoly models is that constraints exist which prevent the full exploitation of the gains from trade since at the simple monopoly solution, the gains from trade have not been maximized.¹ To find a more satisfying answer

to the question of why particular auction forms are observed, I start by examining various types of auctions which have existed throughout history.

In this Chapter, some regularities of the world in the form of different auction mechanisms are examined and it will be argued in subsequent Chapters that the existence of systematically different forms of auctions implies that different auctions have different purposes. It is the task of this study to deduce what some of these purposes might be.

Slave Auctions

Auctions have been used since antiquity for the sale of slaves. Plato states that slaves were required to be sold in the town square after public proclamation. In Athens, specific guarantees were required that the slaves were free of certain diseases and had not committed murder.² Although it is not explicitly stated how they were auctioned, it is likely that the common ascending price mechanism was used since Xenophon suggests that slaves be bought by the state and rented out in the same manner as tax farm licenses,³ that manner being by public ascending price auction.⁴

Explicit references to auctioning of slaves in Rome describe public ascending bid auctions. Strict legal codes governed the warranties offered by sellers and Roman Law

required that a third party act as guarantor. One contract from the second Century A.D. specified that a surety of twice the purchase price be supplied.⁵ Similar slave markets are known to have existed in many other places in antiquity, for example, Egypt and Assyria.

In more modern times, slave auctions were commonly used in North and South America and at least for the United States, documentation is plentiful. Many slaves were imported from Africa and the West Indies by joint stock companies from Holland, England, and America. From various points on the Gulf and Atlantic coasts, traders would take groups of slaves to markets in Richmond, Natchez, and New Orleans where ascending price auctions and private sales both were used. That auctions for slaves were common is evidenced by the fact that in the major slave trading centers, commercial directories of the period included many slave auctioneers; for example, an 1842 Pitt and Clarke's Directory for New Orleans listed the names of 185 slave dealers, 25 of whom were designated explicitly as auctioneers.⁶ In addition, the testimony of ex-slaves includes the accounts of many auctions, and where details exist, the auctions appear to have been public, ascending price auctions.⁷

It is noteworthy that over twenty or thirty centuries of known slave trading across at least three continents, the

common ascending price auction was so consistently employed.

Handshake Auctions

One very peculiar form of auction which can be traced from antiquity to the present day is a form of auction in which the auctioneer communicates with potential buyers by means of a handshake, with hands hidden under a towel or cloth. Potential buyers are arranged in a circle around the auctioneer who shakes hands with each while both of their hands are hidden. By grasping specific groupings of fingers, the bidders communicate the level of their bids to the auctioneer. Cassady states that this method had its origins in China centuries ago.⁸ This method was used for dried fish in Pakistan until 1959 when it was made illegal, and a variant is still used in Hong Kong for the sale of precious jade.⁹

In Les Secrets de la Mer Rouge, Henry de Monfried recounts such an auction apparently having taken place in the Red Sea area around 1910. Two traders are having trouble deciding upon a price for some pearls and call in a broker who conducts the negotiation in a handshake auction manner:

"He [the broker] unfolds his headgear, spreads it over his hands and those of the seller, and a silent dialogue starts between both pairs of hands hidden under the fabric. Here is how it works: Catching one finger means: 1-10-100-1,000, etc.; catching two fingers indicates:

2-20-200-2,000, etc., and so on up to ten.

One understands that all figures can be conveyed in this manner down to decimal fractions, since the opening bids make it clear whether one deals in multiples of one hundred, one thousand, ten thousand.

During the broker's act, the seller utters protesting noises, then makes a counter bid by in turn groping for the broker's fingers, and it all lasts half an hour.

Then, secure in the knowledge of the seller's secret proposal, the broker starts the same silent discussion with the buyer.

At long last, when he thinks that a figure agreeable to both sides has been reached, the broker renders his arbitration.

He seizes the seller's hand and forcibly puts it into the buyer's. 'Say "I sell"'.
.

At first, the seller makes a fuss and refuses, but finally he utters the sacred words. The bargain has now been struck; the broker announces the price which he has set. Immediately there is a howl from both sides.

The seller: 'You have robbed me of my property, you are a thief, God will punish you, etc.'

The buyer: 'Because of a fool like you, I am bankrupt, may your fee be your ticket to...etc.'

Often, as custom allows, the unmoved broker gets beaten up in the process."¹⁰

Whispered Bid Auctions

Cassady states that whispered bid auctions, in which prospective buyers whisper to the auctioneer, are common for fish auctions in Singapore, Manila, Venice, and Chioggia

where competing vendors and buyers were assembled in close proximity. He also states that according to a fish company executive in Venice, the bids are used only for demand information so that the vendors can price their fish on a take-it-or-leave-it basis.¹¹

Agricultural Product Auctions

All over the world, agricultural products are commonly auctioned. In India and Pakistan, cattle, fruit, and vegetables are auctioned. In most circumstances, open, ascending bid auctions are used but in at least some cases, descending price or sealed bid auctions are employed. Bullocks in Pakistan, for example, are commonly auctioned by sealed bids. In Europe, perhaps the most famous auctions include the flower and vegetable auctions of the Netherlands. In the flower auction, the Dutch or descending price method is used with a very costly reserve price mechanism. When sellers observe that prices are falling below some reservation level which they might choose, they are able to stop the auction but in this case, the produce which was for sale is destroyed. (A similar reserve price system exists in the Vancouver flower auction except that the flowers are not destroyed but must be removed from the auction for that day. Such produce may be re-auctioned on following days.)

In North America, auctions are used for cattle, hogs, tobacco, fish, and flowers. In most cases, the method of auctioning is consistent across geographical boundaries although there are exceptions. For example, tobacco in Ontario is sold by Dutch auction while in the United States, the English system is used. Another example of a product being auctioned by different mechanisms is hogs. Again, in Canada, hogs are auctioned by the Dutch method while in the United States, where auctions are used, the method is English. In the cases of both hogs and tobacco in Canada, marketing or production, or both, is within a government sanctioned monopoly.

The first Dutch auction for flowers in North America is the Vancouver auction. This mechanism has been subsequently introduced to the Toronto and Montreal flower markets and more recently to a market in San Diego.

Auctions for Financial Instruments and Gold

In both Canada and the United States, auctions are used for the sale of Treasury Bills, and recently, Exxon Corporation started using auctions for the sale of bonds. Commercial paper has been sold by Citicorp through auctions starting in 1978.¹² Gold is auctioned by the F.M.F. and in France, new issues of stock are auctioned.¹³

Tax Farming by Auction

Tax farming is an institution by which private citizens collect taxes on behalf of the government. Tax farming has been used as a fiscal instrument by governments in ancient Rome, Greece, China, medieval Europe and Russia, and in modern times in Turkey. In Rome, an ascending bid public auction was used to allocate the licenses for five year periods. In ancient China it is unclear how licenses were allocated, but for more modern tax farm licenses (nineteenth and twentieth centuries), public auctions were prescribed although much corruption is alleged. The corruption apparently occurred when the sale of licenses was by private appointment or by an auction which was not public.

Perhaps the largest auction ever held was a tax auction. In 193 A.D. the Praetorian Guard auctioned off the Roman Empire. Didius Julianus offered the highest bid and was then awarded the Empire. The Roman Legion subsequently contested the right of the Praetorian Guard to sell the Empire and after two months, Didius Julianus had both the Emperorship and his head removed.¹⁴

Miscellaneous Auctions

A huge number of other goods are auctioned all over the world. Oil leases, timber leases, antiques, art, machinery, and used furniture are commonly sold under auction. In the

case of governmental auctions for resource leases, sealed bids are often used while for art and antiques, the English method is the most common.

A fairly bizarre auction occurs in Seattle where what appears to be very cheap and valuable information is deliberately suppressed: the Allied Van Lines warehouse auctions boxes of articles which have gone unclaimed for certain periods of time, and the Company guarantees that the contents of the boxes are unknown to it. For example, the auctioneer will announce that a certain box is of some set of dimensions, of a certain weight, and was shipped from some source at some time. The box will have been sealed from delivery and the auctioneer will refuse to open the box to inspect the contents. The auction proceeds by English rules. It is very interesting, but unclear why the Company refuses to open the box when knowledge of the contents would seem to be so valuable in relation to the cost of ascertaining that knowledge.

A Final Auction

The Dutch East India Company was one of the first joint stock companies ever formed. Seventeen merchants formed the company to trade spices and silks from India and China. The company was formed in the early years of the seventeenth century and the first sales of goods were by direct sale to

companies of buyers in Amsterdam and other cities in the Netherlands. In 1629, a lawsuit was launched by some of the stockholders who charged that some of the directors of the company, who were also shareholders, were selling goods at prices detrimental to other stockholders. These stockholders alleged that only certain buyers were gaining access to the goods returning from the Orient and that this access was at preferential prices. It turns out that the accused directors of the Company and the buyers were related, both by blood and finances. To control what appeared to be potential fraud, the Company changed some of its selling procedures to an auction system.¹⁵

Summary

In this Chapter, details of several auctions have been provided. In some cases, it is noted that similar forms of auctions have been used across time and geographical boundaries. In other cases, auction procedures are described which, to say the least, appear difficult to explain. While most current theory on auctions assumes that factors which might determine the choice of auction are irrelevant to the observed prices and allocations, these descriptions provide some factual background against which an alternative view can be considered: the type of auction and indeed the use of auctions at all, are endogenous

responses to specific market characteristics. If all auctions were equivalent, then the choice of one type over any other must have been determined by chance (or by revenue maximizing monopolists). If these examples of auctions are indicative, then we must take that the use of similar types of auctions for similar items over disparate time periods, and geographical areas is purely by chance. Also chance determined, if all auctions are equivalent, are the uses of such seemingly bizarre mechanisms as the handshake and whispering bid auction. An alternative explanation is warranted.

In the following Chapters, it is argued that auctions are means of obtaining information, including price information, with a warranty. The use of auctions by the Dutch East India Company, for example, can be viewed in this light as a means of producing warranted price information for shareholders. The auction assists them in monitoring their employees and other stockholders who have incentives to sell to themselves at prices which are detrimental to shareholders as a whole. The auction controls fraud.

NOTES TO CHAPTER 1

- 1) Even under the assumption of monopoly sellers, if joint gains from trade are greater under, for example, an English auction than a Dutch auction, a Dutch auction cannot be the maximizing solution unless extra-price mechanisms such as entry fees cannot be used. The typical model which purports to show that Dutch auctions produce higher revenue than English auctions, e.g. Harris and Raviv, includes no reason why, for example, an entry price equivalent to the expected consumer surplus could not be combined with an English auction. Such a mechanism would produce higher revenue for sellers because the area under the demand curve from the "monopoly output" quantity to the "competitive output" quantity would be capturable by the sellers.
- 2) From Plato, Laws, quoted in Wiedmann, Greek and Roman Slavery, p. 108.
- 3) Wiedmann, p. 95ff.
- 4) See following section on tax farming.
- 5) See Cobb, p. 79ff. and Wiedmann, p. 109.
- 6) See Bancroft, p. 314.
- 7) Examples include Ford, p. 143-3 and Rawick (ed.), pp. 9-11.
- 8) See Cassady, p. 71.
- 9) Reference to the jade auction can be found in Cheung (1982).
- 10) This passage is taken from the back cover of the Journal of Political Economy, V86, No. 2, Part 1, April, 1978.
- 11) See Cassady, p. 74.
- 12) This is noted in Harris and Raviv, p. 1477.

- 13) McDonald and Jacquillat analyze the prices of initial equity issues which are auctioned in France.
- 14) Several references to tax farming are found in Chang, Tax Farming in North China. For reference to early European tax farming, see Andreas, A History of Greek Public Finance.
- 15) The history of the Dutch East India Company, along with details of their selling and trading methods is found in Glamann, Dutch Asiatic Trade -1620-1740. The auction is discussed on pp. 32ff.

CHAPTER 2

LITERATURE SURVEY

Overview

Hundreds of articles on the broad topic of auctions are available in the economics and related literature.¹ These articles can be broadly grouped into three categories: theoretical, experimental, and what is called here "pure bidding strategy". The third category deals with discovering optimum strategies for bidders under specific assumptions regarding the distribution of bidders' valuations, the degree to which bidders are risk averse, and the information under which bidders operate. Insofar as this thesis approaches the subject of auctions from the point of view that the environment determines the type of auction rather than taking the type of auction as a datum,² the determination of optimal bidding strategies is of limited interest. While this is not to say that the rules do not affect bidding as indeed they will, it is to say that other factors are important enough that the observed pattern of bidding cannot be analyzed as though the rules were drawn independently of the environment in which the auction

operates. For example, the contention of the thesis is that rules encourage the production of information and as a result some auction rules will produce different patterns of bidding because systematically different stocks of information are differentially rewarded by different auction rules. Because of these considerations, no complete survey of the "pure bidding strategy" literature is provided here, although occasionally, papers are cited.

The current literature in both the theoretical and experimental categories is closely related insofar as both lines of investigation are implicitly asking similar questions: why do we observe auctions at all, and what determines the choice of auction form.³ However, while the current focus of these two lines of investigation are closely linked, the origins of these researches are not. The experimental literature started as an attempt at finding ways with which economic propositions could be tested in a way more analagous to what economists considered the repeatable, controllable environment of the hard sciences; auctions were a convenient environment in which to "demonstrate the potentialities of experimental techniques in the study of applied market theory" [Smith (1962), p. 112]. On the other hand, the theoretical literature was born out of an investigation not unrelated to the present study: in his seminal paper, Vickrey (1961) set his task as finding a way

in which efficient allocations of goods could be achieved in the face of a market in which buyers were few enough that each had a non-trivial impact on the market, but numerous enough that collusion was prohibitively expensive. As one mechanism which could achieve such a result, Vickrey proposed, and then analyzed, a simple auction procedure.

Subsequent researchers have started where Vickrey left off: they have concentrated on analyzing the results, in terms of price and allocation patterns, of various auction rules. Unlike Vickrey, however, they treat the type of auction as exogenous (or at best the result of choices made by monopolistic sellers) rather than derive it as an endogenous response to a given environment or problem.

This survey is roughly divided into the above categories of theoretical and experimental. In the first part, the theoretical literature, including some recent work on optimal auction design, is traced from Vickrey and then the experimental literature is examined, primarily by way of the research of Vernon Smith although mention is made of earlier but more obscure work by Edward Chamberlin (1948).

The Theoretical Literature

A common element within the theoretical auction literature is the use of the model (or derivative therefrom) first derived by Vickrey (1961). Most subsequent work is

presented against the background of that model and for that reason this survey starts with an abbreviated exposition of the basic Vickrey model.

The Vickrey Model

There are N bidders who each draw their marginal valuation (v) of the item for sale from a "common" rectangular distribution ranging over the $(0,1)$ interval. In contrast, other researchers have bidders draw their evaluations from a "private" distribution, that is, each bidder uses an individual distribution from which the estimate of the value of the item to be auctioned is drawn. In the auction, bidders make oral bids (b) in an ascending manner until only one bidder is left. Corresponding to a highest expected value drawn of $(N-1)/N$, the winning bid is the amount that the bidder with the second highest valuation is prepared to bid, plus epsilon, which can be conveniently neglected. The expected price in this ascending, or English auction therefore, is the second highest draw (bidder valuation) from the rectangular distribution with N draws. This is:⁴

$$(1) E(P_e) = \int_0^1 [N(N-1)](v^{N-1} - v^N) dv$$

which equals $(N-1)/(N+1)$.

The variance of prices from this auction is calculated as:

$$(2) \sigma_e^2 = \int_0^1 [v - (N-1)/(N+1)]^2 N(N-1)(v^{N-2} - v^{N-1}) dv$$

which equals $[2(N-1)]/[(N+2)(N+1)^2]$.

If, on the other hand, the auction were such that the auctioneer started at the highest maximum price and called out subsequently lower and lower prices until some bidder accepted, the optimum strategy can be derived on the assumption that each bidder knows that all other bidders draw their valuations from the same distribution. When all bidders are risk neutral, a Nash equilibrium exists where the expected gain is maximized subject to the probability of being the winning bidder. The solution is to maximize:

$$(3) E(G)_i = (v_i - b_i) \left(\int_0^{b_i} f(v) dv \right)$$

The unique equilibrium is therefore for each bidder to bid according to:

$b_i = [(N-1)/N]v_i$, where b is the bid and v is the marginal valuation drawn from the rectangular distribution. The problem now is reduced to finding the highest expected bid rather than the highest expected second value as in the case of the ascending auction. The winning expected bid then, is:

$$(4) E(P_d) = \int_0^1 ((N-1)/N)vNv^{N-1} dv$$

which is $(N-1)/(N+1)$ and is equivalent to the expected winning bid, or second highest valuation, in the ascending price auction.

This result of Vickrey, that both ascending and descending price auctions result in the same expected price or seller revenue, at least under the assumption of risk neutral bidders, can be found replicated in almost every auction paper written since. The common interpretation of this result, often called an equivalency theorem, is that, at least for risk neutral bidders, the prices determined in an auction are invariant to the auction rules chosen.

With respect to the variance of prices under the descending or Dutch method, it is shown to be higher under the Dutch method. The variance is:

$$(5) \sigma_d^2 = \int_0^1 ([(N-1)/N]v - [(N-1)/(N+1)])^2 N v N^{N-1} dv$$

which equals $[(N-1)^2] / [N(N+1)^2(N+2)]$.

In the limit, the variance of prices under English rules is twice the variance under Dutch rules.

One other comparison made between the English and Dutch auctions concerns the variance of gains to buyers, gain being defined as the difference between the marginal valuation and the bid of the winning bidder. Vickrey concludes that if risk aversion is introduced to evaluate the results of different auction systems, the Dutch system is preferable because the variance of gains is smaller than under English rules. Note however that the bidding strategies remain those of risk neutral bidders even though the evaluation is based upon risk aversion.

Although the description of the model here is done only for the ascending English auction and the descending Dutch auction, Vickrey points out that a second-price sealed bid auction is equivalent to the Dutch auction. In the sealed bid version, the individual making the highest bid is the winner but the price paid is that of the second highest bidder.

An interesting feature of this second-price rule is that it induces demand revealing behaviour on the part of the bidders. No strategy is preferable to revelation of true marginal valuation: that is, if a bidder makes a bid below his best estimate of the marginal value, the probability of winning the auction falls but the price to be paid does not change since the price paid is determined by not the winning bidder but by the bidder with the next lowest marginal valuation. Likewise, if the bidder were to make a bid in excess of his marginal value, then in the limit, losses will be expected.

Extension to sales where more than one item is for sale

In cases where more than one item is to be sold, Vickrey extends the second-price auction to a next-to-last-price auction where if j items are for sale, the j highest bidders are awarded the items but at the price submitted by the j plus first bidder. Beyond the full demand revealing

characteristics which exist for this method, Vickroy points out that informational requirements on the part of the bidders are reduced: "general market appraisal...[will be] entirely superfluous" (1961, p. 22). This point is of interest in at least two ways. First, it introduces the idea that different auction mechanisms might be associated with different information requirements of bidders, either by encouraging different information production or revelation. Second, it suggests arguments that Smith (1966, 1967), Friedman (1963) and others make concerning the relative merits of two different auction procedures for U.S. Treasury Bills.

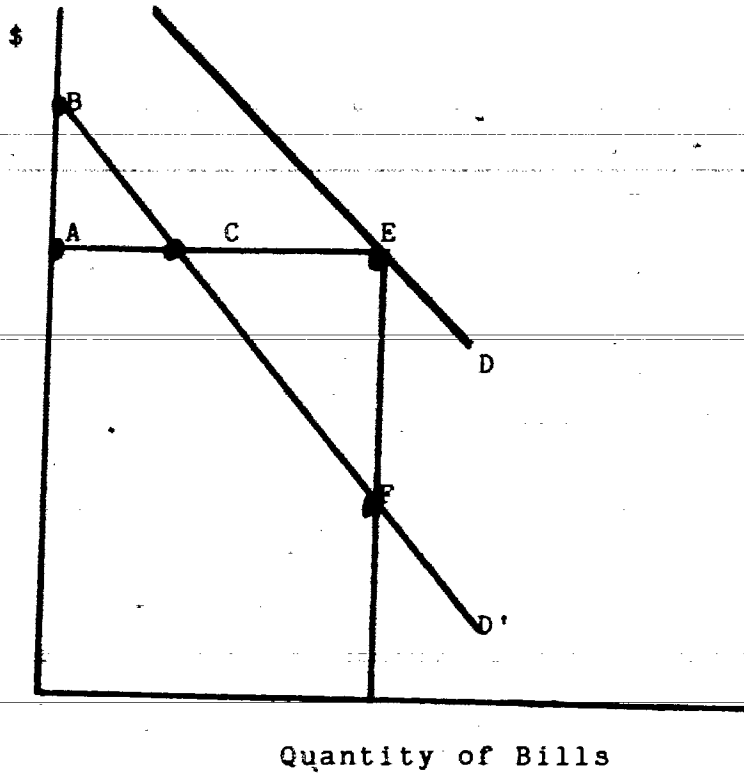
Discriminatory vs. Competitive Rule Auctions

In auctions where there is more than one item for sale, an issue has arisen with respect to which type of auction maximizes revenue for the seller. Two types of sealed bid auctions are considered: the first price auction in which the highest j bidders are awarded the items at the prices they bid, and the "second" price auction in which all winners pay the same price, that of the j -plus-first bid. The former is conventionally termed "discriminatory", and the latter "competitive".

Using a model very close to that of Vickrey, but with the addition of risk aversion on the part of bidders, Smith

(1966, 1967) argues that it is unclear which type of auction will produce more revenue for the U.S. Treasury from sale of its Bills. While it is clear that if bids are invariant with respect to the type of auction that the discriminatory auction will produce higher revenues, Smith argues that risk aversion will induce bidders to shade their bids when they are bidding under discriminatory rules. In this case it becomes an empirical issue whether the discriminatory or competitive auction will yield higher revenues. Graphically, the issue is demonstrated in figure 1: the "true" demand function is D and the observed demand function, ie the one representing the shaded bids, is D' . If the area ABC is greater than the area CEF , the discriminatory auction rule will produce more revenue. The issue is only one of determining how much the demand function shifts inward under discriminatory rules. (Some of Smith's empirical results are considered in a following section.)

figure 1



Arguing from a slightly different perspective, Friedman (1963) concludes that Treasury costs would fall (seller revenues would rise) if a competitive auction were used. Friedman argues that discriminatory rules imply that only very knowledgeable investors can get into the Treasury Bill market since investors who are buying bills for resale are using a derived demand curve and this means that "a bidder cannot afford to consult only his tastes; ...[he] must also try to guess what others will bid." (p. 319) Friedman

continues the argument by suggesting that current specialists are earning "a higher rent than they otherwise could" (p. 320). This higher rent indicates to Friedman that distribution costs to the Treasury are in excess of what they would be under competitive auction rules where there would be lower payments for the specialized services of Treasury Bill investors. While it is unclear why entry into the Treasury Bill market does not eliminate these "higher" rents,⁵ two implications of the argument are of interest: first, Friedman explicitly recognizes that the form of the auction can have an impact on the information producing activities of the agents in the market, or on the implicit selection of bidders. Second, there is the implication that observed prices will reflect the information producing activities of the agents. That is, he says that the specialists are earning a rent due to the fact that they are informed and that their rent would be reduced if the rules were such as to make the production of the specialized information less valuable. In such a case, the reduction of rent would be manifest in a lower observed price for the Treasury Bills.

There is another point made by Friedman which is of interest from the point of view of the current work: he suggests that by limiting the market to specialists, the discriminatory rules "tend[s]...to establish a strong

incentive for collusion among bidders" (p. 319).⁶ In Chapter 3, this capability of auctions, to reduce fraud on the part of specialist employees, is discussed in some detail.⁷

Another paper which analyzes the discriminatory versus the competitive auction is Holt (1980). Holt uses a game theoretic approach within the standard Vickrey model to reproduce Vickrey's original results that expected prices are invariant with respect to the choice of discriminatory or competitive auction rules when risk neutrality is assumed. When risk aversion on the part of bidders is introduced, Holt reaches the conclusion that discriminatory auctions produce higher revenues. The difference is accountable by the amount of risk aversion assumed and in this way is similar to the results of Smith (1966). Holt's results are not surprising when considered against the earlier work of, among others, Vickrey and Smith, and are indicative of a large body of the modern literature which uses game theory to analyze auctions. Most of this literature is directed toward ascertaining the optimal bidding strategy given various distributions of prior valuations, and degrees of risk aversion on the part of buyers.

A final example of a recent paper which considers the difference between discriminatory and competitive auctions is found in Riley and Samuelson (1981). Their results are

generally equivalent to those of Vickrey, Smith and Holt: under assumptions of risk neutrality, expected prices are invariant with respect to the choice of either the discriminatory or competitive auction but when risk aversion is introduced, the expected price of the discriminatory auction is higher than that of the competitive version.

Auctions with Bidders who have Asymmetric Information

This case was treated briefly by Vickrey (1961) who stated that while the mathematics of a general solution was intractable, the result was easily seen by example. Using an illustrative example, Vickrey attempted to show that if bidders had asymmetrical information then while the common or progressive auction was still pareto-optimal in allocation, the Dutch auction was not: with asymmetric information, the item could go to a bidder other than the one for whom the object had the highest value. From this example, Vickrey goes on "[T]o extrapolate rather boldly, ...one can perhaps hazard the guess that where the bidders are fairly homogeneous and sophisticated, the Dutch auction may produce results that are reasonably close to the Pareto-optimal, but where there is much variation in the state of information ... then the Dutch auction is likely to prove relatively inefficient from the point of view of securing an optimum allocation." (1961, pp.19-20)

The present study takes a perspective almost directly opposite to that of Vickrey: while Vickrey suggests that the Dutch auction is not appropriate in circumstances where information is very disparate, this thesis suggests the contrary - the Dutch auction is a device which tolerates very well informational differences. By rewarding those bidders who reveal better information to other agents in the market, the Dutch auction encourages the revelation of more (and guaranteed) information than would an English auction. Indeed, part of the value of the information arises from the fact that less well informed agents as well as better informed agents at the auction can use information which is revealed. In this setting, both informed and uninformed agents coexist. This theme is developed more fully in Chapter 3.

In a series of papers (1967, 1975, and 1977), Robert Wilson discusses the use of different auction mechanisms in the context of asymmetrical information held by bidders. In the 1967 paper, Wilson describes, within the context of a Vickrey type sealed bid auction, the situation where one bidder has an exact estimate of the value of the item for sale and the other bidder knows only the distribution from which that value is drawn. He shows that the less informed bidder will choose a randomized strategy while the informed bidder maximizes expected profit by making bids which reveal

his exact estimate. The results of Wilson's analysis indicate that the better informed bidder will be the winner less often but that when he wins, he reaps a very large "profit", which is observed as a low price.

Although Wilson does not provide any analysis beyond the derivation of the equilibrium strategies of the two bidders, the model can be interpreted to make predictions which are similar to the present study: when less informed bidders win the first of a series of items in a repeating Dutch auction sale, the observed price will (in an expected sense) fall.

This is due to the fact that the less informed bidder always is observed to bid a price higher than the (unobserved) bid of the informed bidder, i.e., the informed bidder never allows an uninformed bidder to make a bid below his own.

When the uninformed bidder observes a bid by the informed bidder, that bid fully reveals the exact estimate of the item's value and competition drives subsequent prices upward to the zero rent level, but upward from the average price of less well informed bidders.

In two other papers (1975 and 1977) Wilson considers the case where bidders can get information from samples. In this situation and where information is not costly, he shows that the informed bidder will always drive the uninformed bidder either out of the auction or into producing sample information of equal quality. Also in the 1977 paper,

Wilson shows that the estimates of various bidders are consistent, i.e., in large samples, there is no bias in the observed prices. This result is in contrast to the proposition known as the "winner's curse".

The Winner's Curse

The winner's curse is the proposition that the winner always pays too much. Within the format of these kinds of auctions, bidders draw separately unbiased estimates of the value of the item for sale. Since the highest of the unbiased bids is chosen, the observed price is always biased upward- the winner's bid is always in excess of the item's value - the winner loses. This "phenomenon" (Engelbrecht-Wiggans, p. 133) was first analyzed by Capen, Clapp, and Campbell (1971) and has also been noted by Belovicz (1979) and Smith (1980). Smith uses an apparently different model, one in which even individual bids are biased: "Clearly these subjects are bidding in excess of their marginal valuation for the item to be very sure of having their bid or bids accepted." (1980, p. 366). Milgrom and Weber(1982) state that the winner's curse is responsible for the observation that oil companies who bid for leases in the 1960's and 1970's had very low profits.⁸

An interesting way of dealing with informational asymmetries can be found in Milgrom and Weber (1982) where

they introduce what they call "affiliated" random variables. In rough terms, affiliated variables are those variables which carry information from one agent in an auction to another. For example, a bid is an affiliated variable if its disclosure affects the valuation that other agents put on the item for sale. With the concept of affiliated variables, Milgrom and Weber produce some models in which it benefits sellers to provide information or guarantees about the item for sale. The benefit is through the reduction of (redundant) research required by individuals in the auction. Other results from this paper are discussed under the heading "reserve price and entrance fee auctions".

Related to the issue of auctions with asymmetrically informed bidders is the issue of information production within the auction. While most of the literature assumes some stock of information which is fixed for the duration of the auction, a few recent articles have at least hinted at the possibility that auctions might affect the production of information by the choice of rules used. Riley and Samuelson (1981) for example, point out that second price auctions have an advantage in that specialized knowledge about the market becomes redundant; that is, the Dutch auction "economizes on the information each buyer requires to bid optimally" (p. 389). Another point raised in the same paper is a speculation that sellers might profitably

produce information or encourage pooling of information by bidders. The possibility that the auction rules might be designed for just this task is not explored however.

Another paper which hints at the possible inappropriateness of using models in which the stock of information is fixed is Goldberg (1977). In a paper concerned primarily with the issues of pre-contract information and bidding strategy, Goldberg chastizes economists for their neglect with respect to analyzing institutions without any theory for their existence. He says:

"Economists have implicitly assumed that the bidding competition can be judged in one dimension - price - and that the specifications are determined exogenously; the bidding mechanism merely entails incidental transactions of no great cost or analytical import.... Rather we should anticipate bidding mechanisms designed to convey and protect information for formulating specifications and evaluating potential suppliers. The bidding process is not only apt to be costly but it will also have significant impact on the nature of the output itself." (p. 259)

This view is consistent with the contention of this paper that the contemporary research strategy is inappropriate to the questions being asked: the bidding mechanisms entail enough of import that they cannot be ignored. Rather, to extrapolate from Goldberg, we should expect institutions to emerge for the protection and conveyance of information where that information is

sufficiently valuable. This theme is expanded upon in Chapter 3.

Reserve-Price and Entrance-Fee Auctions

Several papers have introduced questions related to the circumstances in which it might be profitable for auctions to use reserve prices or entrance fees. Using a framework in which he considers the possibility that the stock of information brought to the auction might be affected by the rules, Johnson (1979) derives an optimal entrance fee which sorts potential bidders in such a way that expenditure on what could be called redundant information is reduced. The entrance fee serves to notify bidders that only those with expectations of bidding above some level should attend. In this way, bidders who have, for example, low valuations of the item for auction will make fewer resource expenditures on, for example, refining their estimates. By reducing such expenditures, the rules of the auction provide benefits to both buyers and sellers.

In a similar way, Milgrom and Weber introduce reserve prices to act as a filter between bidders with "appropriate" and "too low" valuations of the item for sale. Again, by reducing the expenditures by individuals who would otherwise produce or bring to the auction redundant information, reserve prices are beneficial to both buyers and sellers.

Optimal Auction Design

Some recent literature has explicitly considered the question of the appropriateness of type of auction, the most notable examples being Myerson(1981), Harris and Raviv(1982), Milgrom and Weber, and Riley and Samuelson. While some aspects of these papers have been discussed, their attempts to explain the use of different auction procedures have not.

The prime determinant of the type of auction in these and other papers which explicitly ask the questions of this thesis is revenue maximization on the part of the seller. Riley and Samuelson for example, start by stating that the choice of seller rests with monopolistic sellers and then motivate their research by asking "what form does the competition among the few buyers take...?...[and] by what means can the seller best exploit his monopoly position?" (p.381).

Because of the reliance on monopoly settings, these papers are not directly relevant to the questions asked in this thesis. The determination of the appropriate market mechanism in this thesis is conducted within an environment in which alternative mechanisms are available.

Summary of Theoretical Literature

A strong commonality exists in almost all of the theoretical auction literature. This commonality is found in both the assumptions which form the framework of the analysis, and in the results of that analysis. With respect to assumptions, researchers have, by and large, started by stating that the form of auction is exogenous. Only hints can be found that suggest that the form of the auction might be determined endogenously by any market characteristic (except monopoly power on the part of sellers). Also, the auction is generally described with order statistics; for example, the equivalence result between English and Dutch auctions which nearly every author reproduces can be characterized by deriving the expected second highest valuation from some distribution: in the English auction, bidders need only bid epsilon above the next lowest bid, and in a Dutch auction, the wealth maximizing strategy is to bid the valuation of the next lowest value bidder. In this way, the auction is analyzed as a lottery rather than a mechanism designed to serve particular needs.

The commonality of current research extends beyond the basic models to the results generated. Vickrey's original conclusions about the equivalence of expected prices in different auction settings remains nearly untouched. When risk aversion is introduced, the issue only changes insofar

as it becomes an empirical question. Even the introduction of such issues as reserve prices and entrance fees has not altered the basic thrust of the original Vickrey work which analyzes the impact of exogenously determined allocation mechanisms although hints exist of the possibility that the form of the auction might be better analyzed as endogenous rather than exogenous. However, even those papers which attempt some analysis of optimal auction design have been unsuccessful in producing any refutable propositions about the use of different auctions.

The Experimental Literature

The first example of laboratory-type experiments in the context of markets and bidding that I have found is in Edward Chamberlin [1948]. Chamberlin gave his subjects marginal cost and marginal value "tickets" and directed them to find trading partners at whatever price they could. The trading was executed on a simultaneous bilateral basis; that is, each agent attempted to find a compatible trader but did not announce his bid or offer to more than one other agent at a time. Chamberlin concluded that "no tendency for prices to move toward equilibrium during the course of the market or for the last price to be closer to equilibrium than earlier ones is discernible in the data of our experiment." (p. 101).

Almost fifteen years later, Vernon Smith (1962) published what was to be the first of an impressive body of work on experimental market analysis. Smith's study differed from that of Chamberlin in two fundamental ways: first, Smith analyzed trading over several successive trading periods rather than during a single period, and second, Smith's subjects engaged in multilateral trading by announcing bids and offers publicly. Likewise, Smith's conclusions were much different: "even where numbers are 'small', there are strong tendencies for supply and demand

equilibrium to be attained." (p. 134) Smith criticized Chamberlin's design of the experimental market by saying that there was no presumption that a market clearing price would emerge from a series of unconnected trades in which participants were prevented from learning about the market. Smith attributed the difference in results to the learning which he allowed for in his experiment. He considered the learning a necessary condition for an equilibrium price to be generated in a neo-classical model.

Within the 1962 paper, Smith conducted tests of two competing theories of the tatonnement process. Against the Walrasian hypothesis that price adjustment was a function of the excess demand at a given price, Smith tested what he called the 'excess rent' hypothesis. Under the excess rent hypothesis, price adjustment would be a function of the difference in rents available to buyers and sellers at any given price. For example, if buyers' and sellers' demand and supply schedules implied large differences in rent at some price, then adjustment would be faster than if buyers and sellers had identical potential rents available. Agents with more rent available were, under this hypothesis, more willing to adjust their bid/offer. Smith concluded that the excess rent hypothesis was more satisfactory than the Walrasian hypothesis and suggested that "a competitive market for a single commodity can be interpreted as seeking

to minimize total rent." (p. 134)

In a further study [1964], Smith introduced the possibility that buyers were also allowed to make bids and that both buyers and sellers could make bids. Smith hypothesized that the market organization, i.e., the rules concerning who could make offers or bids, would alter the way in which equilibrium prices were established. The evidence from this series of experiments suggested that at any given market period, prices were highest when only buyers were permitted to make offers, next highest when both buyers and sellers were permitted to make offers, and lowest when only sellers made offers.

Further studies by Smith (e.g., 1965, 1967, 1976a, 1976b, 1980, 1982) and with Miller and Plott (1979) and Williams (1981), maintain similar frameworks and add considerations such as the existence of minimum prices, secret bidding, first- versus second-price mechanisms, and quantity restrictions. One important aspect of these studies from the point of view of the current research is the testing of some of the theoretical hypotheses put forth by Vickrey [1961]. Vickrey suggested some equivalence theorems which related English, Dutch, first- and second-price sealed bid auctions and much of Smith's experimental work is devoted to testing these hypotheses. In his 1967 study, Smith attempts to replicate the U.S.

Treasury Bill auction and experiments with the use of first- and second-price rules. The tests were to some extent also designed to examine the claims of Friedman (1962, 1963) and others relating to whether the Treasury would receive more revenue by instituting a procedure whereby the highest bidders received the Treasury Bills at the price bid by the lowest-price bidder. In terms of revenue generation, in Smith's experiments, the lowest-price rules provide less revenue when a large number of bids are rejected, that is, when the total demand for Bills, regardless of price, is much greater than the supply. When the excess demand so defined is small, the two sets of rules are equivalent in terms of revenue generation. Other conclusions of the study suggest that the variance of bids is higher when lowest-price rules are used than when the winning bidders pay their bid price.

In more recent papers Smith has produced experimental results on the effects of information disclosure in auctions, and on the effect of price limitations. In his 1980 study, for example, evidence is provided to suggest that markets in which the complete demand and supply schedules are known converge to an equilibrium less quickly than markets in which bidders know only their own schedules. This result may be due, according to Smith, to the excess rent hypothesis.

The winner's curse "phenomenon" has also been tested empirically by Smith (1967) and Belovicz (1979). Smith states that in competitive auctions, bidders "sometimes bid in excess of their marginal valuations" (p. 366). Belovicz confirms this result and both authors suggest that this bizarre result is due to risk aversion on the part of the bidders. It is unclear however, why risk would mean bidders prefer negative to zero profits.

In one of the few experimental papers dealing with auctions of multiple units, Fred Williams (1972) extends some of Smith's (e.g., 1964) early work by changing the units for sale from one to some multiple value. In this work, Williams reports that the convergence to equilibrium prices in the multiple unit case is the opposite of that produced by Smith; Williams found that when "price leadership" was exhibited by sellers, prices converged to a value above the theoretical value and if by buyers to a value below the theoretical level.

A significant amount of experimental work has not been included in this survey. The bulk of that work is consistent with the work reported here insofar as the analytical framework is the same and none of the results report any significant departure from those reported above. Some of the representative papers include: Miller, Plott, and Smith (1977), Fiorina and Plott (1978), Plott and Smith

(1978), Isaac and Plott (1981), Plott and Wilde (1982), Arlington Williams (1979 and 1980), Smith and Arlington Williams (1981), Smith, A. Williams, Bratton and Vannoni (1982), and Coppinger, Smith and Titus (1980).

Summary

The economic literature on auctions is divided into two broad categories: theoretical and experimental. The consistent approach in both categories is that of analyzing outputs and prices within the framework of exogenously determined market institutions. While recent articles consider the more fundamental questions concerning why specific institutional forms are chosen, much work is needed toward a more general theory of auctions, specifically a theory which derives the form of market institutions as an endogenous response to economic factors.

NOTES TO CHAPTER 2

- (1) For example, Stark and Rothkopf list nearly five hundred papers in their 1979 bibliography and a survey by Engelbrech-Wiggans in 1980 lists over a hundred articles, many of which are not included in the Stark and Rothkopf work.
- (2) This is very similar to an approach suggested by Hurwicz (1959). "...[T]hese findings suggest the possibility of a more systematic study of resource allocation mechanisms. In such a study, unlike the more traditional approach, the mechanism becomes the unknown of the problem, rather than a datum." (p. 28)
- (3) These questions are asked explicitly in the first paragraph of a recent article by Harris and Raviv (1980).
- (4) See the appendix to Vickrey (1961) for a complete exposition of the model.
- (5) Friedman's expression "higher rent" may be net income, or profit in the sense that Fisher uses: "When risk attaches to any...form[s] of capital...the man in the street calls net income profits." Fisher (1930), p. 33.
- (6) This phrase is originally from Friedman's statement to Joint Economic Committee and is quoted in Friedman (1963).
- (7) See also reference 14 in Chapter 1 on the use of auctions by the Dutch East India Company.
- (8) Milgrom and Weber (1982), p. 1094.

CHAPTER 3
AN ALTERNATIVE STRATEGY

In the last chapter, the literature survey described the basic strategy which generally has been followed in the investigation into auctions. To reiterate, prices and outputs are analyzed under the assumption that the specific allocative mechanism, i.e., the auction, has been determined exogenously.

In this chapter, I demonstrate that except in very unusual circumstances, theorems generated with models of exogenously determined auctions are unlikely to be meaningful. Although the criticism to be made is very general, I choose as an example of a meaningless theorem the equivalence of auctions theorem. This theorem, which is ubiquitous in the literature, states that expected prices in Dutch and English auctions will be equivalent when bidders' strategies and risk attitudes are of an appropriate form. The criticism is restated in more general form as an inappropriate use of partial or "too partial" analysis for the questions at hand. An alternative to the exogenously determined auction strategy is outlined in this chapter and expanded into a theory of Dutch auctions in the next

chapter.

In "Microeconomic Systems as an Experimental Science" (1982), Vernon Smith describes the "methodology and function of experiments in microeconomics" (p.923). The system described by Smith produces results which are claimed to be "transferable to field environments" (p.937) when what Smith calls parallelism holds. Parallelism is defined as: "Propositions about the behaviour of individuals and the performance of institutions that have been tested in the laboratory microeconomies apply also to nonlaboratory microeconomies where similar ceteris paribus conditions hold." (p.936)¹ He goes on to say "the appropriate way to falsify parallelism with respect to some aspect of behaviour is to show that some replicable property of a theory or institution in a laboratory microeconomy is falsified with field data." (p.937)

I focus on a necessary but unstated assumption in Smith's system for that system to be "parallel". I show that if one follows Alchian's survivor principle, and accepts Smith's own requirement that parallelism hold, then the current laboratory and theoretical attempts to compare different types of auctions in terms of price generation etc., must be meaningless. If on the other hand, the survivor principle argument is not accepted, it becomes necessary to follow Smith explicitly by providing some

evidence from "the field" which suggests that parallelism should be rejected in experiments comparing prices and allocations of different, exogenously determined institutions.

The Experimental Microeconomic System.

Smith defines a microeconomic system with the following characteristics: an environment consists of $K+1$ commodities and N agents, each characterized by e^i where e^i is a vector of utility function (u^i), knowledge (T^i), and endowment (w^i). The institution which operates in the environment has a "language" $M = (M^1 \dots M^N)$ consisting of messages $m = (m^1 \dots m^N)$ where messages might be bids or offers, etc.. There exists an allocation rule $H = (h^1(m) \dots h^N(m))$ which states the final allocation as a function of the message sent. In addition, cost imputation rules (c^i) link messages and payments, and adjustment process rules (g^i) determine the conditions under which messages are exchanged. These characteristics together define each agent's property rights to communication and exchange (I^i), where $I^i = (M^i, h^i(m), c^i(m), g^i(t_0, t, T))$. I "specifies the message that (each agent) has the right to send; the starting, transition, and stopping rules which govern these communication rights; and finally the right to claim commodities or payments in accordance with the outcome rules that apply to messages. A microeconomic institution is

defined by the collection of all these individual property right characteristics $I=(I^1, \dots, I^N)$." (p.925)

Smith goes on to provide an example of an experiment in which two different auction procedures are compared. The results of this experiment are summarized by the Nash Equilibrium bids bigenerated by these two different auctions (V_i is the marginal valuation of the i th bidder and r_i is a measure of risk aversion):

$$b_i = ((N-1)V_i)/(N-1+r_i)$$
 where auction rule $j=1$ is used and

$$b_i = V_i$$
 where auction rule $j=2$ is used.

Generally, $b_i = \beta^i[e^i | I]$.

From the above, it is obvious that where bidders are risk neutral ($r=0$), the two auctions generate identical bids, which is an example of the simple Vickrey result which I call here the "equivalence of auctions theorem".

Rejection of Parallelism by the Survivorship Principle.

To consider whether the experiment above (which in terms of methodology is the arch-typical auction experiment)

conforms with "parallelism", I focus on the bid definition,

$b_i = \beta^i[e^i | I]$. The bid is a function of all those characteristics which define e^i , including T^i , the agent's

knowledge endowment at the start of the auction. In some models, the knowledge may change during the course of the auction but this alteration does not affect the criticism. In virtually all formal auction models, the knowledge endowment is fixed when the auction begins, independent of the type of auction. Agents arrive in this experiment without knowing whether a type 1 or type 2 auction is being held on that day.

Keeping in mind the fact that agents arrive without knowing which type of rule they will face, consider the following "experiment". A piece of currency is to be auctioned by two sets of rules, oral Dutch and oral English. The exact denomination of the currency is not known but the distribution from which the denomination is drawn is known by all agents; for concreteness, say the note has an equal probability of being a ten, a twenty, or a fifty dollar bill. Further, suppose that information on the exact denomination of the bill is obtainable at some cost, say one dollar. In this experiment, the identity of any bidder purchasing that information is known by all other bidders.

Consider that the seller announces that the auction will be by English rules and oral ascending bids will be accepted until no further bids are forthcoming. In this setting, no agent will purchase the information. Any bid by a fully informed agent will reveal information and this information

can be costlessly appropriated (stolen) by other bidders. For example, a bid above nine dollars will reveal that the note must be at least a twenty; any bid above nineteen reveals that the note must be a fifty. Any agent who purchases information will be assured to lose money - his costs in this auction are necessarily higher by the cost of his better information.

Now, consider the same experiment with one change - the auction rule will be Dutch. The seller calls out offers in a descending manner from an initial price of fifty dollars until someone bids. As soon as any bidder acknowledges acceptance, the auction is over and the currency is traded at the bid price. At the instant that any information is revealed, the bidder who revealed the information can appropriate the gains from the acquisition of that information. In this setting, agents will have an incentive to spend scarce resources on the acquisition of information.

This "cartoon" experiment demonstrates that the different auction rules can encourage differential acquisition of information prior to the commencement of the auction. Where information is valuable, the English auction described here will encourage less acquisition than will the Dutch auction where the rule provides a property right to the gains from information acquisition.² (Other mechanisms may be available to encourage information in the English

auction; for example, resources could be expended to conceal the identity of the informed bidder.) Indeed, the ability of individuals to conceal information will determine in part whether an English or Dutch auction is more appropriate. In general, to paraphrase Goldberg (1977), we should expect to observe that where information is valuable, institutions will arise to convey and protect that information.³

While it is not possible to say, a priori, which institution would be observed in the example here, it is possible to list some of the important determinants. In some markets, it is observed that sellers provide guarantees while in others, a strict caveat emptor rule applies. One reason why this might be so is that where the appropriate dimensions of a good are relatively costly to measure, guarantees by the seller may be able to replace the replication of searching and measuring done by individual consumers. The increased net gain from trade which results from the reduction of measurement costs implies the survival of that institution. Where the appropriate valuations of the good cannot be cheaply determined by the seller, it is likely that buyers will engage in more "redundant" search and the value of guarantees will be lower.

The bid function used in current research then, is mis-specified: in Smith's notation, b_i should be not a function of e^i but a function of e_j^i where the subscript

refers to the auction rule being used. Where this is not done, the results of the experiment will be meaningless: one of the hypothesized institutions will in general be superior to the other in terms of the generation of gains from trade and this requires that at least one of the institutions will not be observed because it could not survive. Indeed, it is possible that neither of the hypothesized institutions could exist and if this is so, the experiment will produce results on two institutions which could never be observed.

To the extent that different institutions have different capabilities with respect to the promotion and protection of the acquisition of valuable information, experiments which ignore this will be experiments on institutions which could not exist.

In some models (e.g. Milgrom and Weber), information sets do change during the period of the model but this is not sufficient to avoid the problem of observing institutions which do not and cannot exist. Even in a framework where bids convey information, imposition of different trading rules which differentially protect information implies that one of the institutions would be less capable of producing gains from trade than the other and perhaps some third, unconsidered institutional arrangement would be superior to both.

Evidence "from the field" to reject Parallelism.

In Chapter I, a group of auctions were described. Flower auctions in the Netherlands, in Toronto, Vancouver and San Diego were described as being held under Dutch rules. No flower auctions, to my knowledge, are held under English rules. Slave auctions, which have been operating for at least 30 centuries, have been held under English rules. I have found no account of any slave auction which operated under Dutch rules nor any flower auction which operates under English rules. The consistency of rules under which these and many other auctions have operated suggests that laboratory and field behaviour are indeed different.

The equivalency of auction results which is ubiquitous in contemporary research has a very strong implication (at least in the risk neutral case): participants in auctions should be indifferent between rules chosen. The strong consistency of rules for many items commonly auctioned casts severe doubt on this prediction.

In response to the above contention that field and laboratory experiments yield different results we could refer to several caveats offered in the literature. The prime ones concern distinctions between risk neutral and risk averse agents, and between agents who draw their valuations from common and private distributions.

Many researchers have concluded that where bidders are risk averse, monopoly sellers will prefer a Dutch auction. However, at least in the case of the flower auction examined here, the required monopoly power on the part of sellers cannot be maintained - less than half of the flowers sold in the Vancouver market are auctioned and hundreds of buyers and sellers operate without legislative constraint on agents or methods.

With respect to the requirement that buyers be risk averse, it is difficult to believe that flower buyers in Vancouver, who typically purchase flowers in lots worth less than \$50 each could manifest more risk aversion than slave buyers who, in the 1830's paid up to today's equivalent of perhaps a quarter of a million dollars for an individual slave.⁴

Sufficiently General Analysis.

One way of avoiding the problem of investigating phenomena which do not exist is to produce a theory of institutional formation prior to examining any given institution, that is, to endogenize the choice of economic organization.

I contend that current auction research is not sufficiently general, i.e., it includes no theory of institution formation. Admittedly, there is a sense in which

this criticism is a facile criticism, one which must necessarily apply to all scientific research because no model can ever be perfectly general. In response to this observation, it should be stated that perfect generality is not proposed, only sufficient generality, where sufficiency is defined in simple, operational terms: an analysis is sufficiently general when it is capable of explaining the phenomenon under investigation, i.e., when it is capable of producing refutable predictions, but is not refuted. To this end, the approach proposed here contains two elements: first, an existing institutional arrangement is examined within a theory which predicts such an arrangement, and second refutable propositions are derived and tested. More general validity of the theory, that is, the ability of the theory to explain more general phenomena than the examined institution is considered by extending the refutable propositions to other similar institutions and to other alternative institutions.

The two fundamental questions which have prompted recent research into auctions are: why do we observe auctions at all, and what determines the observed form of auction? While these questions have been implicitly considered by nearly all researchers, and explicitly asked by some [e.g., Milgrom and Weber (1982) and Harris and Raviv (1981)], nowhere do refutable propositions emerge which could be

considered as explanations of the observed phenomena. Without a theory which explains why auctions are used in lieu of other allocative mechanisms, for example, firms, assertions about price and allocative outputs are non-testable. Without a theory which explains why one type of auction is used in lieu of another, predictions that English auctions raise more revenue than Dutch auctions are meaningless. Current research strategies have failed to produce explanations for the phenomena supposedly under investigation, in part because the strategy has not been sufficiently general.

Sufficiently general models are defined here as being models which produce refutable, but not refuted hypotheses about the phenomena under investigation. Partial equilibrium models are sufficiently general to the extent that they explain (predict) the observation of interest. In the case of the auction literature, there are no explanations capable of refutation except those which are testable solely in laboratory settings.

One example (of literally hundreds) of the non-refutability of propositions is found in a recent paper by Harris and Raviv (1981). In discussing the differences between discriminating and competitive auctions, they state,

"The main result implied by our model is that the sellers' expected revenue under the competitive auction is the same as under the discriminating auction when the bidders are risk neutral and strictly smaller under the competitive auction when bidders are risk averse". (p. 1488).

In their model, N bidders compete for Q items. Under competitive rules, the Q highest bidders receive the items for the price of the highest rejected bid (the $N-Q$ order statistic). Maximizing strategy of both risk neutral and risk averse bidders is to bid their marginal valuation, and this produces the expected seller revenue of the integral of the marginal valuations times the p.d.f.'s of those valuations over all bidders.

In the case of the discriminating auction, bidders pay the value of the submitted bid. By increasing (decreasing) the bid, the probability of winning the auction rises (falls) but the difference between marginal value and cost decreases (increases). In the competitive auction however, increasing the bid does not affect the difference between marginal value and cost even though it changes the probability of winning the auction. This is because the price is determined not by any winning bidder but rather by the bidder with the valuation below that of the lowest valued winner. In the case of Q items, the valuation of the Q plus first highest value bidder determines the price for the first Q bidders. Because of this difference, observed

bids in a discriminating auction will be below those in competitive auctions. When bidders are risk averse, Harris and Raviv show that seller revenue is less under competitive than discriminatory rules. The question remains; is this result refutable?

Harris and Raviv's result is dependent upon, among others, the assumptions that the valuation distributions from which bidders draw their marginal valuations, are the same under both sets of rules. If this is not so, as in the case where the valuation schedule is affected through differential acquisition of information, then the calculated expected seller revenues cannot meaningfully be compared.

Two unobservables, the distributions from which buyers pick their marginal valuations, and the degree of risk aversion, are both required to make the proposition testable (in other than laboratory settings).

In another recent paper, Milgrom and Weber (1982) state that they provide testable predictions:

"Despite its generality, the model yields several testable predictions. First, the Dutch and first price auctions are strategically equivalent... Second, when bidders are uncertain about their value estimates, the English and second price auctions are not equivalent: the English auction generally leads to larger expected prices... A third prediction of the model is that when bidders' value estimates are statistically dependent, the second-price auction generates a higher average price than does the first-price auction". (p. 1095)

If the authors mean by testable that laboratory experiments could be used then indeed their predictions are testable, since risk aversion, certainty about estimates and statistical dependence can be controlled to some degree in that setting. Beyond the laboratory, however, it is unclear how one might attempt to test their predictions.

The Alternative Strategy

Having argued that current research into auction phenomena suffers from an important weakness, i.e., it does not explain why specific institutional arrangements exist, an alternative approach is offered.

The approach contains two basic elements: first, a specific auction mechanism is viewed as one alternative of many which could have been chosen, including non auction mechanisms such as the integrated firm. The second element is that the research must be directed toward producing refutable propositions which are capable of explaining the phenomena under investigation.

In the next chapter, one example of such an approach is presented. Firms and auctions are viewed as mechanisms which use information. The relative capabilities of firms and auctions and various auction forms to encourage the appropriate amount of information acquisition and revelation

are hypothesized to be important determinants of the choice of organizational form.

NOTES TO CHAPTER 3

- 1) More precisely, "We apply the term 'parallelism' to the proposition suggested by Harlow Shapely (1964, p. 43) that 'as far as we can tell, the same physical laws apply everywhere.'" V. Smith, 1980, p. 349.
- 2) see chapter 4 for a fuller discussion about the use of rules in an auction to convey property rights to information.
- 3) Goldberg, p.259.
- 4) Slaves in the early 1800's fetched prices up to \$30,000. In today's prices that is nearly a quarter of a million dollars. (The price index grew about eight times from 1830 to 1982.)

3

CHAPTER 4

THE ECONOMICS OF A REPEATING DUTCH AUCTION

In this Chapter, I provide an approach to auction theory which departs significantly from traditional work in this area. The line of work, which started with Vickrey, analyzes prices and allocations from exogenously determined auction mechanisms (even though Vickrey's original auction was endogenously determined) while my task is to set forth a framework which explains why a Dutch auction would be chosen. The endogenously determined repeating Dutch auction is seen to be designed to encourage some participants in the market to acquire and reveal information valuable to all participants.

For the purpose of expositional ease, I focus on two simplified versions of alternative market mechanisms - the "firm" and the "auction". The term firm is used as a generic - it refers to a set of contracts where exchanges are conducted through some directed activity rather than through market prices. Concrete examples, in the flower case could include such organizations as a fully integrated operation where the flower grower also acts as wholesaler

and retailer, or it could include an organization integrated only to the wholesale level. Retail flower shops or fixed price 'farmer's markets' could both involve producers doing the actual selling.

The term Auction is used to denote a kind of market where sellers and buyers come together and prices are set (and changed) by an explicit and continuous bidding process. The distinguishing feature is that while prices are "directed" by sellers in the "firm", they are set by all bidders simultaneously in the "auction".

The Importance of Information.

Information is valuable to the extent that it allows for the more profitable allocation of resources among competing activities. While all economic organizations produce information of some degree of reliability, it is possible that some institutions may encourage "too much", or "too little" information, and some may encourage "redundant" or even fraudulent information. In this section, I consider some reasons why different economic organizations may have different comparative advantages in encouraging the appropriate amount of acquisition and revelation of valuable information.

Information Production in Firms.

Within what we think of as the typical integrated firm, information production is centrally directed and is usually carried out by specialist employees. Specialist employees may be involved in forecasting output or factor prices, or they may be involved in producing information for design or invention purposes. However, the very specialist nature of these employees requires that the firm engage in costly monitoring activities.

Monitoring of specialist employees is necessary to reduce the likelihood that "bad" information results in wealth losses for the firm. Bad information could be produced either through inadvertent errors on the part of employees, or it could arise through the deliberate attempts of employees to use their specialist positions to defraud the firm. When an oil company submits a bid for an oil lease, poor quality estimates of the value of the lease could result in the company paying "too much", with resultant wealth losses. The employee who provides the estimate may have made an error, or he could have been deliberately defrauding his employer. By selling stock short in his own company or buying stock long in the current lease holder, an employee who submits an overestimate of the value of the lease can defraud current stockholders.

On the other hand, contracting problems also run the other way - employees may not be able to contract successfully for the value of their research. Even if their output is very valuable, the cost of measuring it may be prohibitive. This would be the case, for example, if the results of the research were only observable after a long period of time. Like Knight's entrepreneur, individuals in this situation can appropriate the gains from their research by starting their own "firm". In any case, when employees cannot be paid, they will leave and those activities may appear in some other organizational form.

Deliberate "bad" information is not even necessary for fraud to occur however. In some cases, adjusting the timing of the revelation can be sufficient to allow the employee to benefit to the detriment of current stockholders. Consider the case of the employee who discovers some device which will increase the value of his firm. By buying stock in his own company prior to revelation of his findings, current stockholders are defrauded to the benefit of the specialist employee.

To reduce both inadvertent errors and deliberate fraud, the firm must engage in costly monitoring activities. In some cases, the information produced by specialist employees may be monitored fairly directly, for example, by looking at

track records in the case of forecasts and while this does not guarantee the quality of any piece of current information, it does allow a check against the persistence of systematic errors, whatever their origin. In many cases however, direct monitoring may be so costly that more indirect forms of monitoring may be required.

One possible way of monitoring agents' activities could include the use of team production methods. By paying bonuses to all members of a team for the production, by any member of the team, of valuable information, each participant has an incentive to ensure that other members do not engage in fraudulent activity (at least to the exclusion of the rest of the team). Another potential way of reducing fraud through indirect monitoring may be to use compartmentalized research. For example, by separating various parts of a common research effort, it may be possible to make any individual's information valueless except in combination with the information of all others. By so doing, the firm reduces the monitoring necessary to the individual who holds the "key" which fits the different pieces of the research together. Perhaps only shareholders will be observed to be in such positions.

Many other examples of indirect monitoring techniques can be readily found. For some employees, insider trading rules provide criminal sanction, for professional athletes,

contracts stipulate that they must not engage in betting activity or associate with known gamblers. The existence of the "closed" corporation may be explainable through a monitoring hypothesis. A closed corporation is one in which all employees are generally stockholders and only the corporation can buy stock. When an employee quits or is fired, the corporation values the stock which must be sold back to the corporation. The captive nature of the employee's wealth acts to constrain the net benefits from fraudulent activity.

Nevertheless, even though direct and indirect monitoring can be accomplished within the integrated firm, it is possible that even the less costly of these alternatives will not be sufficient to encourage the appropriate production of information. In these circumstances, the organizational structure of the firm itself may be inappropriate and a substitute organizational form may be required. One possibility is an auction.

Information Production Within Auctions.

While firms typically use centrally directed research activities to produce information and then use resources to monitor the quality of the information, auctions can produce information by pooling diverse estimates from self-selected sources. By requiring that agents in the auction stake a

portion of their wealth on their estimates, the auction provides a guarantee of the quality of information. In this way, the auction can be thought of as encouraging "redundant" information, that is, the auction encourages many participants to collect and reveal the same piece of information. Each participant's estimate acts as a check against every other estimate and it is in this way that extra resources used in the replication of information are offset by the reduction in the amount of resources expended on direct monitoring activities.

Information is characterized here as having two dimensions-quantity and quality. To produce a given amount of information of a given quality, two substitute techniques can be used- replication and direct monitoring. If a piece of information is produced by only one individual, some amount of monitoring will be required to ensure the quality of that information. By replicating (independently) the production of the information, the information becomes more reliable because the cost of deliberate fraud has been raised while the benefits have been reduced. To engage in fraud, all the replicators of the information will have to engage in costly coordination and then divide the benefits. By increasing the amount of replication of information, that is, by encouraging "redundant" information, fewer resources will have to be directed toward monitoring activity.

The decision therefore, to choose an integrated firm or an auction (which are two extreme and not necessarily mutually exclusive options) will in part depend upon the resource expenditure of replicating information relative to monitoring its quality. Where replication is costly relative to monitoring, an integrated firm will more likely be capable of being the least cost producer of information. Alternatively, where direct monitoring services are costly, the auction, by conserving on the use of those resources, may be a more profitable form of economic organization.

Information Production in Different Forms of Auctions.

The word auction has been used as a generic term for an institution which pools diverse estimates and provides a guarantee by requiring that bidders stake a portion of their wealth on their estimates. Different rules within auctions can encourage more or less replication of information and hence will require less or more monitoring activity. In the simplest case, a choice can be made between two simple types of auctions, the common English, or ascending price auction, or the descending offer auction known as Dutch.

In the previous chapter, an example of an auction was provided in which the incentives for acquisition and revelation of information were very different. In the English auction, bidders would refuse to acquire costly

information without some means of protecting the gains accruing from the private use of the information. One way of protecting those gains was to choose a descending price auction whereby the revelation of the information did not necessitate the loss of the value of the information. An alternative to choosing a Dutch auction could involve the expenditure of resources on hiding the identity of the informed bidder.

Rules other than just the simple choice between Dutch and English can also be used to alter the incentives for the production of information. In the currency auction example for instance, if the denominations of the bills were increased, so would be the incentives for information production. In an auction for goods other than currency, these same incentives could be provided by increasing the number or value of goods to be auctioned as one distinct lot- instead of auctioning separate chairs and tables and sofas, an entire houseful of furniture could comprise one lot.

For the specific market under study, the flower market, the rules of the repeating Dutch auction are explained as a way in which the auction as a whole coordinates the activities of many agents in the common goal of producing valuable information.

What Information is Involved?

Having argued that one important feature of the Dutch auction involves its ability to encourage the coordinated acquisition of information in a market, I turn to the nature of the information which could be important to the participants of the repeating Dutch flower auction under study.

The information on which I focus is price information. Producers can use price information to make decisions regarding which species of flowers to grow and when to harvest them. To the extent, for example, that today's price is a predictor of tomorrow's price, producers can make profitable decisions regarding the appropriate day to bring certain flowers to market. In addition, information on the price/quality relationship allows producers to expend appropriate resources on quality. On the buyer's side, price information can assist in decisions regarding profitable levels of inventory and mixes of flower species. In addition, it is possible that price information generated in the auction is useful in determining long term guaranteed contract prices. For example, in a highly variable market, producers may be reluctant to fix prices over any long period, and purchasers may be reluctant to use a formula contract when the producer has any ability to determine the factors on which the formula is based. By using some fixed

function of auction prices to determine a formula for long contracts, both producers and purchasers are protected from the moral hazard on the part of the other participant.

How is Information Paid For?

In the "cartoon" auction of currency in the last chapter, the seller paid for the information in the sense that the price he received for say, a ten dollar bill was less than ten dollars (else no one would produce the information). In this cartoon, the information was useful only to the one buyer but I hypothesize that in the richer environment of the repeating flower auction, even those potential buyers who do not win the auction for a particular lot of flowers will find that the price information which is revealed is worth something - perhaps the price information assists inventory decisions, perhaps it assists in decisions about which species are more profitable. To the extent that the hypothesis is correct that buyers learn from other buyers' bids, they will be willing to pay for that information. One way in which this payment could be made is through providing a discount to those who reveal valuable information.

Wilson (1967) provides a two person auction model in which differentially informed bidders pay different prices - in effect, better informed bidders receive a price discount.

The model is as follows:

The item for auction has value v which is distributed $f(v)$. Both bidders know $f(v)$ but bidder 2 also knows v with certainty. The Nash equilibrium strategies are such that each party bids to maximize gains conditional on the other's strategy. (Wilson shows) bidder 1 uses a randomized strategy, $g(p)$ conditional on bidder 2's distribution function $G(q)$ (to be determined) where q is bidder 2's bid. Bidder 2 then chooses his bid q to maximize $[v-q]G(q)$ where $G(q)$, bidder 1's distribution function, is his probability of winning. The first order condition becomes:

$$[v-q]g(q)-G(q)=0$$

In equilibrium, bidder 1 knows bidder 2's strategy and so for any bid p , his expected return is:

$E_{-\infty}^{v(p)}(v-p)$ where E is the partial expectation operator.

Thus, bidder 1's randomized strategy is determined from the variational problem:

$$\text{Maximize: } \int_{-\infty}^{\infty} E_{-\infty}^{v(p)}(v-p)g(p)dp$$

Intuitively, the better informed bidder uses a fixed strategy of bidding a determinant function of the true value and the less informed bidder uses a randomized strategy to protect himself from being "strategized against" by the better informed bidder. ¹ The bid of the informed bidder reveals the true value of the item for sale. Any attempt by

the less informed bidder to move from a random strategy will reduce his profit (increase his loss).

In this auction, the better informed bidder makes large profits and the less informed bidder suffers losses. Wilson concludes in a later paper that the less informed bidder's optimal strategy is to drop out of the auction (1975, p5.). This conclusion, however, is based on the fact that the information received by the less informed bidder upon hearing the other bid has no value. If, on the other hand, the received knowledge of the value of the item has value outside the auction, the the less informed bidder will be prepared to suffer losses within the auction up to the point that the marginal value outside is equal to his losses.

Indeed, if he drops out of the auction, the informed bidder no longer has any incentive to produce price information- his strategy in this simple model would just be to bid zero and the auction would cease to exist.

Let us alter Wilson's model somewhat: instead of a single item for sale, consider the situation where several homogeneous items are to be auctioned serially. The observed prices in this auction will behave as follows: if the informed bidder wins the first of the several auctions, that first trade will be consummated at some constant function (call it the reservation price) of the true value. All subsequent trades will be made at the true price since

the first bid disclosed the true price and competition will ensure that no one will be able to make any pure rent. In the event that an uninformed bidder wins the first item, that is, the random bid of the less informed bidder, is greater than the informed bidder's reservation bid, the next auction will be a replica of the first since no information is disclosed from the non bidding of the informed bidder. As soon as the informed bidder wins, the price will rise to the true value and remain there until all items are sold.

On average, less informed bidders will pay more than the true price and informed bidders will pay less than the true price - an exchange of information is made in which those who bring and reveal information to the auction will be observed to pay less than those who arrive with less good information.

Summary of the Approach.

The general approach described so far has two main features: first, the auction is viewed as a mechanism which pools information from diverse sources and provides a guarantee on the information by requiring that bidders stake a portion of their wealth on their estimates. Second, the Dutch auction mechanism is a means of arranging payments, in the form of price discounts, to bidders who reveal valuable information. It is possible that only less well informed

bidders pay for the information (by "allowing" discounts for the information), or that both bidders and sellers provide price discounts.

In the next section, the specific rules of the Dutch auction are explained as fine tuning instruments in the payment for information mechanism. By adjusting various rules, it is possible to alter the amount and quality of information by altering the exact payment formula. From these explanations, a set of refutable propositions is derived and transaction data from the repeating Dutch auction for flowers are used to test these propositions.

A Note on the Data

The data which are used to test the propositions of the theory have been extracted from in excess of sixty thousand individual transactions over more than sixty trading days. Two distinct sets of data are used - details are provided in the appendix.

The Repeating Dutch Auction for Flowers

The auction under examination sells fresh cut flowers and potted plants on a three and sometimes four day a week basis in Vancouver, British Columbia. Approximately forty percent of all flowers and plants sold in the Vancouver area are marketed through the auction with the remainder being

marketed directly from producers to wholesalers and retailers. No legislative or other barriers constrain entry into any part of the flower market, or limit the type of marketing mechanisms available.

The auction is owned and operated by the British Columbia Flower Grower's Cooperative and membership is open to all growers. Members agree to ship a small portion of their produce through the auction but are not required to use the auction as their sole marketing mechanism. Over a hundred growers are members of the Coop. The operation of the auction is financed by one-time membership fees paid at the time of joining the Coop, and sales commission fees which range from three to twelve percent of the value of flowers sold through the auction.

Dutch Rules.

The auction is operated with the assistance of a mechanical "clock" which has prices on the circumference. An auctioneer sets the clock at some "high" price, i.e. significantly above what the auctioneer believes the particular flower will fetch, and allows the single arm of the clock to rotate in such a way that successively lower prices are "called out". Bidders stop the clock with the aid of an electronic switch so ties are avoided. The bidder who stops the clock has bought, at the price indicated, some

minimum quantity of flowers but has an option to purchase more. (The option is described later.) At this point, the clock is reset at the original high price, and the auction recommences. The price at which any sale has been made does not affect the starting price for subsequent sales.

The Grouping of Flowers.

On two or three days per week, there are two separate auctions held. One is for cut flowers and the other is for potted plants. On the remaining auction day, only one auction is held and cut flowers and potted plants are sold in one auction.

Producers arrive with their produce and must decide on how to "package" their flowers. For each type of flower, e.g. 15 inch roses, 25 inch roses, chrysanthamums, etc., the producer must divide the flowers into "wagons" and sub-divide the wagons into "lots". For example, consider a producer with 300 dozen 15 inch roses. He can choose to put all 300 dozen on one wagon or he can choose to use two wagons with a hundred dozen on one and two hundred dozen on the other. No explicit restrictions exist on how many wagons can be used for a given amount of flowers but ad hoc rules are issued from time to time which restrict the minimum size of wagons. (These rules are explained later.)

Beyond deciding how many wagons to use for his 300 dozen roses, the producer must also decide how many "lots" will make up each wagon. If two wagons with 150 dozen roses each were chosen, the 150 dozen on the first wagon could be divided into 10 lots of 15 dozen or 30 lots of five dozen or any other such combination. On the second wagon, a similar decision must be made and the producer is not constrained to use the same lot combination as on the first wagon.

The Order of Sales

Having simultaneously decided upon the number of wagons and size of lots for each type of flower, the producer must now place his wagons in a queue for the auction. On the floor of the auction building, from four to ten painted columns are marked on the floor. Producers are free to place their wagons of produce in any column with the only restriction being that each column must be filled sequentially. For example, the first producer to place a wagon may choose any column but must place his wagon in the first row of that column. The next wagon brought can be placed in the second row of the column with a wagon in it, or that wagon can be placed in the first row of any empty column. This process continues on a first-come first-served rule until all the flowers brought that day have been placed.


At this point, the auctioneer randomly chooses one column and this choice determines the order in which the produce will be offered for sale. The wagons of the randomly chosen column are offered in the order of their placement and then the adjacent columns are offered. In this way, the producers can only estimate the order in which their flowers will be sold. For example, if ten columns are each filled with ten wagons, the first wagon in any column has a one in ten chance of being the first wagon offered that day. The last wagon in any column has a one in ten chance of being the tenth wagon offered, a one in ten chance of being the twentieth, etc.

The explanation for this random ordering rule can be seen as an extension of the view that differentially informed bidders pay different prices for apparently identical flowers. Buyers who reveal valuable information receive price discounts which producers perceive as lower prices. Buyers who arrive with less information receive no discount and therefore pay, on average, higher prices. The higher price they pay can be considered as the premium paid for the information which has already been imbedded into the flowers. In this situation, if producers can estimate where better informed buyers will be in the selling queue, it will be individually profitable for sellers to avoid selling their produce to better informed buyers in favour of less

well informed (higher average price) buyers.

However, while it will be individually profitable for sellers to avoid well informed buyers, it is impossible for all sellers to avoid these buyers and hence the result will be competition among sellers for preferred places in the selling queue. If a nonrandom selling queue existed, we would expect that sellers would compete for the preferred places and while this would redistribute wealth from some producers to others, it would be at the cost of the resources used in the competition. By constraining the competition with a (partially) random order rule, this Dutch auction reduces the costly wealth transferring (and hence wealth destroying) activity that competition for preferred placement in the selling queue implies. Inherent in the random ordering rule is also a random payment rule - producers "pay" for information on a random basis unconnected with their placement since each producer will provide the discount for information on a random basis.

The intent of this random ordering rule is, I think, clear - it reduces the incentive for individual producers to spend resources which transfer wealth but do not increase it. Other rules could achieve similar ends and as an aside, it is interesting to consider another Dutch auction, this time the Dutch auction for hogs in Ontario.



In this auction, there is no random placement rule for the selling queue despite potentially the same incentives given the hypothesis that the Dutch auction exists (partially) to encourage information by providing price discounts for the revelation of valuable information. When this auction first started, producers were paid for the hogs they brought, in the same way that flower producers are paid for their flowers. (Without a random placement rule), the auction experienced erratic deliveries of hogs to the auction - on some days, so many hogs were brought that some had to be returned to the farmers while on other days, only a few were brought and subsequently sold. This arrangement was expensive for both buyers who could not be certain about the availability of hogs on a given day, and farmers who occasionally had to bear the added expense of extra transportation on those days when the auction could not sell all the hogs which had been brought.

Instead of a random ordering rule, the hog auction solved the problem by introducing a payment scheme which made the hypothesized payment for information independent of when hogs were sold. The auction started a pooled pricing system. Instead of being paid for their own hogs, farmers are now paid on a quality weighted formula basis which uses the average price over a week as the basis. In this way, any incentive to avoid specific days would be reduced since the

payment for information would be shared among all who sold during the week.

The Order of Sales - Cut Flowers versus Potted Plants

While all producers have an incentive to avoid being the producer who sells to better informed buyers and therefor provides the price discount, producers of different types of flowers will be under different incentives, depending upon the relative price discount which is provided. That is, there will be some flowers which will call forth a large discount because the value of marginal information on those flowers is high. For other flowers, where the value of marginal information is low, smaller price discounts will be sufficient to call forth the information. When producers compete for places, producers of the "high information content" flowers will be prepared to spend more resources than will producers of low information content flowers. The amount of price discount offered will be a function of the value of the marginal information revealed at the auction.

Of the two broad categories of produce at the auction, cut flowers and potted plants, the cut flowers are likely to be what is called here "high information content" flowers. The reason is that cut flowers are significantly less durable than potted plants. Once flowers have been

harvested, they have an effective selling life of only two or three days (only very costly watering and chemical treatment would keep them fresh for longer and even then their value in the retail trade would be severely diminished). Potted plants on the other hand, are very durable and the same plants can be brought to the auction week after week without significant deterioration. In this situation, the variance of prices from day to day and week to week are likely to be much smaller for potted plants than for cut flowers. This will make marginal contributions to the information stock on any potted plant worth less than on cut flowers.

While producers cannot know exactly where in the selling queue a given wagon of flowers will eventually be placed, they are able to estimate a probability. The first rows in any column are more likely to be sold early in the auction than are the last rows. Each column then represents an "expected selling queue" - producers can expect that the order of the rows in any column represent the order in which the wagons will be offered for sale.

Information is revealed by bids and therefore more information will have been revealed late in the auction than early. To the extent that information on any wagon of produce provides information on all other wagons, all producers will have an incentive to place their produce late

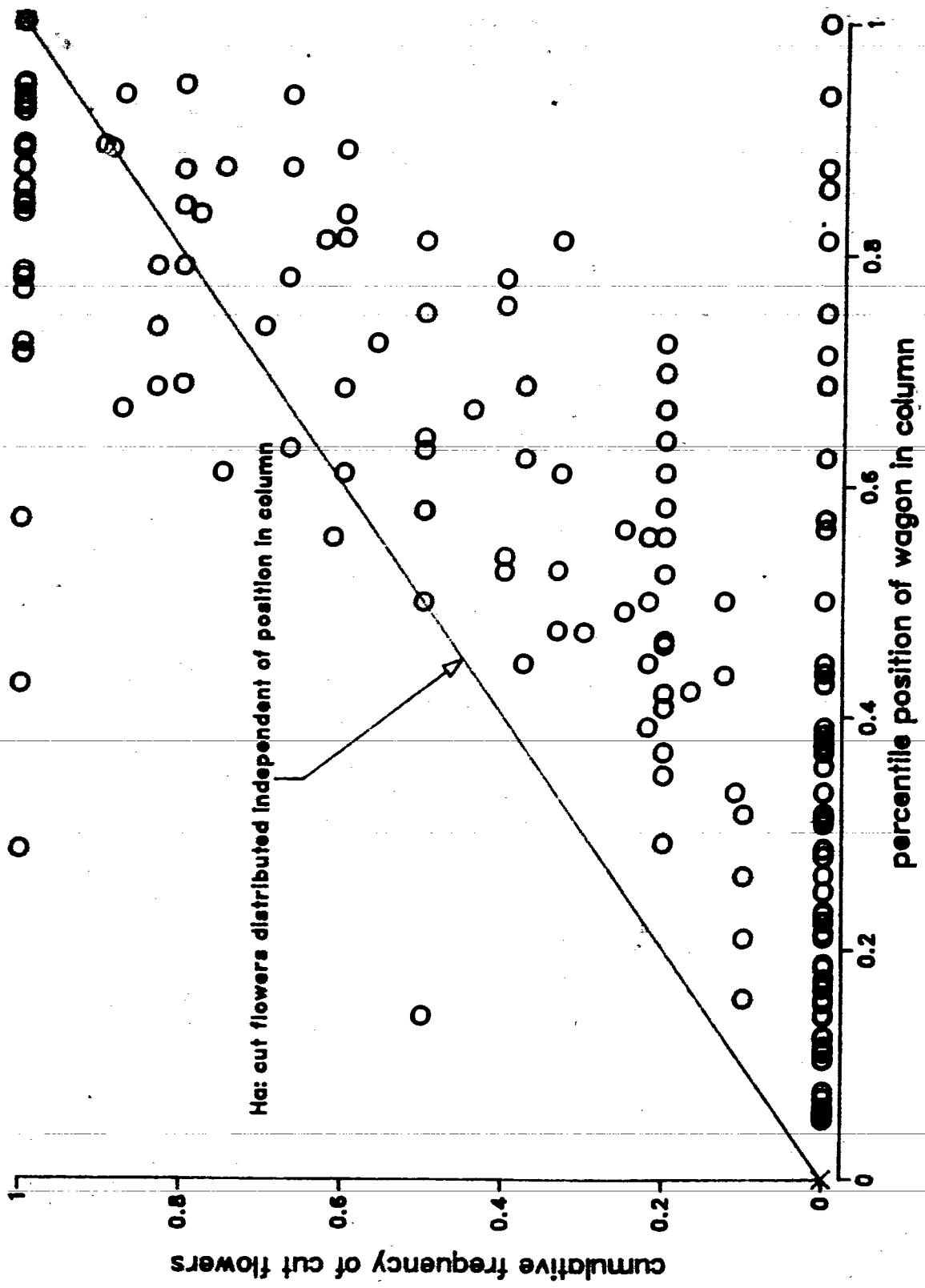
in the expected selling queue, (after information has been revealed) and cut flower producers will be prepared to expend more resources in the competition because of the relatively larger marginal information content of cut flowers. The prediction then is straight forward: the distribution of cut flowers and potted plants in the selling queue will not be random, but rather cut flowers will be observed relatively late in the expected selling queue.

To test this hypothesis, the frequency of placement of cut and potted plants was tested against the null hypothesis that they would be observed randomly. Data representing nine trading days and fifty columns were examined.

Two formal tests were used: first, a two sample Kolmogorov-Smirnov test rejected (at $p=.001$) the hypothesis that placements were random in favour of the hypothesis that cut flowers were sold later in the expected selling queue. On average, cut flowers were more than twice as likely to be sold in the last half of the expected queue than a random hypothesis would indicate.

The second test was suggested by examining the cumulative frequency distribution of placement of cut flowers (see figure 2.).

figure 2



Visual inspection of the data suggested that they might fit a cumulative normal or logistic function. To test this hypothesis against the null hypothesis that cut flowers and potted plants were randomly distributed, two regressions were run: a logit (where the underlying distribution is assumed to be the logistic) and a probit (where the underlying distribution is assumed to be cumulative normal). The dependent variable in both regressions assumed the values zero and one according to whether cut flowers or potted plants were observed. The independent variable was the percentile position of the wagon of produce in the expected selling queue. For example, the first wagon in a ten wagon column would take on the independent value .1, the third wagon in that column would take on the independent value .3.

The results of the two regressions are in table 1.

Table 1

	<u>Normal</u>	<u>Logistic</u>
coeff:	-.50	-.45
std err	.22	.21
-2 log		
likelihood	264	264
no. of obs.	214	214

While the two regressions cannot be distinguished from each other, both are capable of rejecting the null

hypothesis that the placement of cut flowers and potted plants is random, at $p=.0001$. In this sample at least, cut flowers are placed significantly later in the expected selling queue than are potted plants.

Option to Purchase Entire Wagon.

After the produce has been placed into columns and the auctioneer has randomly chosen one column, the queue of wagons is brought to the entrance of the auction floor. At one end, the auctioneer sits on a podium beside the auction clock which, besides the price, displays the identity of the producer and the identity of all successful bidders. Opposite the auctioneer sit the buyers and producers who are equipped with electronic buttons to stop the auction clock.

When the first wagon of produce is brought in front of the bidders, the auctioneer announces the type and grade of flower and the size and number of lots on the particular wagon. He then positions the hand of the clock at the "high" price and starts it so that the hand rotates to successively lower prices. When some bidder has stopped the clock with his electronic switch, that bidder calls out the number of lots he wishes to purchase. While he is constrained to buy at least one lot, he has the option of purchasing any quantity up to the total on the wagon. If the entire wagon is not purchased, the auction is re-started and the option

to purchase whatever remains passes to the next "winning" bidder. (There also exists a rule by which producers can prevent sales by stopping the clock. This rule is discussed later.)

The theory of auctions as mechanisms designed to encourage the acquisition and revelation of information has the following implication with respect to the exercise of the option to purchase the entire wagon: when more than one wagon of the same type of flower is offered on the same day, the option to purchase the entire wagon should be exercised on the first wagons more frequently than on the last wagons offered. There are two reasons that this is so. First, because the information is valuable to other bidders at the auction by giving them better estimates of the value of the flowers, the value of the information is greater when it is revealed relatively early in the auction. It is only when the guaranteed information can be used at some later period that it has any value. In some cases, the information may not deteriorate very quickly and could be used on subsequent days, as perhaps might be the case for potted plants but still, the information will be more valuable when it is fresh than when it is stale.

The second (related) reason that the theory predicts that the option to purchase the entire wagon will be observed early rather than late in the auction concerns the

way in which information is transmitted from well to less well informed bidders. For the transmission of guaranteed information to be effective, there is a requirement that well informed bidders be identifiable since some bidders will be bidding randomly to discipline the well informed bidders. The size of purchase could act as the signal that identifies the well informed bidders. The information is guaranteed by the fact that bidders are prepared to stake a portion of their wealth on their estimates. When well informed bidders "win", and purchase an entire wagon, it is a signal that a "good" price was achieved. Less well informed bidders are less likely to make large purchases early in the auction since they know that on average, they are paying more by using their random bidding strategy than they would if they were to wait for the disclosure of information. The purpose of the random bidding is to discipline other bidders and this can be done more cheaply with small than with large purchases.

The following tables show the frequencies of wagons purchased in their entirety as a function of their position in the selling queue. Column one shows that on occasions when two wagons of the same flower were offered for sale on the same day, eighteen first offered wagons were purchased in their entirety and only 5 wagons offered second were so purchased. Table 2a represents the observations for cut

flowers and table 2b represents those for potted plants.

Table 2a.
number of wagons offered, cut flowers, same type, same day

		2	3	4	5	6	total
position of	1	18	8	4	5	6	38
wagons purchased	2	5	9	1	0	0	15
in their	3		1	0	0	0	1
entirety.	4			0	1	0	1
	5				0	0	0
	6					0	0
total		23	18	6	6	2	55

Table 2b.
number of wagons offered, potted plants, same type, same day

		2	3	4	5	6	total
position of	1	17	5	3	2	0	27
wagons purchased	2	18	6	1	1	3	29
in their	3		12	0	1	1	14
entirety.	4			3	0	2	5
	5				0	1	1
	6					1	1
total		35	23	7	4	8	77

The implication of the theory is that first rows of the tables should have more observations than later rows. However, the distinction in the relative values of information between cut flowers and potted plants (because of the greater substitutability between plants today and tomorrow) adds some sharpness to the prediction: the effect should be more distinct for cut flowers than for potted plants.

To test the hypothesis, a Kolmogorov-Smirnov(KS) two sample test compared the distribution of wagons of cut and potted plants bought in their entirety. That is, each column in table 2a was compared to its companion column in table 2b, with the hypothesis being that entire wagons of cut flowers would be observed to be purchased earlier than potted plants. Although small sample properties are not well known, the KS-test is very conservative with few observations, i.e. it accepts the null hypothesis more frequently than the test statistic indicates. For each pair of columns, the Chi-square statistics are:

table 3.

<u>number of wagons offered</u>	<u>Chi-square</u>
2	8.4 (p<.025)
3	8.6 (p<.025)
4	2.4 (p<.200)
5	2.0 (p<.300)
6	5.0 (p<.050)

If these statistics can be considered as independent, then the entire sample can be tested and although the test is weak, it rejects the null hypothesis (that purchases of entire wagons of cut and potted plants are distributed identically) at .01..

If the potted plants are tested independently against the null hypothesis that entire purchases are made randomly

throughout the period of the auction, the null hypothesis cannot be rejected. This poses an interesting question that has yet to be answered - why are potted plants in the auction at all? The option to purchase entire wagons of cut flowers is observed to be taken up in a way consistent with the kind of information transfer in this theory, but the random purchases of potted plants remains a puzzle. Ad hoc arguments which depend upon assertions about economies of scale in selling and/or buying flowers at the auction are not satisfying.

Minimum Size of Wagon Rule.

While bidders are more likely to reveal information for larger valued wagons, sellers clearly have an individual incentive to provide smaller valued wagons, thus avoiding the possibility of providing large price discounts. Because of this incentive, the theory presented here predicts that the auction as a whole should employ a rule which constrains this type of activity on the part of individual sellers since, like the random placement rule, a rule constraining the size of wagons offered will reduce wealth transferring competition and thus increase the value of the auction as a whole.

However, no systematic rules of this kind have been observed at the auction. The only observation consistent

with a minimum size rule is the appearance, apparently on an ad hoc basis, of notices from the auctioneer reminding producers that wagons of certain types of cut flowers have been "too small" "lately". The notice goes on to state that in future, such wagons will be either refused sale or amalgamated with other wagons, at the discretion of the auctioneer.

Variance of Prices.

While no explicit explanations are offered, the experimental literature demonstrates falling variances of prices (i.e. a convergence to some "equilibrium") over the period of the auction.² The theory here provides a partial explanation for the falling variance of prices: the rules of the Dutch auction provide a mechanism by which bidders are encouraged to reveal information. The mechanism is the price discount which equals the expected marginal value of the added information. As more information is revealed, the value of further (marginal) information falls and hence so must the price discount. This effectively increases what I have called the informed bidder's reservation price. Since this price truncates from below the distribution from which uninformed bidders draw their estimates, observed prices become less variant over the period of the auction.

To refine the prediction about price variance, I again use the assertion that information on potted plants deteriorates less quickly than does information on cut flowers. Because of this, the marginal value of information on potted plants must be worth less than for cut flowers. The observed fall in variance will be greater for cut flowers than for potted plants.

To test this hypothesis, a price equation was estimated on a vector of characteristics including the size and number of lots purchased and the order of the sale (these variables will convey information about the informedness of the buyer). Under the hypothesis that information is being transferred by bids, the error terms from this equation then include a signal about that dispersion of unobservable information. The squared errors are then regressed against an order term to test for the hypothesized negative heteroskedasticity. As the auction proceeds, the unexplained variance of prices, that is the reduction of variance which arises because of the revelation of information, is predicted to fall.

For several types of cut flowers and potted plants, the following equation was run:

$$P_t = \alpha + \beta * Lot_t + \gamma * Size_t + \delta * Order_t + \lambda *(dummies for days)_t + \epsilon_t$$

First order autocorrelation of the error term required that a transformation be used to correct the error structure prior to testing for heteroskedasticity.³ The transformed squared errors were then regressed on the order variable and the order coefficient tested against the null hypothesis of homoskedasticity.

The equation and results are:

CUT FLOWERS

20 inch roses

$$\mu_t^2 = \alpha' + \beta' * \text{Order}_t + v_t$$

coeff: 38.32 -1.95
t-values: 5.77 -3.66
F=13.4, R=.051, N=252

15 inch roses

	α'	β'
coeff:	22.72	-1.65
t-values:	6.32	-3.83
F=14.6, R=.078, N=175		

pom pom dahlias

	α'	β'
coeff:	262.5	-17.24
t-values:	3.50	-2.42
F=5.88, R=.029, N=196		

POTTED PLANTS

crysanthamums

	α'	β'
coeff:	162.50	-.40
t-values:	2.49	-.71

F=.51 R=.002 N=265

begonias

	α'	β'
coeff:	775.27	-59.59
t-values:	6.03	-3.40
F= 11.53, R=.062, N=177		

cyclamen

	α'	β'
coeff:	253.74	-34.99
t-values:	4.67	-2.86
F= 8.20, R=.065, N=119		

In all regressions, the coefficient on the order variable is negative and only in the cysanthamum case was it not significantly different from zero. As in the test for purchases of entire wagons, the potted plant result shows less consistency with the incentives implied by this theory. Nevertheless, the strong evidence of falling variance (especially for cut flowers) supports the view that some systematic activity consistent with the kind of information transfer I hypothesize is occurring.

The Double Zero Rule.

During the course of the auction, producers have the right to stop the clock, thus stopping the descent of prices on their produce. On each wagon of flowers, producers may stop the clock twice. On the first occasion, the auctioneer simply calls out "zero", thus informing the bidders that the seller stopped the clock and restarts the clock at the

original high price. There is no penalty exacted from the producer for stopping the clock once per wagon.

If a producer stops the clock again on the same wagon, whether or not any sales have been made in the interim, the remaining flowers on the wagon are removed from the auction and cannot be offered for sale again that day. Producers are free to return that produce on the next auction day.

I have no explanation for the use of this rule: if the first "zero" were designed to convey information about the producer's reservation price, the second "zero" should occur at the same price. Although only a few double zeros have been observed, it appeared that the second zero was systematically below the first zero. When only one zero was observed, i.e. when sales were made after a zero, prices were systematically below the zero level.⁴

(4)

NOTES TO CHAPTER 4.

- 1) As an example, if $f(v)$ is distributed $(0, 1)$ and bidder 1 chooses to bid from the i.i.d. over that range, then bidder 2 will maximize expected gain by bidding . The use of randomised bids as a protective strategy is also found in other research, see d'Aspremont and Gerard-Varet (1979) for an example in a game-theoretic setting.
- 2) Smith and others posit that some kind of learning occurs within the period of the auction but do not specify how or what mechanisms might be involved.
- 3) Coefficients from regressions assuming either the cumulative normal or the probabilistic function are not distinguishable from each other.
- 4) Although it is possible that producers give a biased estimate of their reservation prices, it is unclear why this should be so. If that is what they are doing, it appears that bidders have caught on - they systematically bid lower than the level of the first zero.

CHAPTER 5

CONCLUSIONS

Some evidence has been provided which is not inconsistent with the view that the repeating Dutch auction is a mechanism designed for the encouragement of the production and revelation of valuable information. Using this theory, successful explanations of certain aspects of the auction are offered: the random ordering rule constrains producers from expending resources on what might be called "destructive" competition. Also, activities of buyers in purchasing entire wagons early in the auction are seen as ways in which buyers can be provided payment for information at the same time as they guarantee that information.

Nevertheless, while this view has successfully explained a small number of rules and activities in the auction, many rules and activities have yet to be explained. Some of these include the "double zero" rule by which producers have two opportunities to stop the auction clock, the use of different commissions on different days, and the rule which specifies that potted and cut flowers are sold together on some days.

In a more general way, the research should be extended in two ways: first, the theory as it stands should be tested against other auctions - the flower auctions in San Diego, Montreal, and Toronto, the Dutch auction for hogs in Ontario, and perhaps the tobacco auction in Ontario (these latter two may pose insurmountable problems since they are run as legislated monopolies). The second, and more interesting way in which this research might be extended is to use the general theory of institutional choice implied here to examine the use of different economic organizations.

As one example, the theory elaborated here suggests that differential costs and benefits of employee fraud may be useful in explaining the degree to which firms are integrated: consider an employee of say Champion Spark Plugs whose job description says that he is a spark plug researcher, and an employee of General Motors whose job description is identical to the Champion employee's. Consider now that each employee independently and without knowledge of the other's work, invents say a spark plug which will double the gas mileage of any car. Maximizing employees now must decide what to do with the invention - do they announce it to their respective firms, sell it outright to some competing firm, or buy stock (long or short) in their own or a competitor's firm? While the present value of the invention is the same, the cost of appropriating

(fraudulently) this value will be different for the two employees. While each is capable of selling the invention outright, the ability to defraud their respective companies by buying the stock of their own company depends upon the degree to which the company is integrated. With a given wealth constraint, the General Motors employee can only capture an amount equivalent to the number of shares the wealth constraint allows times the per share increase in the value of General Motors. Because of the more narrow product line of Champion Spark Plug, the amount the employee can appropriate from Champion will be much higher - fraud is more profitable for the Champion employee, ceteris paribus.

The information theory of the choice of economic organization developed here can be tested by examining the employee contracts of the two spark plug researchers - the Champion employee (and research employees of narrow product firms) will be more constrained against this kind of fraud than will employees of General Motors (and other more highly integrated firms). One way this constraint may be observed is through the pay schedule. The Champion employee will have a larger portion of his pay package made up of stock options or bonus payments. Another way this potential fraud may be reduced is through different working conditions, e.g. team research.

The basic contribution of this work is twofold: first, the work explains why the analysis of institutions without a theory which predicts their existence should be conducted carefully - more carefully than is now the case. The analysis of the Dutch auction simply serves to highlight why current research in this one area must be used carefully - theorems about the output of Dutch and English auctions will only be valid if the participants are identical in the two auctions but if this is the case, one must explain why the two institutions exist and are used in such systematic ways.

In more general terms, the criticism applies to various areas of current research, one example of which is the efficient market literature. In this literature, it is necessary to assume that all financial instruments are identical in purpose before any conclusions can be drawn about the relative "efficiency" of any market.

The second contribution of this work is that a general determinant of the choice of economic organization has been offered. This determinant, the ability of different organizations to produce and process valuable information, has been shown to have explanatory power the case of one Dutch auction. The generalization of this approach is of course toward a broad theory of economic organization.

APPENDIX

A NOTE ON THE DATA

Two sets of data were collected for this study. An important variable was not collected in the first set and this made it impossible to test one of the important hypotheses (the systematic placement of cut flowers and potted plants). With the exception of this test, all results are generated with the original set of data.

The first set of data (which has been transcribed to computer tape), consists of observations on 6198 individual transactions taken over seven auction days. The data was collected in the form of receipts which are generated at the auction. While these receipts are available to sellers at the conclusion of each auction day, only an estimated five to ten percent of them were actually collected by sellers and therefore absent from the sample used. The fact that the data are in the form of receipts provides some assurance as to their accuracy since both buyers and sellers have incentives to monitor the prices and quantities upon which their respective payments are based.

The variables collected for each transaction are:

- 1) buyer identification number.
- 2) seller identification number.
- 3) date of transaction.
- 4) flower identification code.
- 5) wagon identification code.
- 6) order variable indicating the order in which a given sale occurred.
- 7) price paid (per stem, per bunch, or per pot)
- 8) size of lots offered (number of stems, bunches, or pots)
- 9) number of lots purchased.
- 10) number of lots on a wagon.

This set of data does not include any variable indicating the column of flowers in which any wagon was placed. Since this variable was necessary to test the hypothesis concerning the placement of wagons of cut flowers and potted plants, a further set of data was collected.

The second set of data represents an estimated fifty thousand transactions conducted over 54 auction days, and includes the column variable. The placement hypothesis was tested using hand calculations since this set of data has not been transcribed to computer tape.

References

- Alchian, Armen, A., and Demsetz, Harold, (1972), "Production, Information Costs, and Economic Organization", American Economic Review, Vol. 62, pp.777-95.
- Amihud, Y. (ed.), (1976) Bidding and Auctioning for Procurement and Allocation, New York: N.Y.U. Press.
- Andreades, A.M., (1933) A History of Greek Public Finance (translated by Carrol N. Brown), Cambridge: Harvard University Press.
- Arrow, Kenneth, Karlin, Samuel, and Suppes, Patrick (eds.), (1960) Mathematical Methods in the Social Sciences, Stanford: Stanford University Press.
- Arrow, Kenneth, (1962) "Economic Welfare and the Allocation of Resources for Invention", in The Rate and Direction of Economic Activity: Economic and Social Factors, Princeton: Universities National Bureau of Economic Research Conference Series
- Bancroft, Frederic (1959) Slave Trading in the Old South, New York: Frederick Ungar Publishing Co.
- Barzel, Yoram, (1982) "Measurement Costs and the Organization of Markets", Journal of Law and Economics, Vol. XXV(1), pp.27-48.
- Becker, Gary, (1965) "A Theory of the Allocation of Time", Economic Journal Vol. 75, pp. 493-517.
- Belovicz, M.W., (1979) "Sealed Bid-Auctions: Experimental Results and Applications", in V. Smith, Research in Experimental Economics, Vol. 1, Greenwich: Jai Press, pp. 279-338.
- Blake, W.O., (1957) The History of Slavery and the Slave Trade, Detroit: Negro History Press.
- Capen, E.C., Clapp, R.V., and Campbell, W.M., (1971) "Competitive Bidding in High Risk Situations", Journal of Petroleum Technology, Vol. 23, pp. 641-651.

- Cassady, Ralph Jr., (1967) Auctions and Auctioneering, Berkeley and Los Angeles: University of California Press.
- Chamberlin, Edward H., (1948) "An Experimental Imperfect Market", Journal of Political Economy, Vol. LVI, pp. 95-109.
- Chang, C.M., (1936) "Tax Farming in North China", Nankai Social and Economic Quarterly, 8(4), pp. 824-52.
- Cheung, Steven N.S., (1970), "The Nature of a Contract and the Theory of Non-Exhaustible Natural Resources", Journal of Law and Economics Vol. 3, pp. 49-70.
- _____, (1982) "Let Us Ride With the Surging Tide", working paper, University of Hong Kong.
- _____, (1983), "On the Contractual Nature of the Firm", Journal of Law and Economics, Vol. 26, pp. 1-21.
- Coase, Ronald H., (1937) "The Nature of the Firm", in Stigler and Boulding (eds.), Readings in Price Theory, Chicago: Irwin 1952. [originally published (1937), Economica n.s. 4], pp. 331-51.
- Cobb, Thomas R.R., (1858), Historical Sketch of Slavery, Detroit: Negro History Press.
- Coppinger, Vicki M., Smith, Vernon L., and Titus, Jon A., (1980) "Incentives and Behaviour in English, Dutch, and Sealed-Bid Auctions", Economic Inquiry, Vol. XVIII, No. 1, pp. 1-22.
- d'Aspremont, Claude and Gerard-Varet, Louise-Andre, (1979), "Incentives and Incomplete Information", Journal of Public Economics, Vol. II, pp. 25-45.
- De Vany, Arthur S., (1976), "Uncertainty, Waiting Time and Capacity Utilization: a Stochastic Theory of Product Quality", Journal of Political Economy, Vol. 84, pp. 523-42.
- Dow, George F., (1969) Slave Ships and Slaving, Port Washington, N.Y.: Kennikat Press (first published 1927).
- Engelbrech-Wiggans, Richard, (1980) "Auctions and Bidding Models: A Survey", Management Science, Vol. 26, No. 2, pp. 119-142.

- Fiorina, M. and Plott, C., (1978) "Committee Decisions Under Majority Rule: An Experimental Study", American Political Science Review, Vol. X, pp. 575-598.
- Fogel, Robert William and Engerman, Stanley R., (1974) Time on the Cross, Boston: Little Brown and Co.
- Ford, E.C., (1955) "First, Probably Only Slave Auction in Kansas", Negro Hist. Bull. Vol. XVII, Mar., pp. 143-144.
- Friedman, Daniel, (1984), "On the Efficiency of Experimental Double Auction Markets", American Economic Review, Vol. 74, pp. 60-72.
- Friedman, Milton, (1959) A Program for Monetary Stability, New York: Fordham University Press.
- _____, (1963) "Price Determination in the United States Treasury Bill Market: A Comment", Review of Economics and Statistics, Vol. XLV, No. 3, pp. 318-320.
- Glamann, Kristof, (1958) Dutch-Asiatic Trade 1620-1740, Copenhagen: Danish Science Press.
- Goldberg, Victor, (1977) "Competitive Bidding and the Production of Pre-Contract Information", Bell Journal of Economics, Vol. 8, pp. 250-61.
- Gould, John P, (1978) "The Economics of Markets: A Simple Model of the Market Making Process", University of Chicago Working paper.
- Harris, Milton and Raviv, Artur, (1981a), "Allocation Mechanisms and the Design of Auctions", Econometrica, Vol. 49, pp. 1477-1499.
- _____, (1981b), "A Theory of Monopoly Pricing Schemes with Demand Uncertainty", American Economic Review, Vol. 71, pp. 347-65.
- _____ and Townsend, Robert, (1981), "Resource Allocation under Demand Uncertainty", Econometrica, Vol. 49, pp. 33-64.
- Hirschleifer, Jack, (1971) "The Private and Social Value of Information and the Rewards to Inventive Activity", American Economic Review, Vol. 61, pp. 561-74.

- Holt, Charles A., (1980) "Competitive Bidding for Contracts under Uncertainty", Journal of Political Economy, Vol. 88, pp. 433-445.
- Hurwicz, Leonid, (1959), "Optimality and Informational Incentives in Resource Allocation Processes", in Arrow et al., (eds), Mathematical Methods in the Social Sciences, Stanford: Stanford University Press, pp. 27-46.
- _____, (1973), "The Design of Mechanisms for Resource Allocation", American Economic Review, Papers and Proceedings, pp. 1-30.
- Isaac, M. and Plott, C., (1981) "Price Control and the Behaviour of Auction Markets: An Experimental Study", American Economic Review, Vol. 81, pp. 448-459.
- Johnson, Ronald (1978), "Oral Auctions Versus Sealed Bids: An Empirical Investigation", Natural Resources Journal, Vol. 19, pp. 315-35.
- _____, (1979), "Auction Markets, Bid Preparation Costs, and Entrance Fees", Land Economics, Vol. 55, pp. 313-18.
- Kirzner, Israel, (ed.), (1982), Method, Process and Austrian Economics: Essays in Honour of Ludwig von Mises, Lexington Mass and Toronto: D.C. Heath and Co.
- Klein, Benjamin and Kenney Roy, (1983), "The Economics of Block Booking", Journal of Law and Economics, Vol. 61, pp. 1-33.
- McDonald, J.G. and Jaquillat Bertrand C., (1974) "Pricing of Initial Equity Issues: The French Sealed-Bid Auction", Journal of Business, Vol. 47, pp. 37-52.
- McManus, John, (1975), "The Cost of Alternative Economic Organizations," Canadian Journal of Economics, Vol. 8, pp. 334-354.
- Milgrom, Paul R. and Weber, Robert J., (1982) "A Theory of Auctions and Competitive Bidding", Econometrica, Vol. 50, No. 5, pp. 1089-1122.
- Miller, R.C., Plott, C. and Smith, V., (1977) "Intertemporal Competitive Equilibrium: An Empirical Study of Speculation", Quarterly Journal of Economics, Vol. 91, pp. 599-624.

Monfreid, Henry de., (1932) Les Secrets de la Mer Rouge, Paris: Bernard Grassset, as quoted in Journal of Political Economy (back cover), Vol. 86, No. 2, Part 1, April 1978.

Myerson, R., (1981), "Optimal Auction Design", Mathematical Operations Research, Vol. 6, pp. 58-73.

Palfrey, Thomas R., (1983), "Bundling Decisions by a Multiproduct Monopolist with Incomplete Information", Econometrica, Vol. 51, pp. 463-83.

Plott, C. and Smith, V., (1978) "An Experimental Examination of Two Exchange Institutions", Review of Economic Studies, Vol. 55, pp. 133-153.

and Wilde, L., (1982) "Professional Diagnosis vs. Self-Diagnosis: An Experimental Examination of Some Special Features of Markets with Uncertainty" in V. Smith, ed. Research in Experimental Economics, Vol. 2, Connecticut: Jai Press.

Rawick, George P. (ed.), (1941) The American Slave: A Composite Autobiography (Vol. 12), Westport, Conn.: Greenwood Publishing Co., 1974.

Riley, John and Samuelson, William F., (1981) "Optimal Auctions", American Economic Review, Vol. 71, pp. 381-392.

Smith, Vernon L., (1962) "An Experimental Study of Competitive Market Behaviour", Journal of Political Economy, Vol. 70, pp. 111-127.

_____, (1964) "Effect of Market Organization on Competitive Equilibrium", Quarterly Journal of Economics, Vol. 78, pp. 181-201.

_____, (1965) "Experimental Auction Markets and the Walrasian Hypothesis", Journal of Political Economy, Vol. 73, pp. 387-393.

_____, (1966) "Bidding Theory and the Treasury Bill Auction: Does Price Discrimination Increase Bill Prices", Review of Economics and Statistics, Vol. 48, pp. 141-146.

_____, (1967) "Experimental Studies of Discrimination versus Competition in Sealed-Bid Auction Markets", Journal of Business, Vol. 40, pp. 58-84.

- _____, (1976a) "Bidding and Auctioning Institutions: Experimental Results", in Y. Amihud, ed., Bidding and Auctioning for Procurement and Allocation, New York: New York University Press, pp. 43-64.
- _____, (1976b) "Experimental Economics: Induced Value Theory", American Economic Review, Vol. 66, pp. 174-179.
- _____, (1979) "Incentive Compatible Experimental Processes for the Provision of Public Goods", in V. Smith, ed. Research in Experimental Economics, Vol. 1, Greenwich: Jai Press, pp. 59-168.
- _____, (1980) "Relevance of Laboratory Experiments to Testing Resource Allocation Theory", in Jan Kmenta and James Ramsey, Evaluation of Econometric Models, New York: Academic Press, pp. 345-377.
- _____, (1982) "Microeconomic Systems as an Experimental Science", American Economic Review, Vol. 72, pp. 923-955.
- _____ and Williams, A., (1981) "On Non-Binding Price Controls in a Competitive Market", American Economic Review, Vol. 71, pp. 467-474.
- _____, Williams, A., Bratton, K. and Vannoni, M., (1982) "Competitive Market Institutions: Double Auctions versus Sealed-Bid Offer Auctions", American Economic Review, Vol. 72, pp. 58-77.
- Stark, Robert M. and Rothkopf, Michael H., (1979) "Competitive Bidding: A Comprehensive Bibliography", Operations Research, Vol. 27, pp. 364-390.
- Verrecchia, Robert E., (1982), "Information Acquisition in a Noisy Rational Expectations Economy", Econometrica, Vol. 50, pp. 1415-30.
- Vickrey, William, (1961) "Counterspeculation, Auctions and Competitive Sealed-Bid Auctions", Journal of Finance, Vol. 16, pp. 8-37.
- _____, (1976) "Auctions, Markets, and Optimal Allocations", in Y. Amihud, ed., Bidding and Auctioning for Procurement and Allocation, New York: New York University Press.

Wiedmann, Thomas, (1981) Greek and Roman Slavery, London: Croom Helm.

Williams, Arlington, (1979) "Intertemporal Competitive Equilibrium: On Further Experimental Results", in V. Smith, ed., Research in Experimental Economics, Greenwich: Jai Press, pp. 255-278.

_____, (1980) "Computerized Double Auction Markets: Some Initial Experimental Results", Journal of Business, Vol. 53, pp. 235-258.

Williams, Fred, (1972) "the Effect of Market Organization on Competitive Bidding: The Multi-unit Case", Review of Economic Studies, Vol. 40, pp. 97-113.

Wilson, Robert B., (1967) "Competitive Bidding with Asymmetric Information", Management Science, Vol. 13, pp. 816-820.

_____, (1975) "On the Incentives for Information Acquisition in Competitive Bidding with Asymmetrical Information", Stanford Graduate School of Business working paper, 11/1/75.

_____, (1977) "A Bidding Model of Perfect Competition", Review of Economic Studies, Vol. 44, pp. 511-518.

Wish, Harvey (ed.), (1968) Slavery in the South, New York: Farrar, Straus Giroux.