MARKET MAKING IN THE RESIDENTIAL REAL ESTATE MARKET

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
In partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 2001

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REAL ESTATE MARKET

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PREFACE

This research investigates using a market maker mechanism in the 1998 Northern Virginia residential real estate market. A market maker stands willing and able to buy or sell a good at their quoted bid and ask prices even when no one else is interested. Market maker functions are defined and described as they have been characterized in the literature. The benefits of having market makers range from shortening trading time and reducing transaction costs to transmitting information quicker and cheaper and reducing total selling costs and equilibrium prices. The market maker assumes risk from the seller and provides future liquidity to buyers. Real estate agents are not true market makers since they do not fulfill most market maker functions. Ideas from many authors are used to describe theoretical models of the existing and alternative market structures. Almost all sellers currently list their homes with a realtor using the Multi-Listing Service (MLS), indicating that trying to sell their home on their own or becoming a landlord are unattractive options. Although for buyers there is very little difference, market makers make a big difference for sellers. Since sales to a market maker are immediate, there is no need to discount expected future revenues. The data for this study comes from the 1998 Northern Virginia MLS sales database. After the theoretical models are reduced using some basic assumptions about the real world market, regression analysis is used to estimate sales prices. Sales timing data is used to compute the probabilities of selling a home as well as the revenues and costs of the market maker. The final results are shown for several different assumed discount rates. These results show that market makers could have replaced real estate agents and been profitable while providing valued services to buyers and sellers. This research fills several gaps in the literature. No one has taken market maker theory and applied it to the residential real estate market. The assumptions in this study are new and are a combination of the best applicable ideas from the literature. In addition, the models have been developed using individual optimizations that only apply in the real estate market. Finally, the large MLS database consisting of over 21,000 observations has never been used before.

ACKNOWLEDGEMENTS

I sincerely appreciate Dr. Michael Applegate, my dissertation committee chairperson for accepting the challenge of an independent research topic. He always responded to my requests for help in a timely fashion with constructive criticism and encouragement. He is a pleasure to be around and work with. I also wish to thank the other members of the committee for their valuable time, effort, and encouragement throughout this process. Both Dr. Ron Moomaw and Dr. Kent Olson are great teachers and mentors inside the classroom and out. Dr. Tim Krehbiel, the outside member, was very helpful and generous with his time and talents. I also must thank Dr. Lee Adkins for his most valuable guidance with the econometric portion of this dissertation. I must express my sincere appreciation for the Richard H. and Maxine D. Leftwich fellowship because I would never have had the opportunity to begin my Ph.D. studies without it. I could not have finished the Ph.D. program without the help of Ruby Ladd (she's a Diamond!) and the rest of the economics department. I am very grateful to the United States Air Force for allowing me two years of full-time study to complete my coursework and preliminary exams. I also want to thank Mary Rapoza for running the office alone while I took leave to finish this dissertation. Dr. Andy Sherbo was indispensable by reviewing my proposal and first draft and encouraging me to set my priorities to finish. As he often said, "there are more ABDs than Ph.D.s." Brian Feikema was instrumental in helping me obtain market data and answering all my real estate questions (not to mention him and Pam being such great friends!). I thank my parents, Ted and Betty Tenney for their encouragement all my life, which has helped me during some very challenging times. I am especially thankful to my children, Michael, Robert, Allana, Lena, TC, and Anthony for their sacrifice of time we could have had together while I worked on this research. I am most grateful to my wife, Robbie, not only for the sacrifice of family time, but also for encouraging me to continue even though I could tell she either needed my help or wanted more time with me. She kept our family going strong during some very stressful times.

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NOMENCLATURE

π	Profit per period
#	Number of homes
Π	Present value of all expected future profits
α	Time delay period
A	Total number of delay periods before finding a buyer or seller
β_0	Constant term
β_1	LSTPRICE coefficient
ε_t	Disturbance term
b	Designates the buyer
C	Buyer's present value expected cost of obtaining housing services
c	Commission rate as a percentage of the sales price
cdf	cumulative density function
DOMPROP	Days On the Market for a PROPerty
DP	Discounted Probabilities
f	Number of expected periods before selling a home or moving out of a rental
FC	Fixed Costs
H	Market Maker as a Holder of rental property
i	Expected inflation rate of sales price per period
I	Market maker as an Intermediary
k	Cost of capital
LL	Landlord
LSTPRICE	Final listing price variable (at time of contract acceptance)
M	Monetary costs of not transacting
MLS	Multiple Listing Service
MM	Market Maker
N	Non-monetary costs of not transacting
NETPRICE	Sales price variable, net of buyer concessions
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
pdf	probability density function
PI	Overall probability of matching traders
P^m	Probability of finding a home that matches the buyer's standard
P^s	Seller's expected probability of selling a home in a period
q	Expected rental inflation rate per period
Q	Initial rent per period
r	Discount rate (risk free rate + rate of impatience)
R	Present value of expected revenue to the seller
RENT	Designates renting a home
S	Current expected sales price net of buyer concessions
s	Designates the Seller
T	Fixed transaction costs
t	Transaction costs rate as a percentage of the sales price
VC	Variable Costs
x	Bid price rate as a percent of market value
y	Ask price rate as a percent of market value

CHAPTER I

INTRODUCTION

This chapter introduces the concept of a market maker and relates it to the residential real estate market. After a brief background of market making will come the definition of the problem, the purpose statement, the objective of this research, and the significance of the results.

Background

In economics and finance, market making refers to the activities of individuals or entities designated, formally or informally, as the source of both sales and purchases of a good at all times. Market makers stand willing and able to buy or sell a good at their quoted bid and ask prices. There need not exist an immediate offsetting buy or sell transaction at the same time, therefore, a market maker is not an arbitrageur. Since they use their own funds to execute each transaction, market makers are not considered brokers. Market makers, or "specialists" in the New York Stock Exchange, evolved out of the need to provide liquidity in stocks that traded too infrequently to support investor confidence that one could sell their holdings without undue time delay or large price concession. By raising confidence and lowering risk of investors, a market maker can attract more participants into the market for a particular stock and create a relatively more stable environment without having to buy and sell every share of stock that executes.

Researchers have identified many functions that market makers perform. Demsetz (1968) described the initial function of a market maker as providing for "predictable immediacy" in the market. Garman (1976) equated this to a market maker providing inter-temporal smoothing of demand and supply by buying and/or selling the security without large fluctuations in price even when no one else is interested. Lindsey and Schaede (1992) attributed market makers with the role of generating "endogenous liquidity" in addition to the inter-temporal smoothing of demand. By providing inter-temporal smoothing of demand and supply, market makers reduce the risk of market participants and increase the number of people willing to buy the asset. Providing the direct impact of "predictable immediacy" leads to the indirect effect of "endogenous liquidity" as soon as enough participants are drawn into the market. The increased number of traders can then transact among themselves, and the market maker will only be involved in a fraction of that market's trades. Stoll (1985) showed that, by providing intermediary services, market makers hold inventory and take on market risk. Bagehot (1971) introduced another type of market maker risk. Market makers may have the possibility of trading with better-informed market participants. In addition, Demsetz (1968) identified the function of asset standardization that a market maker may fulfill. By standardizing the asset, a market maker may reduce communication and exchange costs. Rubinstein and Wolinsky (1987) identified yet another market maker function. Market makers can shorten the expected search time to find a trading partner. A market maker may also be able to reduce total transaction costs. By transmitting information quicker and cheaper, they can also reduce the imperfect information problem identified by Shapiro (1983). Biglaiser (1993) pointed out that market makers could reduce inefficiencies of adverse selection by becoming an expert and distinguishing between high and low quality goods. Yavas (1993a) proposed that market makers might reduce total selling costs and lower equilibrium prices.

Market making is common in financial markets (e.g. equities) where the functions performed by market makers are necessary, not only for efficient trading, but also for the very existence of the market. The residential real estate market already exists without the help of market makers, but introducing market makers should decrease risk, increase liquidity, and boost efficiency in the market.

Problem Definition

There is no entity in the residential real estate market that will assume an owner's market risk and provide liquidity and certainty services. Almost anyone who has sold a home using a real estate agent has wondered if the service provided was really worth the cost of the commission. Real estate agents do not assume any market risk and cannot offer certainty of a sale because they do not offer to buy the seller's home. Buyers may have also asked themselves if they could have paid a lower price and received more or better services. Real estate agents do not offer a buyer future liquidity to boost their confidence of being able to sell quickly when required. A small percentage of buyers and sellers avoid real estate commissions altogether by entering the for-sale-by-owner market, but they pay lower costs only to do more work and experience added uncertainty. Most people still list their homes with a real estate agent because it is the best available alternative and brokers have monopoly access to the Multiple Listing Service (MLS). Some potential homeowners just keep renting because of the market and personal financial risks involved in buying and selling a home. This problem of market risk, uncertainty, and lack of liquidity would disappear if the market maker structure that works so well in equity markets could also replace the existing real estate agent mechanism and provide buyers and sellers more valuable services than currently provided.

Purpose of the Study

The purpose of this study is to develop a model involving market makers as experts in valuing similar but unique homes and find out if a market making mechanism is a viable alternative in the Northern Virginia residential real estate market.

Objective of the Study

The objective of this study is to determine if a market maker could have been a viable alternative to real estate agents in the Northern Virginia residential real estate market in 1998.

Significance of the Study

Just as market makers evolved out of the need to provide liquidity in stocks that traded too infrequently, market makers could develop in the real estate market to support homeowner confidence in their ability to sell their homes without undue time delay or large price concession. The market maker mechanism will be the financially preferred alternative when a seller's net revenue increases and/or a buyer's cost of ownership decreases. Market makers will also be preferred if more people are attracted to homeownership. Homeowners would be willing to sell to a market maker (rather than listing their home with a realtor) if the net revenue from the market maker is greater than the expected net revenue from listing their home with a realtor. Buyers would be willing to use the market maker in their search for a home if their expected net cost of ownership is less than using a realtor. Because market makers can significantly reduce risk in owning a home, many more renters would be willing to enter the market to buy a home. Buyers and sellers of homes are not the only ones that could benefit from a market maker arrangement. Reduced risk of loss to financing institutions may attract more capital and could lead to better financial terms on mortgages. Unfortunately, not everyone would benefit from this market making arrangement. Real estate agents could be hurt if the market makers are able to capture a significant share of the market. Agents would either be absorbed into the market making activity or forced to find another means of support.

A potential conflict of interest exists for real estate agents. They take on an advisory role and pledge to work for their client's best interest. At the same time, both listing and buyer agents only make money when sales take place. Therefore, there is an incentive to lead clients into a less than optimal transaction. A market maker is also self-interested, but the arrangement benefits both seller and buyer. The market maker assumes market risk from the seller and provides future liquidity to buyers. There is no possibility of a conflict of interest since each transaction is at arms length with no advisory role assumed by the market maker.

The market maker stands ready to buy or sell at their bid and ask prices at any given time. For example, table 1-1 shows an example of a bid sheet that could be generated by a real estate market maker. By keeping up with all market sales, a market maker could adjust the bid and ask prices continually and be ready and willing to buy any home in the market at any time.

Development: Mantua Fairfax, VA, 22031										
Unit No./ Address	Type	Style	BR	FB	HB	#Gar Spcs	Age	Lot SF	Buy	Sell
3529 GLENBROOK RD	Detached	Contemporary	5	3	1	0	35	29961	$338,400	$360,000
3130 BARKLEY DR	Detached	Split Level	3	1	1	0	37	27988	$227,480	$242,000
3614 DORADO CT	Detached	Rambler	4	3	0	0	33	20000	$246,750	$262,500
3303 EDENVALE RD	Detached	Contemporary	4	3	0	0	35	22495	$252,860	$269,000
9113 CORONADO TER	Detached	Contemporary	3	3	0	0	34	20000	$314,900	$335,000
3516 BARKLEY DRIVE	Detached	Rambler	5	3	0	0	43	44428	$296,100	$315,000
3515 KIRKWOOD DR	Detached	Rambler	4	3	0	0	43	24988	$228,420	$243,000
3808 LYNN REGIS CT	Detached	Split Level	5	2	1	2	28	22238	$214,320	$228,000
9129 SAINT MARKS PL	Detached	International	5	3	0	2	37	20057	$338,400	$360,000
3611 DORADO CT	Detached	Contemporary	5	3	0	2	33	20129	$265,080	$282,000
3801 LATROBE CT	Detached	Split Level	5	3	0	2	29	21692	$282,000	$300,000

Table 1-1. Market Maker Bid Sheet.

The implications of replacing real estate agents with market makers are important and far-reaching. Indeed, the whole real estate industry could be transformed with such a significant change in the market trading mechanism. Before continuing down this research path, it is expedient to understand prior research contained in the literature. The next chapter summarizes the market microstructure and market making literature applicable to the real estate market.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter summarizes previous market making research applicable to real estate. This is not an exhaustive coverage of market making or market microstructure research because the present study is concerned only with market making theory that can be applied to the real estate industry. Since no one has applied market-making theory to real estate yet, a gleaning approach to the literature has been taken to find the most appropriate theory for the problem at hand.

Market Microstructure Theory

Market making theory has evolved out of and is a subset of market microstructure theory. Market makers are just one type of middleman discussed in the literature. Maureen O'Hara (1995) wrote: "Market microstructure is the study of the process and outcomes of exchanging assets under explicit trading rules." Market making is simply a process with a set of 'rules' that can be used to efficiently exchange assets in a given market. Before researchers began raising price-setting process questions and developing what we now call market microstructure theory, it was common to assume away the problem. One would simply state that the equilibrium price and quantity were set by the intersection of the supply and demand curves. Another way to avoid explaining the price-setting process was to employ a Walrasian auctioneer. A Walrasian auctioneer is an imaginary auctioneer who works tirelessly (without compensation), instantaneously matching up the demands and supplies at the equilibrium price.

The emphasis in market microstructure theory (including market making) is on explaining the process or mechanism that results in rational economic agents agreeing to a common price for a common quantity of goods traded. Market making theory and research has concentrated almost entirely on financial markets, particularly focusing on equities and their derivatives. The theory tried to explain the observed behavior of real-world market makers in financial markets.

Authors have taken differing approaches to the process of price setting, depending on the players involved, trading locations, and trading rules involved in the market under study. Researchers developed their models by making assumptions about the players involving their preferences, objectives, roles, knowledge base, and constraints. In addition, the rules of the market under study play a big role in determining each individual theory. As long as the trading mechanism affects price setting in the market, trader behavior and the behavior of all other participants in the market, depend on that trading mechanism [O'Hara, 1995].

Beginnings of Market Making Theory

One of the first individuals to raise the question of the price forming process was Harold Demsetz. Demsetz (1968) studied the cost of transacting in the New York Stock Exchange (NYSE) by investigating the effect the scale of trading had on transaction costs. He defined transaction costs as the total cost to exchange ownership title. Major costs on the NYSE are brokerage fees, transfer taxes, and the bid-ask spread. The bid-ask spread, he wrote, is the compensation to market makers or specialists for providing "predictable immediacy" in the market. Other types of markets use different methods for their compensation (e.g. inventory markup).

Demsetz asserted that even if the number of buyers and sellers are the same over time, there is no guarantee that this equality will exist at a particular point in time. In that case, there may be no single market-clearing price and the price would depend on whether one is a buyer or seller, not just whether one is willing to trade. He argued that two supply and two demand curves exist for each commodity. One set of supply and demand curves symbolizes those who wish to trade immediately. The other set of supply and demand curves represents those who are willing to wait to transact, but are still actively engaged in the market. Sellers willing to wait have a supply curve above those that want to sell immediately and buyers willing to wait have a demand curve below those that want to buy immediately. The intersection of the waiting supply and the immediate demand is the equilibrium ask price (the price to those who want to buy immediately). The intersection of the waiting demand and immediate supply is the equilibrium bid price (the price to those who want to sell immediately).

In Demsetz' opinion, there are two roles for market makers. First, they match buyers with sellers over time. Second, market makers trade on their own accounts just like other investors. Without simultaneity of immediate supply and demand, the market maker substitutes two transactions (one buy and one sell) for one transaction (if supply and demand found each other simultaneously). The market maker steps in to keep transactions occurring without large fluctuations in price when the bid-ask spread in the market becomes too wide.

Demsetz' model implicitly assumes knowledge of all the supply and demand curves so that the bid-ask spread only compensates for predictable immediacy. When the supply and demand curves are not known, uncertainty is introduced and the bid-ask spread would then compensate for both risk and predictable immediacy.

Demsetz found that in the NYSE, the bid-ask spread comprised about 40 percent, and commissions about 60 percent, of transaction costs. Total transaction costs were about 1.3 percent of each transaction. The bid-ask spread is larger for thinly traded stocks than for those that are heavily traded because of lower waiting and inventory costs of market makers. Any market participant shortens the expected time of wait by lowering their ask price or raising their bid price. In fact, market makers only receive orders by making ask (bid) quotes lower (higher) than those in existence at the time.

Demsetz shows that the bid-ask spread increases with price and the natural log of price, decreases with transaction rates and the natural log of transaction rates, and decreases with the number of markets available to trade the security. One reason transaction costs can be kept low at high transaction rates is the willingness of people to accept the goods sight unseen. This is the case because of a high level of standardization that reduces communication and exchange costs. Of course, the number of markets available increases competition and puts pressure on the bid-ask spread.

Demsetz made some very important contributions to market making theory. His most important contribution is that trading is costly, just like any other activity. Participants must consider these costs when optimizing individual outcomes. He also pointed out that, besides matching buyers and sellers over time, market makers also trade and hold inventory for their own portfolio. In addition, Demsetz contemplated that competition from other market makers, other markets, and other market structures would keep the bid-ask spread close to costs.

Similar to Demsetz, Gould (1980) treats the market-making process as an economic activity that uses scarce resources. Since "buying" and "selling" to him are artificial and misleading labels, Gould simply calls market participants "traders." After all, each participant is both a buyer and a seller during the transaction and would not participate unless they would be better off with the trade. Both parties are interested in helping make a market so they can trade and be better off. Both traders' gains from trade are positive, but there are costs involved in finding each other and executing a trade. Gould does not model or assume any particular search process; he only assumes that this process leads to a probability of finding a trading partner. Gould models the trader's choice of how much to spend on searching for a partner by assuming that participants maximize their individual expected outcome. Gould identified PI, the overall probability of matching traders, as a measure of market making success. When PI = 1, there is a perfect market because trade is certain. When PI = 0, there is no market since no traders will be matched.

Gould shows that higher potential gains from trade will lead to higher search expenditures and/or more effort at making a market work. As the gain to one trader increases, (s) he will be willing to spend more to find a trading partner and this will cause others to spend less on market making activity. This will not necessarily increase the overall probability of matching traders. Only if those with the increased gain are more efficient at search, will the overall probability of matching traders in the market increase with a rise in search expenditures

The most important contribution from Gould is that, in addition to explicit and implicit transaction costs, there exists a cost of search in transacting and one must account for this cost in any market microstructure study. He also identified a search efficiency measure that can be used to measure differences in model efficiency.

Modeling the Trading Process

Rubinstein and Wolinsky (1987) included a model of the actual trading process in their equilibrium analysis. They allow for buyers, sellers, and middlemen. In their model, middlemen can function and extract surplus from buyers and sellers only if they shorten the expected search time of traders. Their emphasis was on the time-consuming nature of the search for both buyers and sellers. They specifically mention the housing market as fitting this kind of model well because intermediation should be able to reduce the search times of buyers and sellers. In their model, buyers and sellers can trade directly with each other or with a middleman.

Each market participant can be in four possible states: 1) buyer, 2) seller, 3) middleman without the good, and 4) middleman with the good. In the steady state, the probabilities of meeting a possible trading partner are constant. When middlemen are active participants (e.g. a market maker) in the market, buyers will receive a higher share of the gains from trade because of their bargaining position. With a consignment arrangement, the gains from trade for buyers and sellers are equal. The middleman's markup (spread) will depend on the rate of impatience (discount rate) of buyers and sellers. One result that Rubinstein and Wolinsky did not mention is that discounting and inefficiencies in the matching process (low expected gains from trade) will keep some potential market participants from entering the market at all. Adding intermediation can attract traders into the market by decreasing matching time and increasing expected gains.

The most important contribution of Rubinstein and Wolinsky is that middlemen, or market makers, will maximize the discounted value of their expected stream of profits. They also introduced the importance of using discount rates in individual optimization problems to account for the timing of expected cash flows.

Introducing Uncertainty

Following Demsetz' investigation of transaction costs, some researchers began modeling the uncertain nature of security order flow and its associated inventory problem for market makers and specialists. They focused on the dealer's optimization problem and the effect of having competition in the dealer market. They also considered the execution problems of individual traders. One of the first to model these uncertainties was M. B. Garman.

Garman (1976) initiated the research into the inter-temporal nature of supply and demand. He described a market where buy and sell orders may arrive at the market at different times. These orders result from traders' unspecified individual optimization problems. He identified the possibility of a feedback mechanism where the prices evolving from the matching process actually affect the buy and sell orders through individual optimization decisions. When imbalances in the order flow are combined with price feedback, the process of matching buyers with sellers becomes very important.

Garman models the monopolistic market maker by assuming it is a profit-maximizing agent subject to avoiding failure or bankruptcy. The market maker maximizes expected profit per period of time and has an infinite time horizon. The bid and ask prices can only be set once at the beginning of time.

Failure occurs when the market maker runs out of inventory or cash. Garman also assumed other restrictive assumptions in his model. The market maker may not borrow either cash or inventory and each order is for only one unit of stock. The only endogenous variables are the buy and sell order arrival rates that are driven by independent stochastic (Poisson distribution) processes. This order flow does not provide information about future prices. Since the market maker cannot change its bid and ask prices, it is uncertain if a set of prices exists that will allow the market maker to survive through time. Using a Poisson distribution for the order arrival rates assumes that there are many agents in the market, that no group of agents can dominate order generation, and each agent acts independently and is limited in order capability.

Using the gambler's ruin problem as a guide, Garman finds that at every bid and ask price, there is a positive probability of failure. To avoid certain failure, a market maker must, of course, set the ask price above the bid price. In order to get his results, Garman had to limit the uncertainty of the dealer by assuming a zero-drift inventory policy. This means that the market maker decides on an inventory level and adjusts to that inventory in every period of time. This assumption is not a good one for goods that have an alternative use. A better assumption would be to assume that the inventory has some positive earning potential and that a market maker will be indifferent between holding and not holding inventory depending on the profit maximizing problem and the positive earnings from inventory. Garman's assumption that the order flows follow a Poisson distribution seems to fit the real estate market well, since single buyers have no market power, each order comes from one individual for one unit, and no one seems to have better information than anyone else.

Garman's contributions to the literature consist of the introduction of the inter-temporal nature of supply and demand and the feedback of the matching process and prices to individual optimization problems.

Dealing with Inventory

Amihud and Mendelson (1980) took Garman's model and relaxed the assumption that prices may not change over time. They took into account that the market maker's inventory position will determine the bid and ask prices in order to maximize profits. They discard the market maker's ruin problem by introducing exogenous limits on inventory position. Running out of inventory is no longer possible. This inventory assumption results in decreasing bid and ask prices when inventory increases. In addition, the bid-ask spread will be positive and the dealer will have a preferred inventory position. The preferred inventory position in this model is driven by the profit maximizing problem rather than the fear of failure. In this model, the bid-ask spread is simply a reward for being a monopolist. The spread goes to zero when competitive market makers are introduced. This is mainly because the liquidity desires of buyers and sellers and the risk to the market maker have been ignored.

Amihud and Mendelson contributed two important concepts to the literature. First, the market maker's inventory position will affect bid and ask prices. As inventory rises (falls), both bid and ask prices fall (rise). Second, they pointed out that the preferred inventory position should be determined by the market maker's optimization problem.

Rather than focusing on the monopolistic nature of the market maker, Stoll (1978) modeled the market maker as a market participant with risk aversion. This market maker requires compensation for portfolio risk and for providing intermediary services to other market participants. In other words, a dealer must be compensated for the risk of holding inventory. Other costs to the market maker include transaction costs and the cost of trading with more informed traders. As it turns out, the asymmetric information costs that Stoll identifies are quite important in the market making literature. With the assumption that a market maker maximizes its expected utility of wealth, Stoll shows that bid and ask prices depend on the market maker's inventory position, but the spread between them does not. Unfortunately, his model ignored the inter-temporal properties set forth by Garman and Amihud and Mendelson.

Ho and Stoll (1981) extended Stoll's model to take account of the inter-temporal dimension of the market maker's optimization problem. They assumed random order arrival rates and random returns. They kept the risk aversion assumption originally in the Stoll model and assumed that the market maker maximizes its expected utility of final wealth. Ho and Stoll found that the bid-ask spread does depend on the time horizon of the problem. The longer the time horizon, the higher the risk to the market maker and the larger the spread between the bid and ask prices. Ho and Stoll also found that the market maker's inventory position does not affect the bid-ask spread. The most important contribution of Ho and Stoll was identifying the possibility of trading with market participants with superior information. Another important point was that market makers may be risk averse and the longer the time horizon of the problem, the more risk involved and the wider the bid-ask spread.

Other authors such as O'Hara and Oldfield (1986), Cohen, Maier, Schwartz, and Whitcomb (1981), and Ho and Stoll (1983) continued to refine models that addressed the inventory effects on market makers. They expanded the research by considering things like infinite time horizons, preferred inventory positions, and risk aversion for market makers as well as inventory value uncertainty, different types of orders, and inter-dealer market mechanisms. Almost every one of these models assumed, either explicitly or implicitly, that information did not enter into the price-setting process. None of these models had any participants with superior information.

Dealing with Asymmetric Information

Bagehot (1971) introduced the information problem into market making research. He divided gains and losses into two categories: 1) market gains and losses and 2) trading gains and losses. With market gains and losses, over the long-term investors play a 'fair game.' When prices rise, investors win and when prices fall, investors lose. With trading gains, however, informed traders are able to buy when prices are 'too low' and sell when prices are 'too high.' The average investor loses money relative to the market while the informed trader gains. With the possibility of trading with more informed traders, a market maker would have to offset losses by widening the bid-ask spread.

Copeland and Galai (1983) used a simple static model with asymmetric information. They showed that the bid-ask spread would exist even with risk neutral competitive dealers. As Bagehot asserted more than ten years earlier, Copeland and Galai showed that the bid-ask spread compensates the dealer for trading with more informed traders. Glosten and Milgrom (1985) assumed no inventory effects similar to Copeland and Galai. They used a sequential trade mechanism where both informed and uninformed traders must wait to be selected randomly for the chance to trade one unit with the market maker. Otherwise, the informed traders would trade as often as possible and reveal their information to the rest of the market through their activity. Competitive market makers play a strategic game of setting their bid and ask prices. The result is that prices are set so that the expected profit of each trade is zero. To the market maker, the bid and ask prices are seen as conditional expectations and lead to the adjustment of prices as time goes by. Glosten and Milgrom found that a bid-ask spread arises out of the asymmetric nature of information even without any inventory or transaction costs. This could actually lead to a break down in the market if market makers had to raise their bid-ask spread enough so that no trade occurred. This could happen if there were many informed traders who transacted often.

Easley and O'Hara (1991) introduced the concept of varying trade size into their Glosten and Milgrom type model. They modeled information as a dual process involving both the existence of new information, and its direction. In their model, there are two possible equilibriums. The first occurs when informed traders decide only to transact with larger trade size and is called the separating equilibrium. The second is called the pooling equilibrium because informed traders will use both high and low trade sizes. The separating equilibrium results in no bid-ask spread for small trade size transactions but leads to a positive spread for larger trade sizes. The pooling equilibrium leads to a smaller spread in the small trade size segment of the market compared to the large trade size segment. Another revelation from the Easley and O'Hara model is that prices are not Markov. Prices do depend on past prices.

Endogenous Liquidity

Lindsey and Schaede (1992) stated: "In theory, market-makers provide three services to investors—inter-temporal smoothing of demand, risk-sharing and the generation of endogenous liquidity." Market makers accomplish inter-temporal smoothing of demand by setting bid and ask prices and being willing to trade both sides of the market at all times. Risk sharing is achieved through market makers' willingness to absorb market orders without large fluctuations in price. These two functions combined lead to the third function of endogenous liquidity. Because investors can count on their orders being executed immediately at a price similar to the last transaction's price, they are induced to enter and stay in the market for that commodity. If investors expected delays in market transactions and at unpredictable prices, they would be driven out of the market. Lindsey and Schaede identified three costs associated with trading: 1) a price concession to induce someone to trade immediately, 2) communicating that information to others, and 3) the wait time for others to get and react to that information. Absent a market maker, there is a trade-off between price concession and waiting time since large price concessions usually lead to quick sales. Lindsey and Schaede's contribution is the idea of endogenous liquidity attracting and keeping people in a market with active market makers

The Adverse Selection Problem

There is an adverse selection problem if one party to a transaction knows more about the good (e.g. quality) than another. Biglaiser (1993) defines middlemen as those agents who trade in a good but do not originally own or alter it, and get no consumption value from it. By becoming an expert in the quality of goods, middlemen can reduce inefficiencies when an adverse selection problem exists. This is always true if transaction costs are low and the quality of goods varies widely. Using the assumption of a Walrasian auctioneer would not even eliminate inefficiencies if an adverse selection problem exists. Middlemen must incur an up front fixed cost to become an expert at inspecting and determining the quality of a good. Middlemen can offer a warranty since they buy many more goods than an ordinary buyer and will stay in the market for a long time. A middleman does not have to inspect every good, but may choose to do so depending on 1) the probability of buying a low quality good and 2) the cost of inspection.

The market with expert middlemen has higher welfare because trade occurs more quickly and this offsets the fixed initial investment. Biglaiser's model results in all high quality sellers and most low quality sellers selling to middlemen. This causes the market to become segmented. The middlemen's price is high enough to keep them from cheating (selling low quality goods as high quality). These results hold even if the initial investment in inspection technology is very high. Biglaiser described the conditions that are most likely to lead to the existence of middlemen in the market:

1. A large proportion of low quality goods in the market.
2. A large difference between low and high quality goods.
3. A high cost to buyers of differentiating between high and low quality goods.
4. Low transaction costs.

In markets where middlemen and direct trade co-exist, the price and quality of the goods sold by middlemen will be higher. Biglaiser asserts two reasons for middlemen to enter a market. First, they reduce the search time of buyers and sellers. Second, they validate the quality of the goods. Biglaiser's major contribution was identifying that a market maker can be an expert or informed trader. Market makers, as experts, can solve adverse selection problems by revealing their knowledge of the quality of a good and guaranteeing that quality to their customers.

Biglaiser and Friedman (1994) identified four reasons that middlemen can improve efficiency in the market. Middlemen can reduce the search costs of market participants as discussed by Rubinstein and Wolinsky (1987) and Yavas (1992). Middlemen can also become experts and thus resolve the adverse selection problem between sellers and buyers as discussed by Biglaiser (1993), Chu and Chu (1990), and Marvel and McCafferty (1984). In addition, middlemen may reduce total selling costs by taking advantage of economies of scale and selling goods produced by more than one manufacturer. The presence of middlemen can also reduce the premium required to induce producers to manufacture high quality goods by reducing the up front "investment" required to establish a high quality reputation and raising the penalty of defecting to low quality production. Biglaiser and Friedman developed a model that shows this last function of a middleman. They show that higher quality goods in a market with middlemen will have lower equilibrium prices and signal costs than in a non-middleman market.

Modeling the Real World

Carlton (1978) modeled a market with price inflexibility (prices do not adjust at each instant of time), demand uncertainty (firms set price before they know actual demand), and timing of production commitments (produce or committed to produce before demand is observed). In this market, each good has a price and a probability that it is available for sale. Equilibrium will not necessarily mean that quantity supplied equals quantity demanded. Firms maximize expected profits and are assumed to have no monopoly power. Each period, the firm must set a price and decide on a quantity to produce before demand is observed. Carlton let each consumer be in one of three states: 1) does not desire the good, 2) desires the good but cannot purchase (it is not available), and 3) desires the good and buys it. Competition is not in price only, but also includes availability. Therefore, firms decide on a price/shortage combination. Expected utility of consumers involves the price and the probability of obtaining the good. Instead of being price-takers, firms in this competitive market are utility-takers. Their price and availability combination must achieve the given utility level of the market. If they do so, they get their random share of customers.

The resulting market equilibrium will include a positive probability of not obtaining the good and a price that is above the cost of production. The margin between price and cost is compensation for producing all goods, sold and unsold. There could exist several price/availability equilibrium combinations in this type of market. This would occur especially if there are several distinct types of consumers with different price/availability preferences. That could also lead to distinct types of firms, each with their own niche of price/availability that match their type of customer. Each firm in this market actually sells a different product: the good and its availability.

This applies to market makers because one of their functions is inter-temporal demand smoothing. Market makers do not know the actual demand when they buy, but have a good idea of the demand function. They would set a bid and ask price combination and then their inventory would change according to the market. Market makers can then adjust their prices in the next period to manage their inventory position. Firms can also try to stabilize their demand, keeping their customers loyal by offering price discounts or other benefits for returning to them rather than going to a competitor.

Applying the Literature to the Present Study

Building the models of the existing and alternative structure of the real estate market required the use of many ideas from different authors. The original idea that transaction costs are important came from Demsetz (1968) and was expanded by Gould (1980) so that transaction costs should be included in individual optimization problems. Rubinstein and Wolinsky (1987) later added that middlemen maximize the expected value of their discounted stream of profits. This leads to the use of discount rates to model the rate of impatience in both individuals and middlemen. The use of market maker inventory in the model is traced back to Demsetz' idea that one of the functions of a market maker is to hold its own portfolio inventory. Using the market maker's optimization problem to determine the preferred inventory position is attributed to Amihud and Mendelson (1980). Biglaiser (1993) identified the possibility of modeling a middleman as an expert. Doing so avoids the informed trader problem introduced by Bagehot (1971). Lindsey and Schaede (1992) discovered the fact that endogenous liquidity attracts traders into the market. Gould (1980) was the one to assume that the searching process results in probabilities of finding a match.

Filling Gaps in the Literature

This research fills several gaps in the literature. Since no one has tried to model market makers in the real estate market, no unique set of assumptions exist that apply to real estate. The assumptions for the models in this research have been developed as a combination of the best ideas from the literature in order to apply market making to real estate. Also, the models in this research have been developed using individual optimization problems that only apply to real estate market participants. Finally, the large data set consisting of over 21,000 observations has not yet been used in the literature.

There have been many valuable contributions to our knowledge of market making. This knowledge may be used to describe how the real estate market would work if run by market makers instead of real estate agents. Now that the past research is understood, the existing and alternative models of the 1998 Northern Virginia residential real estate market models may be developed. The next chapter describes the existing market model and is followed by the alternative model with real estate agents replaced by market makers.

CHAPTER III

RESIDENTIAL REAL ESTATE EXISTING MARKET MODEL

This chapter outlines the assumptions, trading rules, and model of the existing real estate market. The seller, buyer, and real estate agent optimization problems are described and put into equation form. The model equations identify important variables used in the analysis to show that market makers could have replaced real estate agents in the Northern Virginia residential real estate market.

Assumptions

The following assumptions about the players, inventories, information, search, market structure, and transaction costs model the existing set of rules in the residential real estate market. These rules along with the individual optimization problems and their resulting equations, constitute the market microstructure model of the existing residential real estate market.

The Players Involved

Sellers. Potential sellers own a home and wish to sell for liquidity reasons. Some external or internal event has caused the seller to either want to sell or have to move to a new home or location. Once the decision to move is entertained, owners must choose between 1) listing their home in the multiple listing service (MLS) with a realtor and 2) renting the home to someone else. Because realtors have exclusive access to the MLS, trying to sell a home on ones own is not much of an option and thus is ignored in this study. Leasing the home to someone else is an alternative use of the home as an asset and the owner holds it as an investment. Sellers obtain the expected sales price (S_{MLS}) of their home through an appraisal, market analysis, or personal experience. The owner of a home knows its condition. Most homeowners have a mortgage that needs to be paid in full at the time of sale. This may keep potential sellers out of the market if the expected sales price is less than their mortgage balance. Sellers are assumed to be risk neutral and simply interested in maximizing the present value of expected net revenue. Without this assumption, an owner may end up holding on to their home indefinitely as long as prices are rising. Sellers prefer selling their home sooner rather than later unless the expected sales price inflation rate (i) is very high. There is a risk that a seller's home will not immediately attract anyone interested in buying. This would result in both monetary (M^{s}_{MLS}) and non-monetary (N^{s}_{MLS}) costs that increase over time. Monetary costs of not selling include mortgage interest, taxes, insurance, homeowner association dues, maintenance, supporting two households, market risk, and the opportunity cost of equity. Non-monetary costs include stress, family separation, time, and productivity.

Buyers. Potential buyers wish to find a home to occupy and enjoy housing services in the future or hold as an income-producing asset (with potential tax benefits). There is also intrinsic value in owning a home (the American dream). If the total cost of ownership (C_{MLS}) is more than renting (C_{RENT}), potential buyers will choose to rent a home. The existence of the rental alternative limits the willingness of potential buyers to pay for a home. Potential buyers will know the expected sales price (S_{MLS}) of each home through the advice of their agent or personal experience. Most buyers will discover the condition of the home they are purchasing through an inspection. They may also obtain a home warranty, which pays for any major breakdowns in the future. Most buyers must obtain mortgage financing in order to purchase a home. Their annual income will usually limit their ability to pay because of the mortgage company's underwriting criteria. Buyers and their agents are aware of this limit and consider only homes with expected sales prices that will lead to a reasonable expectation of obtaining a loan. Buyers are assumed to be risk neutral and simply interested in minimizing the present value expected cost of living in an acceptable home. Buyers set their own expectations of an acceptable home. These expectations will determine how hard or easy it is to find a home that is a match. If buyers have high expectations, their probability of finding a match (P^{m}_{MLS}) is relatively low and they can expect to look for some time. The longer they look without finding a match, the higher will be their monetary (M^{b}_{MLS}) and non-monetary (N^{b}_{MLS}) costs of not buying a home. Monetary costs of not buying a home include market risk, supporting two households, and temporary lodging expenses. Non-monetary costs would include things like stress, family separation, search time, and productivity.

Real Estate Agents. Real estate agents are in business to match sellers with buyers. They receive a commission (c) from the seller that is a fixed percentage of the actual sales price. The buyer and seller agents typically split the sales commission. The only way to list a home in the MLS is by contracting with a real estate agent. The realtor industry holds a monopoly to the MLS and the major service they provide is the ability to access it. Real estate agents also provide guidance, pay for advertising, and handle the administrative details of each sale. Real estate agents are risk neutral and maximize the present value of all future profits (Π_{MLS}).

Society. Society values home ownership. Otherwise there would be no mortgage interest tax deduction. Society also benefits from efficient transfers of ownership.

The Role of Inventories

Sellers hold inventory of one home and incur holding costs of interest, market risk, and other monetary and non-monetary costs of not selling their home. Buyers, on the other hand, hold cash and available mortgage financing. Real estate agents do not hold inventory of homes and they do not provide cash or mortgage financing. They simply act as an intermediary between buyer and seller and may assist buyers in locating their financing.

Search Characteristics

Sellers. Sellers typically do not actively search for buyers even though a few may know of potential buyers and pursue their interest. They may place advertisements in the media in order to attract potential buyers, but most sellers simply list their home with a realtor in the MLS. Sellers experience an expected probability (P^{s}_{MLS}) of selling their home in each period.

Buyers. Buyers search sequentially. Each buyer sets standards for the characteristics of an acceptable home. These standards include minimum requirements and nice-to-have features and include location, amenities, and price range. Each home has a probability (P^{m}_{MLS}) of matching the standards of the individual buyer. These probabilities depend on the restrictive nature of the standards set by the buyer. When a match is found, the buyer must decide to begin negotiations or keep searching for a better match or lower cost home. At some point, each buyer must decide to make an offer on the best match available because of a time constraint or the rising monetary and non-monetary costs of not buying a home.

Information Properties

Buyers, sellers, and real estate agents share similar expected sales prices (S_{MLS}) of each home. This information is obtained through an appraisal, market analysis, or personal experience. Sales prices carry information on the changing value of homes, but the quantity of homes sold does not carry information by itself. The number of homes not sold (left on the market) changes the expected time to buy or sell a home and will affect the decisions of buyers and sellers.

Market Structure

Buyers must act strategically since other buyers are free to make offers at any time. This causes buyers to be competitive, at least for the most commonly desired types of homes. Real estate agents try to differentiate themselves from others, but usually do not compete using their commission rate. In this sense, real estate agents compete for business but the realtor industry acts as a monopoly by setting its price (commission rate) and allowing those not willing to pay it to sell their home on their own.

Sellers choose a listing price based on the current expected sales price, the probability of selling their home, holding costs, and other monetary and non-monetary costs. The objective of the seller is to maximize the present value of expected net revenue. Sellers may set a lower asking price to obtain expediency (quicker sale) due to their discounting, holding costs, probability function, and monetary and non-monetary costs of not selling their home.

Buyers choose the matching characteristics including location, amenities, and price range. The objective of the buyer is to minimize the present value expected cost of obtaining housing services. Buyers may pay a higher sales price to obtain expediency (quicker purchase) due to their discounting and monetary and non-monetary costs of not buying a home. A buyer's probability of finding a match depends on the restrictive nature of the matching characteristics chosen.

Many market characteristics identified in the literature do not apply in the residential real estate market. There can be no noise trading because buyers and sellers place intrinsic value on a home and there are no uninformed players in the market. Furthermore, there can be no short selling of homes and there are no trade size or volume effects since each home is unique and is sold separately.

Transaction Costs

Buyers and sellers both pay transaction costs that include legal, administrative, transfer, recording, and financing fees. Sellers also pay a commission to the real estate agents involved in the transaction. Some transaction costs are fixed (T) and others vary (t) with the sales price.

Real Estate Agent Function

Real estate agents are not market makers since they do not perform many of their functions. They do not provide predictable immediacy or endogenous liquidity to the residential real estate market. Since they do not generally buy and then sell properties, they are not burdened with holding inventories and do not take on market risk. They do not provide any asset standardization. Real estate agents help reduce search costs of buyers and sellers and increase market participants' knowledge to help reduce imperfect information problems. This specialized knowledge makes a real estate agent an expert, but clients can have difficulty determining which real estate agent is an expert and which will give less than perfect advice.

The Seller's Decision

Each potential seller has two choices: 1) list the home in the MLS, or 2) rent the home to someone else. The objective is to maximize the present value of expected revenue from selling (R_{MLS}) or renting (R_{LL}) the home. In making the decision between selling and renting, one must consider the timing of all revenues and costs for each alternative.

For the MLS option, the expected sales price (S_{MLS}) must be adjusted by the probability of a sale (P^s_{MLS}) in each period. Also, the commission (c) and the variable transaction costs (t^s_{MLS}) will be netted out. Of course, if not sold immediately, there may be inflation of the sales price (i), either positive or negative. After all these effects are accounted for, the fixed transaction costs (T^s_{MLS}) and the monetary (M^s_{MLS}) and non-monetary (N^s_{MLS}) costs of not selling in each period must be subtracted. All of the seller's costs and benefits must be discounted using his or her personal discount rate (r^s).

For the landlord (LL) option there will exist a market-determined rent (Q) and an expected rental inflation rate (q) for each home. Besides knowing the expected sales price (S_{MLS}), the seller will also know the expected sales price inflation rate (i) applicable to the home. A landlord will incur the cost of capital (k) on the expected revenue of selling his or her home. Landlords must also pay variable costs (VC) and fixed costs (FC) while holding the home as a rental. All these factors must be discounted according to the time they occur. Discounting uses the personal discount rate (r^s) of the owner to sum up the present value of each benefit or cost.

Equations 3-1 through 3-3 sum up in equation form the model of sellers in the existing real estate market. With the LL option, each period (μ) will bring in the expected rent adjusted for any inflation ($(1+q)^{\mu}Q$). In addition, any increase in value to the property (iS_{MLS}) must be added. Subtracted from that is the cost of capital (kR_{MLS}) and the period's variable costs (VC_{μ}) and fixed costs (FC_{μ}). This total is divided by the discount term ($(1+r^s)^{\mu}$) to provide the period's present value. Finally, each period's present value is summed to get the total present value expected revenue (R_{LL}) of renting the home to someone else.

Each period in the MLS alternative, the expected sales price is adjusted with the probability of selling, price inflation, sales commission, and variable transaction costs ($\left(1-c-t^s_{MLS}\right)\left(1+i\right)^{\alpha^s_{MLS}} P^s_{MLS} S_{MLS}$). From this term are subtracted fixed transaction costs (T^s_{MLS}) and monetary (M^s_{MLS}) and non-monetary (N^s_{MLS}) costs of not selling in each period. Then the total for each period is divided by the discount term ($\left(1+r^s\right)^{\alpha^s_{MLS}}$) to get the period's present value. To find the total present value expected revenue (R_{MLS}) for this option; each period's present value is summed. The decision to sell or rent is made by comparing the present value of expected net revenues and selecting the option with maximum value.

$$R_{LL} = \sum_{\mu=1}^{\infty} \frac{(1+q)^{\mu} Q + iS_{MLS} - kR_{MLS} - VC_{\mu} - FC_{\mu}}{\left(1+r^s\right)^{\mu}} \qquad (3-1)$$

$$R_{MLS} = \sum_{\alpha=1}^{A} \frac{\left(1-c-t^s_{MLS}\right)\left(1+i\right)^{\alpha^s_{MLS}} P^s_{MLS} S_{MLS} - T^s_{MLS} - M^s_{MLS} - N^s_{MLS}}{\left(1+r^s\right)^{\alpha^s_{MLS}}} \qquad (3-2)$$

$$MAX\left(R_{MLS}, R_{LL}\right) \qquad (3-3)$$

Where:

A is the total number of delay periods before finding a buyer

α represents the time delay period

c is the commission rate as a percentage of sales price

FC designates fixed costs and is exogenous

i is the expected inflation rate of sales price per period and is exogenous

k is the cost of capital and is exogenous

LL designates being a landlord

M designates the monetary costs of not transacting and is different for each seller

MLS designates using the real estate agent Multiple Listing Service

N designates the non-monetary costs of not transacting and is different for each seller

P_{MLS}^{s} is the probability of selling a home during a period

q is the expected rental inflation rate per period and is exogenous

Q is the initial rent per period and is exogenous

r is the discount rate and is different for each seller

R is the present value of expected revenue to the owner

s designates the seller

S_{MLS} is the expected sales price net of buyer concessions

T is the fixed transaction costs and is exogenous

t is the variable transaction cost rate as a percentage of the sales price and is exogenous

VC designates variable costs and is exogenous

The seller's objective is to maximize the present value of expected net revenue. Listing with a real estate agent reveals that selling the home has a higher expected net revenue than becoming a landlord.

The Buyer's Decision

Each potential buyer has two choices: 1) buy a home or 2) rent a home. The objective is to minimize the present value expected cost of buying (C_{MLS}) or renting (C_{RENT}) a home. In making the decision between buying and renting, one must consider the timing of all costs for each alternative.

For the MLS option, the expected sales price (S_{MLS}) must be adjusted by the probability of a match (P_{MLS}^{m}) in each period and the variable transaction costs (t_{MLS}^{b}) must be added. Of course, if not found immediately, there may be inflation of the sales price (i), either positive or negative. After all these effects are accounted for, the fixed transaction costs (T_{MLS}^{b}), and the monetary (M_{MLS}^{b}) and non-monetary (N_{MLS}^{b}) costs of not buying in each period must be added. At some future date (f) the buyer will sell the home and collect the net sales revenue (R_{MLS}^{f}). All of the buyer's costs and revenues must be discounted using his or her personal discount rate (r^b).

For the rental (*RENT*) option there will exist a market-determined rent (Q) and an expected rental inflation rate (q) for each home. There also exist non-monetary costs of not owning a home (N_{RENT}^{b}) while renting. These two factors must be discounted according to the time they occur. Discounting uses the personal discount rate (r^b) of the buyer to sum up the present value of each cost.

Equations 3-4 through 3-6 sum up in equation form the model of buyers in the existing real estate market. With the *RENT* option, each period (μ) the renter will pay the rent adjusted for any inflation ($(1+q)^{\mu}Q$). In addition, the non-monetary cost (N_{RENT}^{b}) of not owning a home is added. This total is divided by the discount term ($(1+r^b)^{\mu}$) to provide that period's present value. Finally, each period's present value is summed to get the total present value expected cost (C_{RENT}) of renting a home.

Each period in the MLS alternative, the expected sales price is adjusted with the probability of finding a match, price inflation, and variable transaction costs ($(1+t_{MLS}^{b})(1+i)^{\alpha_{MLS}^{b}} P_{MLS}^{m} S_{MLS}$). Added to this term are fixed transaction costs (T_{MLS}^{b}) and the monetary (M_{MLS}^{b}) and non-monetary (N_{MLS}^{b}) costs of not finding a home in each period. Then the total for each period is divided by the discount term ($(1+r^{b})^{\alpha_{MLS}^{b}}$) to get that period's present value. To get the total present value expected cost (C_{MLS}) for this option; each period's present value is summed. From this total is subtracted the expected revenue (R_{MLS}^{f}) from selling the home in the future, divided by the discount factor ($(1+r^b)^f$). The decision to buy or rent is made by comparing the expected present value costs of each alternative and selecting the option with minimum value.

$$C_{RENT} = \sum_{\mu=1}^{f} \frac{(1+q)^{\mu} Q + N^{b}_{RENT}}{(1+r^{b})^{\mu}} \qquad (3-4)$$

$$C_{MLS} = \sum_{\alpha=1}^{A} \frac{(1+t^{b}_{MLS})(1+i)^{\alpha^{b}_{MLS}} P^{m}_{MLS} S_{MLS} + T^{b}_{MLS} + M^{b}_{MLS} + N^{b}_{MLS}}{(1+r^{b})^{\alpha^{b}_{MLS}}} - \frac{R^{f}_{MLS}}{(1+r^{b})^{f}} \qquad (3-5)$$

$$MIN(C_{MLS}, C_{RENT}) \qquad (3-6)$$

Where

α represents the time delay period

A is the total number of delay periods before finding a match

b designates the buyer

C is the buyers present value expected cost of obtaining housing services

f designates the number of expected periods before selling the home or moving out of the rental

i is the expected inflation rate of sales price per period and is exogenous

M designates the monetary costs of not transacting and is different for each buyer

MLS designates using the real estate agent Multiple Listing Service

N designates the non-monetary costs of not transacting and is different for each buyer

P^{m}_{MLS} is the probability of finding a home that matches the individual buyer's standard

q is the expected rental inflation rate per period and is exogenous

Q is the initial rent per period and is exogenous

r is the discount rate and is different for each buyer

R is the present value of expected revenue to the owner

RENT designates renting a home

S_{MLS} is the expected sales price net of buyer concessions

T is the fixed transaction costs and is exogenous

t is the variable transaction cost rate as a percentage of the sales price and is exogenous

The buyer's objective is to minimize the present value expected cost of housing services. By searching and buying a home using the MLS, buyers reveal that owning has a lower expected cost than renting.

The Real Estate Agent's Decision

Equations 3-7 through 3-9 sum up in equation form the model of real estate agents in the existing real estate market. Each period, real estate agents earn revenue from commissions (cS_{MLS}) and incur both variable costs (VC_{MLS}) and fixed costs (FC_{MLS}). To compute the profit per period, the variable costs are subtracted from the revenue for each home sold. Then the fixed costs for the period are subtracted. Real estate agents discount each period's profit (π_{MLS}) with their individual discount rate ($(1+r_{MLS})^{\mu}$) and sum all future period profits to compute the present value of future profits (Π_{MLS}). Real estate agents maximize the present value of all future profits.

$$\pi_{MLS} = \sum_{j=1}^{\#_{MLS}} \left[cS_{MLS}^{j} - VC_{MLS}^{j} \right] - FC_{MLS} \qquad (3-7)$$

$$\Pi_{MLS} = \sum_{\mu=1}^{\infty} \frac{\pi_{MLS\mu}}{(1+r_{MLS})^{\mu}} \qquad (3-8)$$

$$MAX(\Pi_{MLS}) \qquad (3-9)$$

Where

$\#_{MLS}$ is the number of homes sold by the real estate agent each period

π_{MLS} is the profit of the real estate agent per period

Π_{MLS} is the real estate agent's present value of all expected future profits

c is the commission rate as a percentage of the sales price

FC_{MLS} is the fixed cost per period to the real estate agent and is exogenous

r_{MLS} is the real estate agent's discount rate

S_{MLS} is the expected sales price net of buyer concessions

VC_{MLS} is the variable cost per transaction to the real estate agent and is exogenous

Equilibrium in the Existing Market Model

Equilibrium in the existing market model consists of a set of values for sales prices (S_{MLS}). The seller (P^{s}_{MLS}) and buyer (P^{m}_{MLS}) probabilities respectively determine the time before a home is sold and the length of time a buyer spends searching before finding a match.

By listing their home with a realtor, sellers reveal that the MLS option has higher expected revenue than the LL option. Each owner's decision depends on his or her personal discount rate (r^{s}). The discount rate is comprised of the risk-free rate plus an individual rate of impatience (risk premium). Differing individual personal discount rates equate to differing rates of impatience (risk premiums). An individual's rate of impatience (risk premium) in selling a home depends on their wealth, income, expenses and motivation to move. Other determinants of the homeowner's decision include the commission rate, transaction costs, rents, and the cost of capital. Of course the individual's monetary (M^{s}_{MLS}) and non-monetary (N^{s}_{MLS}) costs of not owning a home will also affect their decision. For individual home sellers, the LL option should only be chosen if 1) there is a mismatch between the rental rate and expected sales price (rents are relatively high and/or inflating rapidly), 2) the cost of capital and/or variable or fixed costs of being a landlord are low, 3) the probability of selling is low, 4) the commission rate or transaction costs in the MLS option are high, or 5) the owner is in a negative equity position and does not have the cash needed to sell.

By searching to buy a home with a realtor, buyers reveal that the MLS option has lower expected cost than the RENT option. The potential buyer's decision to rent or buy will depend on the expected sales price (S_{MLS}) and its inflation rate (i), the length of expected stay in the area (f), the rental rate (Q), expected growth rate of rents (q), and the non-monetary costs of renting (N^{b}_{RENT}). Of course fixed (T) and variable (t) transaction costs and the individual's monetary (M^{b}_{MLS}) and non-monetary (N^{b}_{MLS}) costs of not owning a home will also affect their decision. For individual home buyers, the RENT option should only be chosen if 1) there is a mismatch between the rental rate and expected sales price (rents are relatively low and not inflating rapidly), 2) homes are not appreciating much or are depreciating, 3) the probability of finding a match is low, 4) transaction costs are high, 5) non-monetary costs of renting are low, or 6) the expected length of stay is short.

The model of the existing real estate market shows the decision process that buyers, sellers, and real estate agents use to optimize their outcomes. With the model of the residential real estate existing market complete, the alternative model may be described before moving on to the empirical analysis.

CHAPTER IV

RESIDENTIAL REAL ESTATE ALTERNATIVE MARKET MODEL

This chapter outlines the assumptions, trading rules, and model of the alternative real estate market. The seller, buyer, and market maker optimization problems are described and put into equation form. The model equations identify important variables used in the analysis to show that market makers could have replaced real estate agents in the Northern Virginia residential real estate market.

Assumptions

The following assumptions about the players, inventories, information, search, market structure, and transaction costs model an alternative set of rules in the residential real estate market. These rules along with the individual optimization problems and their resulting equations, constitute the alternative market microstructure model in residential real estate. The difference is that the Real Estate Agent in the existing market model is replaced with a market maker in the alternative market model. Most of the assumptions in the alternative market model are the same as the existing market model. Rather than repeat the assumptions again, only the differences are addressed below.

The Players Involved

Sellers. Once the decision to move is entertained, owners must choose between 1) selling to the established market maker and 2) renting the home to someone else. Sellers obtain the bid price, or price to the seller (S^s_{MM}), from the market maker. Since the market maker buys homes immediately, there is no risk that a home will not sell and there are no monetary or non-monetary costs of not selling a home.

Buyers. Buyers will search for a home using the established market maker. Potential buyers obtain the ask price, or price to the buyer (S^b_{MM}), from the market maker. They may choose to rent a home rather than buying if the cost of ownership (C_{MM}) is more than renting (C_{RENT}).

Market Maker. A market maker provides liquidity in the real estate market by standing ready and able to buy any home for a bid price close to its market value. The market maker also sells homes for ask prices that are close to their market values. In order to provide this function, the market maker holds inventory in the short run to provide inter-temporal smoothing of demand and supply. The market maker also holds inventory in the long run to provide price stability, earn alternative-use income, and keep a pool of homes available to meet sudden increases in demand. Market makers are risk neutral and maximize the present value of all expected future profits (Π_{MM}).

The Role of Inventories

Market Makers hold inventory for the short run and the long run. In the short run, market makers hold inventory as an intermediary (*I*) between sellers and buyers and as a source of liquidity through inter-temporal smoothing of demand and supply. Because of seasonal variations in supply and demand, the market maker can buy homes and hold them until they are sold a short time later. In the long run, market makers hold (*H*) inventory to keep prices stable as long as there exists an alternative-use income to offset holding costs. When the value of homes to buyers equals the present value of alternative use, the market maker is indifferent between selling and holding inventory. Market makers incur holding costs of inventory including interest, opportunity cost of capital, and market risk. The market maker's preferred inventory position is that which results in the highest present value of expected future profits.

Search Characteristics

Sellers. Sellers experience a 100% expected probability of selling their home since the market maker stands ready to purchase any home at any time for the bid price. They do not need to search for buyers.

Buyers. Similar to the existing market model, each home has a probability (P^{m}_{MM}) of matching the standards of the individual buyer.

Information Properties

Buyers, sellers, and market makers share the same bid (S^{s}_{MM}) and ask (S^{b}_{MM}) prices of each home. Market makers, as experts, know all information and share it with their buyers and sellers (inspections, appraisals, and condition of homes). They, therefore, have no superior knowledge compared to other market participants.

Market Structure

The market maker complies with a self-imposed rule to set bid and ask prices. The bid price is set at a fixed percent, x, of estimated market value, while the ask price is set at a fixed percent, y, of estimated market value. The variables x and y may be greater than, equal to, or less than 1, but y will be greater than x. The market maker will adjust x, y, and inventory position until indifferent between selling a home and holding it in inventory. After learning the market maker rule for the bid price, potential sellers request a bid from the market maker. The market maker incurs the cost of an appraisal and inspection for each home to determine its estimated value. A percentage of potential sellers presented with a bid will actually sell to the market maker. In addition, a percentage of potential buyers who look at market maker homes will actually buy one. There is no negotiating with the market maker since the bid and ask prices are fixed. Market makers do not price-differentiate based on information obtained about buyers and sellers.

Transaction Costs

Buyers pay the same transaction costs in the alternative market model as they do in the existing market model. Likewise, sellers pay the same transaction costs in both market models except they avoid paying the real estate agent commission. Market makers pay both buyer and seller transaction costs because they participate in two transactions per transfer of ownership. They first buy from the original seller and then sell to the final buyer. Transaction costs that market makers incur include legal, administrative, transfer, recording, and financing fees.

Market Maker Function

A market maker stands willing and able to buy or sell any home at quoted bid and ask prices. A market maker sets the bid price for a property by appraising and inspecting the property and estimating its value in the market. Owners are willing to sell to market makers because they put their money where their mouth is by actually offering to buy the home when they evaluate its value. Buyers go to a market maker because they want the assurance of future liquidity when they decide to sell. Also, by capturing the business of sellers, market makers become the only game in town for buyers. Market makers perform several functions in the alternative market model. By being willing to buy or sell at any time, market makers provide predictable immediacy and endogenous liquidity in the market. Market makers hold inventory and take on market risk. Market makers also shorten the expected search time to match buyers to sellers. Market makers are experts at valuing homes and, by sharing that information, reduce imperfect information inefficiencies.

The Seller's Decision

Each potential seller has two choices: 1) sell the home to a market maker, or 2) rent the home to someone else. The objective is to maximize the present value of expected revenue from selling (R_{MM}) or renting (R_{LL}) the home. In making the decision between selling and renting, one must consider the timing of all revenues and costs for each alternative.

For the MM option, the bid price (S^s_{MM}) to the seller is only adjusted by the variable transaction costs (t^s_{MM}). The fixed transaction costs (T^s_{MM}) must also be subtracted to get the seller's revenue (R_{MM}) from the sale to a market maker.

For the landlord (LL) option there will exist a market-determined rent (Q) and an expected rental inflation rate (q) for each home. Besides knowing the bid price (S^s_{MM}), the seller will also know the expected bid price inflation rate (i) applicable to the home. A landlord will incur the cost of capital (k) on the revenue foregone by not selling his or her home. Landlords must also pay variable costs (VC) and fixed costs (FC) while holding the home as a rental. All these factors must be discounted according to the time they occur. Discounting uses the personal discount rate (r^s) of the owner to sum up the present value of each benefit or cost.

Equations 4-1 through 4-3 sum up in equation form the model of sellers in the alternative real estate market. With the LL option, each period (μ) will bring in the expected rent adjusted for any inflation ($(1+q)^{\mu}Q$). In addition, any increase in value to the property (iS^s_{MM}) must be added. Subtracted from this are the cost of capital (kR_{MM}) and the period's variable costs (VC_{μ}) and fixed costs (FC_{μ}). This total is divided by the discount term ($(1+r^s)^{\mu}$) to provide the period's present value. Finally, each period's present value is summed to get the total present value expected revenue (R_{LL}) of renting the home out.

With the MM alternative, the bid price is adjusted by subtracting variable transaction costs ($(1-t^{s}_{MM})S^{s}_{MM}$). From this term are subtracted fixed transaction costs (T^{s}_{MM}). This gives the total revenue (R_{MM}) from a market maker. The decision to sell or rent is made by comparing the present value of expected net revenue (R_{LL}) from the LL option with the revenue (R_{MM}) from the MM option and selecting the alternative with maximum value.

$$R_{LL} = \sum_{\mu=1}^{\infty} \frac{(1+q)^{\mu} Q + iS^{s}_{MM} - kR_{MM} - VC_{\mu} - FC_{\mu}}{(1+r^{s})^{\mu}} \qquad (4-1)$$

$$R_{MM} = (1-t^{s}_{MM})S^{s}_{MM} - T^{s}_{MM} \qquad (4-2)$$

$$MAX(R_{MM}, R_{LL}) \qquad (4-3)$$

Where

FC designates fixed costs and is exogenous

i is the expected inflation rate of sales price per period and is exogenous

k is the cost of capital and is exogenous

LL designates being a landlord

MM designates using a Market Maker

q is the expected rental inflation rate per period and is exogenous

Q is the initial rent per period and is exogenous

r is the discount rate and is different for each seller

R is the present value of expected revenue to the seller

s designates the seller

S^{s}_{MM} is the market maker bid price to the seller

T is the fixed transaction costs and is exogenous

t is the variable transaction cost rate as a percentage of the sales price and is exogenous

VC designates variable costs and is exogenous

The seller's objective is to maximize the present value of expected net revenue. Selling to a market maker reveals that selling the home has a higher net revenue than becoming a landlord.

The Buyer's Decision

Each potential buyer has two choices: 1) buy a home or 2) rent a home. The objective is to minimize the present value expected cost of buying (C_{MM}) or renting (C_{RENT}) a home. In making the decision between buying and renting, one must consider the timing of all costs for each alternative.

For the MM option, the ask price (S^b_{MM}) must be adjusted by the probability of a match (P^m_{MM}) in each period and the variable transaction costs (t^b_{MM}) must be added. Of course, if not found immediately, there may be inflation of the sales price (i), either positive or negative. After all these effects are accounted for, the fixed transaction costs (T^b_{MM}), and the monetary (M^b_{MM}) and non-monetary (N^b_{MM}) costs of not buying in each period must be added. At some future date (f) the buyer will sell the home and collect the net sales revenue (R^f_{MM}). All of the buyer's costs and revenues must be discounted using his or her personal discount rate (r^b).

For the rental (*RENT*) option there will exist a market-determined rent (Q) and an expected rental inflation rate (q) for each home. There also exist non-monetary costs of not owning a home (N^b_{RENT}) while renting. These two factors must be discounted according to the time they occur. Discounting uses the personal discount rate (r^b) of the owner to sum up the present value of each cost.

Equations 4-4 through 4-6 sum up in equation form the model of buyers in the alternative real estate market. With the *RENT* option, each period (μ) the renter will pay the rent adjusted for any inflation ($(1+q)^{\mu}Q$). In addition, the non-monetary cost (N^b_{RENT}) of not owning a home is added. This total is divided by the discount term ($(1+r^b)^{\mu}$) to provide that period's present value. Finally, each period's present value is summed to get the total present value expected cost (C_{RENT}) of renting a home.

Each period in the MM alternative, the ask price is adjusted by the probability of finding a match, price inflation, and variable transaction costs ($\left(1+t^b_{MM}\right)\left(1+i\right)^{\alpha^b_{MM}} P^m_{MM} S^b_{MM}$). Added to this term are fixed transaction costs (T^b_{MM}) and the monetary (M^b_{MM}) and non-monetary (N^b_{MM}) costs of not finding a home in each period. Then the total for each period is divided by the discount term ($\left(1+r^b\right)^{\alpha^b_{MM}}$) to get that period's present value. To get the total present value expected cost (C_{MM}) for this option; each period's present value is summed. The decision to buy or rent is made by comparing both expected present value costs and selecting the option with minimum value.

$$C_{RENT} = \sum_{\mu=1}^{f} \frac{(1+q)^{\mu} Q + N_{RENT}^{b}}{\left(1+r^{b}\right)^{\mu}} \tag{4-4}$$

$$C_{MM} = \sum_{\alpha=1}^{A} \frac{\left(1+t_{MM}^{b}\right)(1+i)^{\alpha_{MM}^{b}} P_{MM}^{m} S_{MM}^{b} + T_{MM}^{b} + M_{MM}^{b} + N_{MM}^{b}}{\left(1+r^{b}\right)^{\alpha_{MM}^{b}}} - \frac{R_{MM}^{f}}{\left(1+r^{b}\right)^{f}} \tag{4-5}$$

$$MIN\left(C_{MM}, C_{RENT}\right) \tag{4-6}$$

Where

α represents the time delay period

A is the total number of delay periods before finding a match

b designates the buyer

C is the buyer's present value expected cost of obtaining housing services

f designates the number of expected periods before selling the home or moving out of the rental

i is the expected inflation rate of sales price per period and is exogenous

M designates the monetary costs of not transacting and is different for each buyer

MM designates using the market maker

N designates the non-monetary costs of not transacting and is different for each buyer

P_{MM}^{m} is the probability of finding a home that matches the individual buyer's standard

q is the expected rental inflation rate per period and is exogenous

Q is the initial rent per period and is exogenous

r is the discount rate and is different for each buyer

R is the present value of expected revenue to the owner

RENT designates renting a home

S_{MM}^{b} is the market maker ask price to the buyer

T is the fixed transaction costs and is exogenous

t is the variable transaction cost rate as a percentage of the sales price and is exogenous

The buyer's objective is to minimize the present value expected cost of housing services. By searching and buying a home using the market maker, buyers reveal that owning has a lower expected cost than renting.

The Market Maker's Decision

Equations 4-7 through 4-11 sum up in equation form the model of market makers in the alternative real estate market. Each period, market makers earn profit from two sources. The profit from being an intermediary (*I*) between buyers and sellers (π^I_{MM}) is computed by subtracting the bid price (S^s_{MM}) and variable costs (VC_{IMM}) from the ask price (S^b_{MM}) for each home sold during the period. From that total, the fixed costs (FC_{IMM}) are subtracted to get the period's profit from intermediary operations. The profit from being a holder (*H*) of inventory derives from the alternative use of renting homes to others. The rent per period (Q_{MM}) is added to the increased value ($iS^b_{MM_j}$) of each home. From this is subtracted the cost of capital (kS^s_{MM}) and the variable costs (VC_{HMM}) for each home. From that total, the fixed costs (FC_{HMM}) are subtracted to get the period's profit from inventory holding operations. Market makers discount each period's profit from intermediary and inventory operations (π^I_{MM}, π^H_{MM}) with their individual discount rate ($(1+r_{MM})^\mu$) and sum all future period profits to compute the present value of future profits (Π_{MM}). Market makers maximize the present value of total future profits.

$$\pi^I_{MM} = \sum_{j=1}^{I\#_{MM}} \left[S^b_{MM_j} - S^s_{MM_j} - VC_{IMM_j} \right] - FC_{IMM} \qquad (4-7)$$

$$\pi^H_{MM} = \sum_{j=1}^{H\#_{MM}} \left[Q_{MM_j} + iS^b_{MM_j} - kS^s_{MM_j} - VC_{HMM_j} \right] - FC_{HMM} \qquad (4-8)$$

$$\pi_{MM} = \pi^I_{MM} + \pi^H_{MM} \qquad (4-9)$$

$$\Pi_{MM} = \sum_{\mu=1}^{\infty} \frac{\pi_{MM\mu}}{(1+r_{MM})^\mu} \qquad (4-10)$$

$$MAX(\Pi_{MM}) \qquad (4-11)$$

Where

$\#_{MM}$ is the number of properties held or turned over by the Market Maker

π_{MM} is the profit of the market maker per period

Π_{MM} is the market maker's present value of all expected future profits

FC designates fixed costs and is exogenous

H indicates the Market Maker as a holder of rental property inventory

i is the expected inflation rate of sales price per period and is exogenous

I indicates the Market Maker as an intermediary

k is the cost of capital on rental property and is exogenous

MM designates the market maker

Q is the rent received on rental property and is exogenous

S^{b}_{MM} is the market maker ask price to the buyer

S^{s}_{MM} is the market maker bid price to the seller

VC designates variable costs and is exogenous

Equilibrium in the Alternative Market Model

This model will exist in the long run after the market maker mechanism has replaced the current MLS arrangement. This could happen through a competitive process between market makers and real estate agents. For the market maker mechanism to prevail, the market maker's bid price (S^{s}_{MM}) would not necessarily have to be greater than the expected sales price (S_{MLS}) with the MLS. What really matters is the present value of expected revenue (R_{MLS}), not the expected sales price (S_{MLS}) alone. Since the sale to a market maker is immediate, there is no discounting of the seller's revenue. As long as R_{MM} is greater than R_{MLS}, owners will be willing to sell to the market maker rather than list their home with a real estate agent. In like fashion, the market maker's ask price (S^{b}_{MM}) to sell homes would not have to be less than the expected sales price (S_{MLS}) in order to attract buyers away from the MLS option. Market makers could charge more as long as the probability of finding a match is greater and/or the expected time delay period is les

Equilibrium in the alternative market model consists of a set of values for bid (S^{s}_{MM}) and ask (S^{b}_{MM}) prices. The individual buyers' probabilities will determine the time a home stays in inventory before being sold and the length of time buyers spend searching before finding a match.

By selling their home to a market maker, sellers reveal that the MM option has higher revenue than the expected revenue of the landlord option. Each owner's decision depends on their personal discount rate (r^{s}), fixed (T) and variable (t) transaction costs, rents (Q), and the cost of capital (k). As long as the market maker efficiently balances costs and benefits of holding inventory and being an intermediary, individual home sellers should only choose the LL option if 1) the owner's individual discount rate is lower than the market maker's, or 2) the owner is in a negative equity position and does not have the cash needed to sell. Because of the market maker's inventory position, there will be no mismatch between rents and bid prices. The cost of capital and variable/fixed costs of being a landlord should be higher for an individual than for the market maker. In addition, the MM model has no probability of selling, commission rate, or monetary and non-monetary costs like the MLS model does.

By searching to buy a home with a market maker, buyers reveal that the MM option has lower expected cost than the RENT option. The potential buyer's decision to rent or buy will depend on the ask price (S^{b}_{MM}) and its inflation rate (i), the length of expected stay in the area (f), the rental rate (Q), expected growth rate of rents (q), and the non-monetary costs of renting (N^{b}_{RENT}). Of course fixed (T) and variable (t) transaction costs and the individual's monetary (M^{b}_{MM}) and non-monetary (N^{b}_{MM}) costs of not owning a home will also affect their decision. As long as the market maker efficiently balances costs and benefits of holding inventory and being an intermediary, individual home buyers should only choose the RENT option if 1) the probability of finding a match is low, 2) transaction costs are high, 3) non-monetary costs of renting are low, or 4) the expected length of stay is short. Because of the market maker's decision process, there will be no mismatch between the rental rate and ask price. The individual discount rate should not determine the buyer's decision since it enters both options in the same manner. In addition, since the market maker takes into account the appreciation of homes and adjusts ask prices and inventories accordingly, the buyer's decision will not depend on the inflation rate (i) of home prices.

The alternative model that replaces real estate agents with market makers seems to make both buyers and sellers better off by lowering risk and raising liquidity in the market. With both models of the residential real estate market described, the research plan for empirical analysis will be drawn.

CHAPTER V

RESEARCH SUMMARY

The previous two chapters described the existing (MLS) and alternative (MM) residential real estate market models in a general context. The next step is to use these models to evaluate the 1998 Northern Virginia residential real estate market. This chapter explains the research plan that was followed to determine if market makers could have replaced real estate agents in the 1998 Northern Virginia real estate market. The existing and alternative models are simplified and reduced to a level necessary to perform the empirical analysis. The method of analysis is then described to show the research path taken.

Simplifying Assumptions

In order to make the comparison of market makers and real estate agents reasonable, sellers and buyers must both be assumed to be indifferent between using a market maker or real estate agent. On the buyer side, the decision between renting and owning a home is not relevant to the comparison of the market maker and realtor mechanisms and will be ignored. Buyers are assumed to be financially indifferent dealing with a market maker or realtor when the expected cost (C_{MM}) from a market maker is equal to the expected cost (C_{MLS}) from a real estate agent. This assumption will be made throughout the empirical analysis. On the seller side, because homeowners who move and become landlords are the exception and the LL option is the same in both models, this alternative will be ignored. Sellers are financially indifferent listing with a realtor or selling to a market maker when the expected revenue (R_{MLS}) from the MLS arrangement is equal to the net revenue (R_{MM}) from the MM mechanism. This assumption will be made throughout the empirical analysis.

This study concentrates on sellers mainly because buyers will search for homes wherever they can find homes for sale. In addition, the buyer's decision is essentially the same in both the MLS and MM models. The MLS is successful only because sellers list their homes with realtors. If market makers held all the inventory of homes available for sale, buyers would flock to them for their home search because the probability of finding a match would be high while the probability of a match with a realtor would be close to zero.

To simplify the problem without losing relevancy, variable and fixed transaction costs (t and T), the sales price inflation rate (i), and monetary (M) and non-monetary (N) costs of not selling a home (equations 3-1 through 3-6 and 4-1 through 4-6) are all assumed to be zero. The transaction cost variables (t and T) may be assumed to be zero since they are the same in both models. The average time on the market is relatively short (64 days), so the appreciation variable (i) and costs of not selling (M and N) should be small.

The variables that remain in the analysis include the commission rate (c), the expected sales price (S_{MLS}), the bid (S^s_{MM}) and ask (S^b_{MM}) prices, and the probabilities of a sale (P^s) and a match (P^m). The commission rate (c) is constant and exogenous. The estimated sales price (S_{MLS}) will be determined by regression analysis while the probability of a sale (P^s) will be computed using the number of days that homes stay on the market. Bid prices will be set in order to keep sellers financially indifferent between selling to a market maker and listing their home with a realtor. Ask prices will be set in order to keep buyers financially indifferent between buying from a market maker or a realtor.

Reduced Equations

The above assumptions reduce equations 3-2, 4-2, 3-5, and 4-5 down to equations 5-1 through 5-4, which determine the revenue of sellers and cost of buyers under the MLS and MM regimes.

$$R_{MLS} = \sum_{\alpha=1}^{A} \frac{(1-c)P^s_{MLS}S_{MLS}}{\left(1+r^s\right)^{\alpha^s_{MLS}}} \qquad (5-1)$$

$$R_{MM} = S^s_{MM} \qquad (5-2)$$

$$C_{MLS} = \sum_{\alpha=1}^{A} \frac{P^m_{MLS}S_{MLS}}{\left(1+r^b\right)^{\alpha^b_{MLS}}} - \frac{R^f_{MLS}}{\left(1+r^b\right)^f} \qquad (5-3)$$

$$C_{MM} = \sum_{\alpha=1}^{A} \frac{P^m_{MM}S^b_{MM}}{\left(1+r^b\right)^{\alpha^b_{MM}}} - \frac{R^f_{MM}}{\left(1+r^b\right)^f} \qquad (5-4)$$

Where

A is the total number of delay periods before finding a buyer

α represents the time delay period

b designates the buyer

C is the buyers present value expected cost of obtaining housing services

f designates the number of expected periods before selling the home or moving out of the rental

c is the commission rate as a percentage of the sales price and is exogenous

MLS designates using the real estate agent Multiple Listing Service

MM designates using the Market Maker

P_{MLS}^{m} is the probability of finding a home that matches the buyer's standard using the MLS

P_{MM}^{m} is the probability of finding a home that matches the buyer's standard using the MM

P_{MLS}^{s} is the probability of selling a home in a period using the MLS

r is the discount rate and is different for each seller

R is the present value of expected revenue to the seller

s designates the seller

S_{MLS} is the current expected sales price net of buyer concessions

S_{MM}^{b} is the market maker ask price to the buyer

S_{MM}^{s} is the market maker bid price to the seller

To make a seller just as well off financially selling to a market maker as listing with a realtor, one must assume that the revenue from a market maker (R_{MM}) is equal to the expected revenue from listing the home with a realtor (R_{MLS}). By making this assumption, equation 5-5 shows the relationship between the MM bid price (S_{MM}^{s}) and the MLS expected sales price (S_{MLS}). This shows that the market maker bid price (S_{MM}^{s}) will be equal to the expected sales price (S_{MLS}) less the commission, discounted for the probability of selling within the MLS mechanism.

To make a buyer just as well off financially buying from a market maker or a realtor, one must assume that the cost from a market maker (C_{MM}) is equal to the cost from a realtor (C_{MLS}). Since a market maker should be as good at searching for homes as a realtor, the probability of a match with a market maker (P_{MM}^{m}) is assumed to be equal to the probability of a match with a realtor (P_{MLS}^{m}). In addition, since the revenues in both the MM and MLS regimes have been assumed to be equal, the expected future revenues (R^f_{MM} , R^f_{MLS}) in each regime are assumed to be equal. By making these assumptions, equation 5-6 shows that the MM ask price (S^b_{MM}) is equal to the MLS expected sales price (S_{MLS}). In accordance with equation 5-6, buyers in the MM regime are assumed to pay no higher of a price for a home than they did in the MLS system.

$$S^s_{MM} = \sum_{\alpha=1}^{A} \frac{(1-c)P^s_{MLS} S_{MLS}}{(1+r^s)^{\alpha^s_{MLS}}} \qquad (5-5)$$

$$S^b_{MM} = S_{MLS} \qquad (5-6)$$

Since the expected sales price and commission rate in the MLS market do not vary over time, they can be brought outside the summation of equation 5-5. Equations 5-7 through 5-9 show how the summation of discounted ($1/(1+r^s)^{\alpha^s_{MLS}}$) probabilities (P^s_{MLS}) are separated from the expected sales price (S_{MLS}) and commission rate (c). The discounted probabilities (DP) variable is simply the present value of all period probabilities of selling the home by listing in the MLS. The individual discount rate (r) and the probability density function (pdf) of selling a home listed in the MLS determine the DP value.

$$S^s_{MM} = (1-c) S_{MLS} \sum_{\alpha=1}^{A} \frac{P^s_{MLS}}{(1+r^s)^{\alpha^s_{MLS}}} \qquad (5-7)$$

$$S^s_{MM} = (1-c)(DP) S_{MLS} \qquad (5-8)$$

$$Where \quad DP = \sum_{\alpha=1}^{A} \frac{P^s_{MLS}}{(1+r^s)^{\alpha^s_{MLS}}} \qquad (5-9)$$

Commission Rates and Discounted Probability Combinations

Equation 5-10 is a rearrangement of equation 5-8 showing the ratio between the market maker bid price (S^s_{MM}) and expected sales price (S_{MLS}) when sellers are indifferent to market makers and realtors. As long as the actual value of this ratio in the market is kept equal to or greater than the value computed using the probability of selling (P^s_{MLS}) and the discount rate (r), individual sellers will prefer the market maker.

$$S^{s}_{MM}/S_{MLS} = (1-c)(DP) \qquad (5-10)$$

Table 5-1 shows examples of different assumed commission rates and discounted probabilities and their associated minimum ratios of S^{s}_{MM} to S_{MLS}. The values in Table 5-1 are minimum ratios for the assumed values of the commission rate (c) and discounted probabilities (DP) because any value above them makes the seller financially better off by going to a market maker rather than a real estate agent. In other words, the minimum ratio values in Table 5-1 are the break-even points between using a realtor and selling to a market maker. These break-even values depend on the assumed commission rate (c) and the discount rate (r) used by the owners.

Commission Rate	Discounted Probability	Minimum S^{s}_{MM} / S_{MLS}
6.0%	100.0%	0.9400
6.0%	99.00%	0.9306
6.0%	98.00%	0.9212
6.0%	97.00%	0.9118
6.0%	96.00%	0.9024
6.0%	95.00%	0.8930
5.0%	100.0%	0.9500
5.0%	99.00%	0.9405
5.0%	98.00%	0.9310
5.0%	97.00%	0.9215
5.0%	96.00%	0.9120
5.0%	95.00%	0.9025
4.0%	100.0%	0.9600
4.0%	99.00%	0.9504
4.0%	98.00%	0.9408
4.0%	97.00%	0.9312
4.0%	96.00%	0.9216
4.0%	95.00%	0.9120
3.0%	100.0%	0.9700
3.0%	99.00%	0.9603
3.0%	98.00%	0.9506
3.0%	97.00%	0.9409
3.0%	96.00%	0.9312
3.0%	95.00%	0.9215

Table 5-1. Commission rates, discounted probabilities, and minimum ratios of S^{s}_{MM} / S_{MLS}.

Table 5-1 shows that the bid price (S^s_{MM}) offered by the market maker can be less than the expected sales price (S_{MLS}) net of commission (c) as long as the probability of selling in the MLS alternative is spread over time and individuals use discounting in their decision process. For example, with a commission rate (c) of 6.0% and discounted probability (DP) value of 99.0%, the ratio of S^s_{MM} to S_{MLS} is .9306 instead of the .9400 without discounting (DP = 100.0%). Since individual discount rates of sellers are different, the only way to capture every rational seller would be to use a discount rate less than or equal to the risk-free rate.

Research Overview

The data for this research comes from the Northern Virginia multiple listing service (MLS) data set of over 21,000 home sales in 1998. The data include a cross-section of all types, styles, locations, etc. The first step is to estimate expected net sales prices in the MLS regime using regression analysis. As possible independent variables, the database contains amenities of the homes to include things like location, lot size, home type, home style, number of bedrooms, number of bathrooms, taxes, etc. Unfortunately, the database does not contain key variables like living space area, existence of finished or unfinished basements, or physical condition. The lack of these important variables would most likely lead to misspecification of the model by leaving out important independent variables.

Another option would be to use the appraised value of a home as the combination of all the applicable variables that determine market value. Appraisals would be an excellent single independent variable because appraisal methods are fairly standard and are performed by independent professionals. Unfortunately comprehensive appraisal data for these homes is not available.

The MLS database does contain several proxy variables for overall market value. These proxy variables are 1) Original Listing Price, 2) Final Listing Price, and 3) Tax Assessment. The local taxing authority determines tax assessments, but methods differ greatly and values are not kept current. Each individual seller sets the listing price variables after consultation with their realtor. In most cases the values will reflect the best estimate of market value similar to an appraisal but based on a realtor's comparative market analysis. In some cases the values may represent the high hopes of the seller in spite of the realtor's analysis and recommendation. The Original Listing Price variable may be biased upward since, in some cases, it may be set above the actual expected sales price in order to test the market. The Final Listing Price variable should be a better proxy for market value than the Original Listing Price, because; for originally overpriced homes, time elapsed since first listing and owners may lower their listing price to attract potential buyers. The final listing price variable is used in the regression analysis to determine the expected net sales prices.

After computing the expected net sales prices, the probability density function (pdf) of selling a home will be estimated. The days-on-the-market variable in the MLS data set will be used to accomplish this. Essentially, the number of homes that sold in each number of days will be summed and then divided by the total number of homes. This will result in an estimate of the probability of selling a home for each day after listing.

With both expected prices and probabilities of selling a home, it will be possible to calculate market maker bid prices at various discount rates that would allow a market maker to meet or exceed the expected revenue of sellers for the MLS alternative. Under a market maker arrangement, the homes in 1998 will be assumed to have sold in the same amount of time and for no more than the actual net sales prices. These assumptions along with the costs of operating as a market maker will then allow the computation of expected market maker profits. To conclude the analysis, the sensitivity of projected profitability to the model assumptions will be investigated.

Now that the research plan has been described, the next chapter will detail the execution of the plan and review the results.

CHAPTER VI

ANALYSIS

This chapter takes the simplified, reduced form equations from the previous chapter and describes the analytical work performed to discover if market makers could have replaced real estate agents in the 1998 Northern Virginia residential real estate market. Expected net sales prices are first estimated using regression analysis. The probabilities of selling a home are then computed. With this information it will be possible to calculate market maker bid and ask prices. After accounting for the cost of operations, the estimated profits of a market maker will then be computed. If expected profits are positive, then market makers could have replaced real estate agents in the 1998 Northern Virginia residential real estate market.

Empirical Model Description

The reduced form equations 5-6, 5-8, and 5-9 from the previous chapter are shown again as equations 6-1 through 6-3.

$$S_{MM}^{b} = S_{MLS} \qquad (6-1)$$

$$S_{MM}^{s} = (1-c)(DP)S_{MLS} \qquad (6-2)$$

$$Where \quad DP = \sum_{\alpha=1}^{A} \frac{P_{MLS}^{s}}{(1+r^{s})^{\alpha_{MLS}^{s}}} \qquad (6-3)$$

Where

A is the total number of delay periods before finding a buyer

α represents the time delay period

c is the commission rate as a percentage of the sales price and is exogenous

DP is the discounted probability variable

P^{s}_{MLS} is the probability of selling a home in a period

r is the discount rate and is different for each seller

S_{MLS} is the current expected sales price net of buyer concessions

S_{MM}^{b} is the market maker ask price to the buyer

S_{MM}^{s} is the market maker bid price to the seller

The first step is to use regression analysis to estimate expected net sales prices (S_{MLS}). Then the discounted probabilities (DP) may be calculated using several different discount rate assumptions. After computing the market maker bid and ask prices and operating costs, the market maker profitability can be derived to determine if a market maker could have replaced Northern Virginia real estate agents in 1998.

Final Listing Price (listing price at the time a sale occurs) is the best proxy available for the characteristics that determine the value of a home in Northern Virginia. To arrive at a value for the listing price, a realtor performs a comparative market analysis that is very similar to an appraisal. The realtor gathers recent comparable home sales and makes adjustments in the price for any differences in location, type, style, or amenities. As long as the comparables used in the analysis are similar in location, type, size, and other amenities, errors will be random and kept to a minimum. The Final Listing Price is used because it should be closer to the realtor's actual market analysis recommendation than the Original Listing Price. In 66 percent of cases (14,196 of 21,401), Original Listing Price and Final Listing Price are equal.

Figure 6-1 shows a scatter plot of Final Listing Price vs. Net Sales Price (sales price less any monetary concessions). It appears that Net Sales Price (NETPRICE) is a linear function of Final Listing Price (LSTPRICE), plus a disturbance term. Since it looks like the variance may increase along with LSTPRICE, heteroscedasticity may be a problem.

Because each real estate transaction is unique, the disturbance terms should be uncorrelated and have an expected value of zero. The main reason the disturbance term should be fairly well behaved is the role of human indeterminacy. The incomes, motivations, financial conditions and other personal situations of both buyers and sellers all add to the randomness of the disturbance term. The listing realtor's analysis of market value has random variation resulting from personal judgment.

In addition to human indeterminacy, there is a small amount of measurement error contained in the data. Some values in the data set had obvious order-of-magnitude problems with misplaced zeros. Those errors that could be verified were corrected, but other apparent errors still exist that could not be validated (the most obvious being a home with LSTPRICE of $1.6M and NETPRICE of $3.0M).

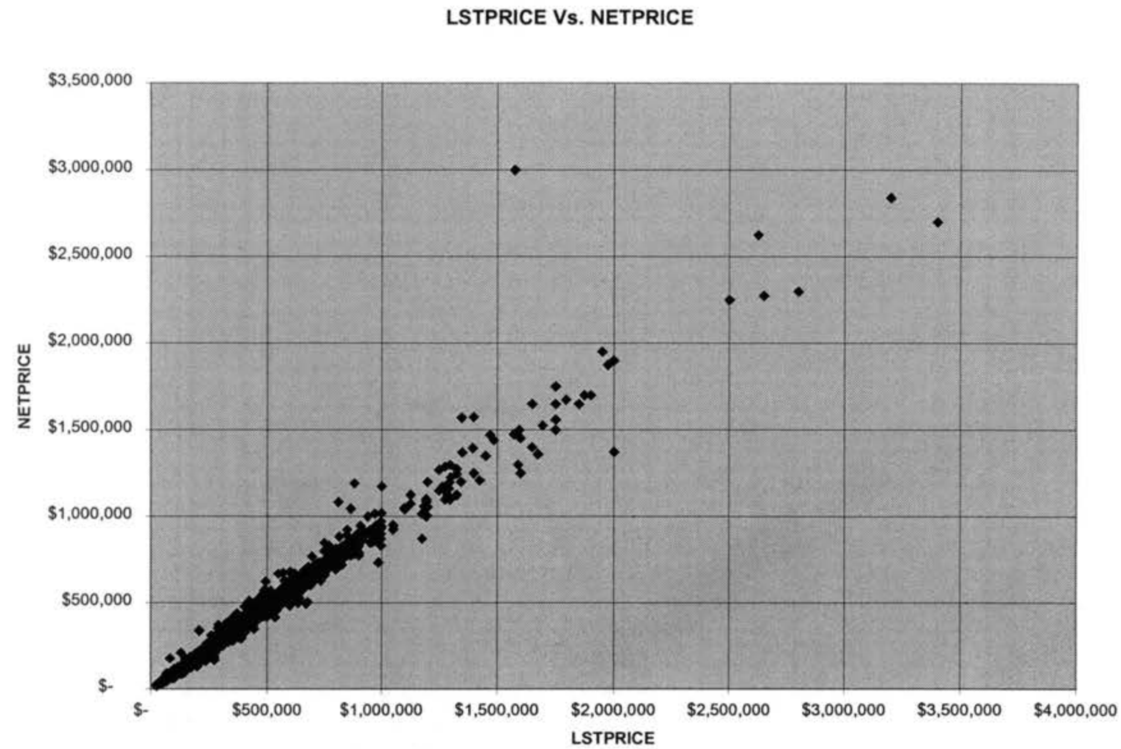


Figure 6-1. Scatter plot of LSTPRICE and NETPRICE.

The classical linear regression model, corrected for heteroscedasticity if needed, is used to analyze the data. The observations of LSTPRICE are fixed in repeated samples. Since the errors are random and the sample is so large, the residuals should be normally distributed. Even if statistical tests reject the assumption of normality in errors, the large number of observations will allow the assumption of asymptotic normality. Thus, Ordinary Least Squares (OLS) is the obvious choice for estimating NETPRICE. Both unbiasedness and efficiency are very important in this analysis since the regression coefficients are used to determine bid and ask prices for a market maker. These prices are used to calculate expected profits and directly affect the conclusion about market makers being able to replace real estate agents.

The GAUSSX econometric software package that runs under the GAUSS matrix programming language was used to perform the regressions and statistical tests. Tests for the statistical properties assumed were performed by the regression software to make sure that OLS is appropriate and to correct for any deficiencies encountered. Ramsey's RESET test is used to test the functional form [Kennedy, 1992]. The Jarque-Bera test [Greene, 2000] is used to check for Normality and the Chow test [Kennedy, 1992] for stability. White's General Test (nR^2) [Greene, 2000] is computed to check for heteroscedasticity. The t-Tests show if the coefficients are individually statistically significant while the F-Test jointly tests the parameters for significance. Because of the large number of observations and the importance in estimating accurately, all critical values of tests are set at the .01 confidence level. This may seem restrictive at first, but the risk inherent in buying every home on the market and then re-selling to someone else requires a very high confidence level.

Linear Model

The sales price, less any monetary concessions to the buyer (NETPRICE), should be a linear function of the final listing price (LSTPRICE). Equation 6-4 is the linear OLS model that estimates the market value of individual home values within the current MLS market mechanism. It shows that NETPRICE is a function of the constant (β_0), final listing price (LSTPRICE), and a disturbance term (ε_t).

$$NETPRICE_t = \beta_0 + \beta_1 LSTPRICE_t + \varepsilon_t \qquad (6\text{-}4)$$

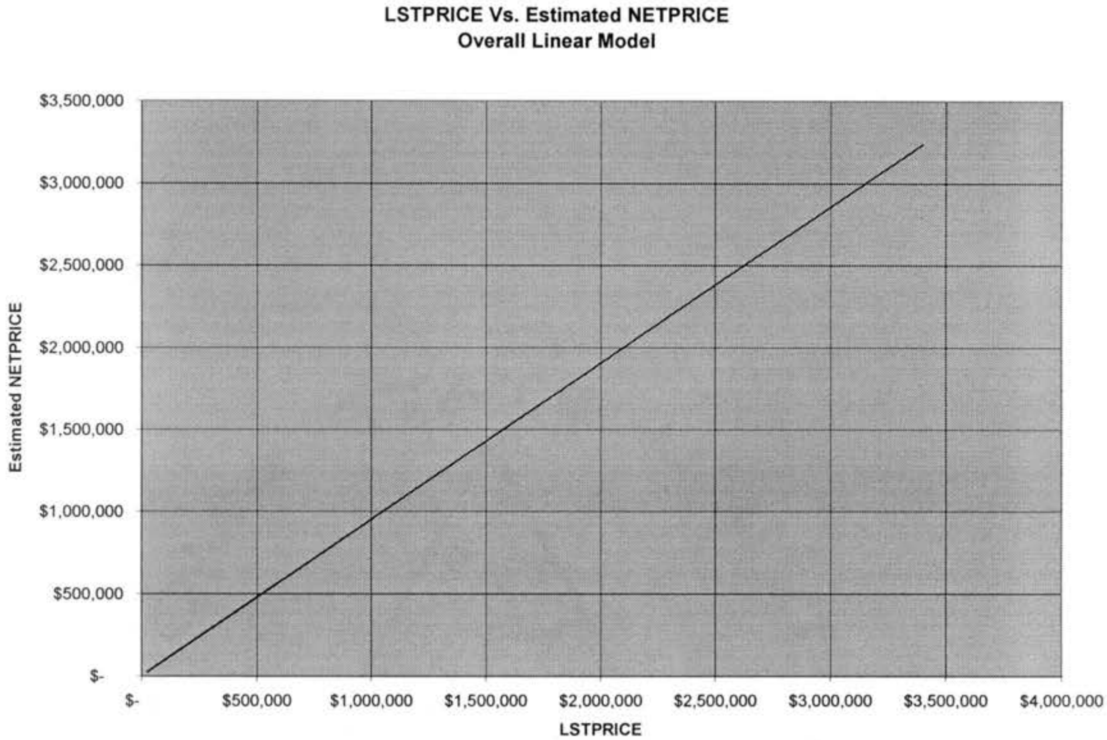
Seven null hypotheses need to be tested in order to validate this OLS model. Table 6-1 shows the null hypotheses and their respective tests. The first null hypothesis (H_{01}) is that the constant term (β_0) is equal to zero. The second (H_{02}) is that the LSTPRICE coefficient (β_1) is equal to zero. A t-test on each of these will allow acceptance or rejection of these hypotheses. When the test statistic is greater than the critical value then the null hypothesis will be rejected. The third null hypothesis (H_{03}) is that both the constant term (β_0) and the coefficient (β_1) are jointly equal to zero. An F-test will lead to acceptance or rejection of this hypothesis. If the test statistic is greater than the critical value then the null hypothesis will be rejected. The fourth null hypothesis (H_{04}) is that the functional form is linear. Ramsey's RESET test will show if this null hypothesis must be rejected. When the test statistic is greater than the critical value then the null hypothesis will be rejected. The fifth null hypothesis (H_{05}) is that the error term (ε) is normally distributed. The Jarque-Bera test will determine if this null hypothesis must be rejected. If the test statistic is greater than the critical value then the null hypothesis will be rejected. The sixth null hypothesis (H_{06}) is that the error term (ε) is homoscedastic. White's General Test will be used to accept or reject this hypothesis. When the test statistic is greater than the critical value then the null hypothesis will be rejected. Finally, the seventh null hypothesis (H_{07}) is that the parameters (β_0, β_1) are stable. The Chow test will lead to acceptance or rejection of this null hypothesis. If the test statistic is greater than the critical value then the null hypothesis will be rejected.

Null Hypothesis	Test
H_{01}: $\beta_0 = 0$;	t
H_{02}: $\beta_1 = 0$;	t
H_{03}: $\beta_0 = 0$ and $\beta_1 = 0$;	F
H_{04}: Model Equation has a linear functional form;	RESET
H_{05}: The set of errors, ε is normally distributed;	Jarque-Bera
H_{06}: The set of errors, ε is homoscedastic;	White's (nR^2)
H_{07}: β_0 and β_1 are stable;	Chow

Table 6-1. Null Hypotheses and tests.

Contained in the data set were 21,401 complete observations from Fairfax and Arlington Counties along with Alexandria, Falls Church, and Fairfax Cities. The resulting OLS regression line of the overall linear model along with the estimated coefficients, standard errors, and t-statistics are shown in Figure 6-2. The results of the tests of the null hypotheses are shown in Table 6-2. According to the t-tests and the F-test, the constant (β_0) and coefficient (β_1) are individually and jointly statistically significant since the t statistics of 12.77 and 1237.84 respectively are greater than the critical value of 2.58 and the F statistic of 1532251.90 is greater than the critical value of 6.64. The regression resulted in an R^2 of 0.9862 showing that the linear model explains 98.62 percent of the variation of NETPRICE.

Although the coefficients are individually and jointly statistically significant at the .01 confidence level, the last four null hypotheses are rejected because all four test statistics are greater than their respective critical values. The most worrisome of the failed tests is Ramsey's RESET test for functional form. Even though the constant term and LSTPRICE variable explain 98.62 percent of the variation in NETPRICE, the overall linear relationship does not pass the test for the chosen functional form. Since the scatter plot of the data seems to show linearity, there are several possibilities to try before abandoning the linearity assumption.



Variable	Coefficient	Standard Error	t Statistic
β_0 (Constant)	2737.9615	214.398	12.770
β_1 (LSTPRICE)	0.9513	0.0008	1237.841

Figure 6-2. Regression line of Linear estimate with coefficients, standard errors, and t-statistics.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(21399)	2.58	12.77
H_{02}	t	t(21399)	2.58	1237.84
H_{03}	F	F(1,21399)	6.64	1532251.90
H_{04}	RESET	$X^2(1)$	6.63	1805.48
H_{05}	Jarque-Bera	$X^2(2)$	9.21	$7.625\text{x}10^9$
H_{06}	White's (nR^2)	$X^2(1)$	6.63	844.03
H_{07}	Chow	F(2,21397)	4.61	179.77

Table 6-2. Results of tests of the null hypotheses from overall linear model equation 6-4.

Location and amenity variables were added to the regression to see if they helped with the rejected null hypotheses. As it turns out, these variables were not statistically significant, confirming the original assumption that the market analysis performed by real estate agents to set LSTPRICE is fairly uniform even with differing locations, types of homes, and amenities. Since the regression also failed the Chow test for stability, it is possible that the correct functional form is linear, but the parameters are not constant over the full range of values of LSTPRICE. For example, the value of the coefficients may change with the value of homes. Another possibility is that the functional form is log-linear rather than linear. Of course, it may be possible that the log-linear relationship and parameter shift both apply. These possibilities are investigated in parallel to find the most appropriate, statistically acceptable relationship between LSTPRICE and NETPRICE.

Model Selection Criteria

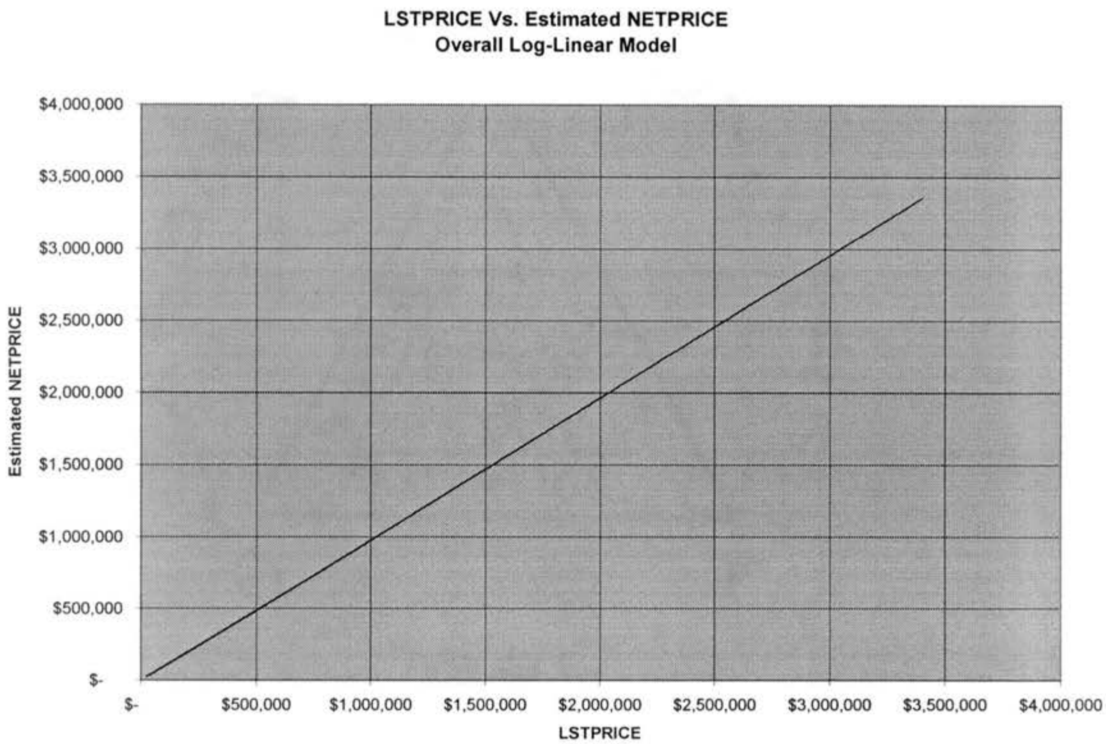
Since exploration of these possibilities is done in parallel, three criteria are used to judge which model would be most appropriate. These criteria are listed in descending order of significance. First and foremost, the chosen model should meet the basic statistical tests or be corrected for any deficiencies. The seven null hypotheses form the basis of this criterion. The chosen relationship should result in the rejection of the first three null hypotheses and failure to reject the last four. The monetary risk criterion is measured by each estimate's profit and variation of profit within its 99 percent confidence interval. Higher profit levels and smaller profit variation within the 99 percent confidence level are better. The explanatory power criterion is measured by a weighted adjusted R^2. Although the least important, a higher weighted R^2 equates to better explanatory power and is considered better than a low one.

Log-Linear Model

Equations 6-5 and 6-6 show the log-linear OLS model for estimating the market value of individual homes within the current MLS market mechanism. The resulting OLS regression line for the log-linear model of equation 6-6 along with the estimated coefficients, standard errors, and t statistics are shown in Figure 6-3. Table 6-3 shows the results of the tests of null hypotheses from Table 6-1. According to the t-tests and the F-test, the constant (β_0) and coefficient (β_1) are individually and jointly statistically significant since the t statistics of 26.66 and 2085.87 respectively are greater than the critical value of 2.58 and the F statistic of 4350872.09 is greater than the critical value of 6.64. The log-linear regression of equation 6-6 results in an R^2 of 0.9951 showing that the log-linear model explains 99.51 percent of the variation of NETPRICE.

$$NETPRICE_t = \beta_0 LSTPRICE_t^{\beta 1} e^{\varepsilon_t} \tag{6-5}$$

$$\ln(NETPRICE_t) = \beta_0 + \beta_1 \ln(LSTPRICE_t) + \varepsilon_t \tag{6-6}$$



Variable	Coefficient	Standard Error	t Statistic
β_0 (Constant)	-0.1578	0.0059	26.66
β_1 (LSTPRICE)	1.0096	0.0005	2085.87

Figure 6-3. Regression line of Overall Log-Linear estimate with coefficients, standard errors, and t-statistics.

Even though the coefficients are individually and jointly statistically significant at the .01 confidence level, three of the last four null hypotheses are rejected because their test statistics are greater than their respective critical values. Even though the constant term and ln(LSTPRICE) variable explain 99.51 percent of the variation in ln(NETPRICE), the overall log-linear relationship does not pass the test for functional form. The regression also shows parameter instability and non-normal disturbances. This overall log-linear model results in failure to reject the sixth null hypothesis (homoscedasticity) because the test statistic value of 3.04 is less than the 6.63 critical value.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(21399)	2.58	26.66
H_{02}	t	t(21399)	2.58	2085.87
H_{03}	F	F(1,21399)	6.64	4350872.09
H_{04}	RESET	$X^2(1)$	6.63	450.73
H_{05}	Jarque-Bera	$X^2(2)$	9.21	99384901.20
H_{06}	White's (nR^2)	$X^2(1)$	6.63	3.04
H_{07}	Chow	F(2,21397)	4.61	157.05

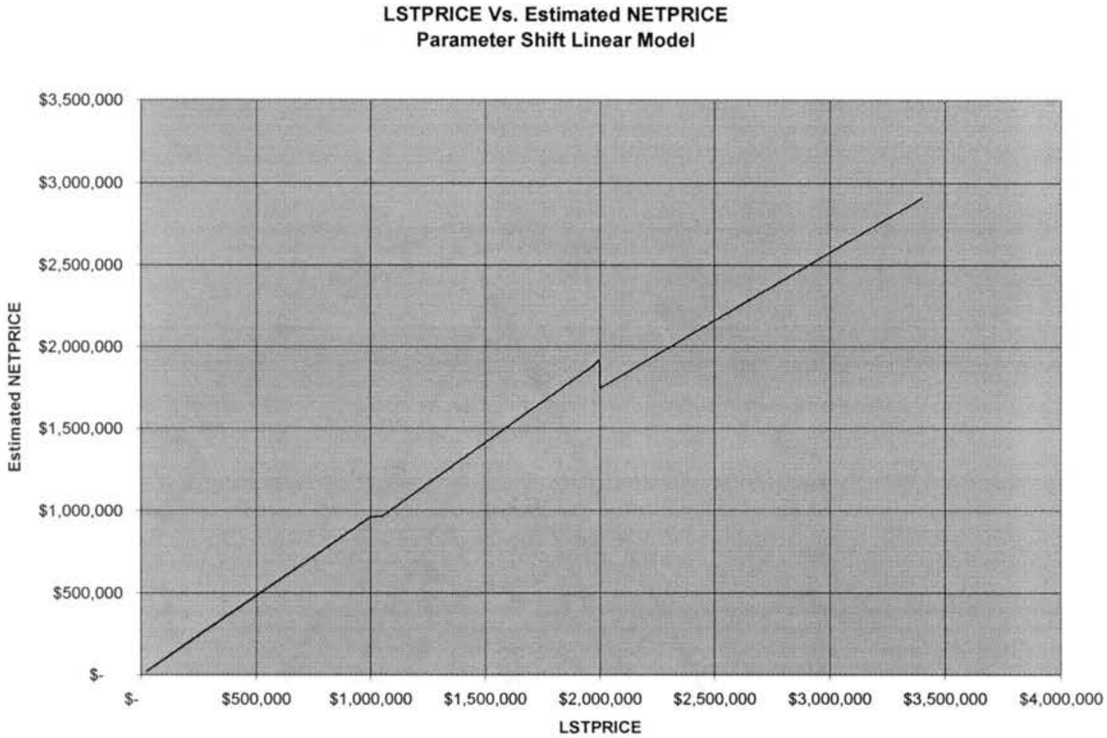
Table 6-3. Results of tests of the null hypotheses from overall log-linear model equation 6-6.

To see if either the linear or log-linear functional form is correct but the coefficients vary with different home values, several different parameter regime shifts were tried for each model. Parameter shifts occur in the linear model at \$250,000, \$500,000, \$1,000,000, and \$2,000,000. For the log-linear model, parameter shifts occur at \$125,000, \$250,000, \$500,000, \$1,000,000, and \$2,000,000. Incorporating these parameter regime shifts, results in estimating a spline function. [Greene, 2000]

Parameter Shift (Spline Function) Linear Model

Figure 6-4 shows the regression results for the spline function linear model. Tables 6-4 through 6-8 show the results of the null hypotheses for each range of the spline function linear model. According to the t-test for H_{01}, the only constant (β_0) of the spline function linear model that is individually statistically significant is for home values below \$250,000. The t statistic value is 13.79, which is greater than the critical value of 2.58. The rest of the t-tests for H_{01} show that the constants (β_0) of the spline function for home values equal to or greater than \$250,000 are not statistically significant since the t statistics range from 0.17 to 0.71 and are all less than the critical values of 2.58 to 3.71. For all calculations involving home values equal to or greater than \$250,000, the constant term (β_0) is assumed to be zero. This restriction is applied on all regressions of the spline function linear model with values above the \$250,000 level.

According to the t-tests for H_{02}, all coefficients (β_1) are individually statistically significant since the t statistics range from 4.46 to 1249.39 and are greater than the critical values of 2.58 to 3.71. Likewise, the F-tests for H_{03} show that all constants (β_0) and coefficients (β_1) are jointly significant since the F statistics range from 19.87 to 1560973.19 and are greater than the critical values of 6.64 to 13.75.



Range	Parameter	Coefficient	Standard Error	t Statistic
$0 - $250K	β_0	-1,842.34	133.63	13.79
$0 - $250K	β_1	0.9723	0.0003	3,844.90
250K-500K	β_0	602.37	844.11	0.7136
250K-500K	β_1	0.9649	.0025	388.16
500K-1000K	β_0	1,711.37	6,911.37	0.2476
500K-1000K	β_1	0.9629	0.0105	91.93
1000K-2000K	β_0	-76,216	150,699	0.5058
1000K-2000K	β_1	0.9939	0.1042	9.5383
2000K-3500K	β_0	82,859	501,172	0.1653
2000K-3500K	β_1	0.8312	0.1864	4.4579

Figure 6-4. Regression line of Spline function linear model estimate with coefficients, standard errors, and t-statistics.

All regressions of the linear spline sections show that the linear functional form (H_{04}) cannot be rejected. The RESET statistic values range from 0.86 to 2.70 and are all less than the critical value of 6.63. Normality of the disturbances (H_{05}) is rejected in all but the highest home values section of the linear spline function. The Jarque-Bera test statistic values range from 3926.21 to 4,055,606.85 and are greater than the critical value of 9.21. For homes with a LSTPRICE greater than $2,000,000, normality of the disturbances (H_{05}) is not rejected since the test statistic value of 0.17 is less than the 9.21 critical value.

The null hypothesis of homoscedasticity (H_{06}) for homes with LSTPRICE less than $1,000,000 is rejected. The White's test statistic values range from 27.20 to 35.75 and are greater than the critical value of 6.63. For homes with LSTPRICE greater than $1,000,000, the null hypothesis of homoscedasticity (H_{06}) is not rejected. The White's test statistic values were 0.31 (home values between $1,000,000 and $2,000,000) and 0.89 (home values greater than $2,000,000) and are both less than the 6.63 critical value. All sections of the spline linear function show parameter stability since the Chow F statistics range from 0.11 to 5.76 and are all less than their respective critical values of 4.61 to 18.00.

The linear spline function regressions of equation 6-4 resulted in R^2 ranging from 0.5833 to 0.9907 showing that the linear spline function model explains between 58.33 and 99.07 percent of the variation of NETPRICE, depending on home value.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(14646)	2.58	13.79
H_{02}	t	t(14646)	2.58	1249.39
H_{03}	F	F(1,14646)	6.64	1560973.19
H_{04}	RESET	$X^2(1)$	6.63	2.70
H_{05}	Jarque-Bera	$X^2(2)$	9.21	4055606.85
H_{06}	White's (nR^2)	$X^2(1)$	6.63	28.02
H_{07}	Chow	F(1,14646)	6.64	5.76

Table 6-4. Results of tests of the null hypotheses from spline function linear model with LSTPRICE less than $250,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(5845)	2.58	0.71
H_{02}	t	t(5845)	2.58	388.16
H_{03}	F	F(1, 5845)	6.64	150671.15
H_{04}	RESET	$X^2(1)$	6.63	1.11
H_{05}	Jarque-Bera	$X^2(2)$	9.21	1642436.91
H_{06}	White's (nR^2)	$X^2(1)$	6.63	27.20
H_{07}	Chow	F(2, 5843)	4.61	0.69

Table 6-5. Results of tests of the null hypotheses from spline function linear model with LSTPRICE equal to or greater than $250,000 but less than $500,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(829)	2.58	0.25
H_{02}	t	t(829)	2.58	91.93
H_{03}	F	F(1, 829)	6.67	8450.57
H_{04}	RESET	$X^2(1)$	6.63	0.95
H_{05}	Jarque-Bera	$X^2(2)$	9.21	17908.13
H_{06}	White's (nR^2)	$X^2(1)$	6.63	35.75
H_{07}	Chow	F(2, 827)	4.63	0.11

Table 6-6. Results of tests of the null hypotheses from spline function linear model with LSTPRICE equal to or greater than $500,000 but less than $1,000,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(65)	2.65	0.51
H_{02}	t	t(65)	2.65	9.54
H_{03}	F	F(1, 65)	7.04	90.98
H_{04}	RESET	$X^2(1)$	6.63	0.86
H_{05}	Jarque-Bera	$X^2(2)$	9.21	3926.21
H_{06}	White's (nR^2)	$X^2(1)$	6.63	0.31
H_{07}	Chow	F(2, 63)	4.96	1.32

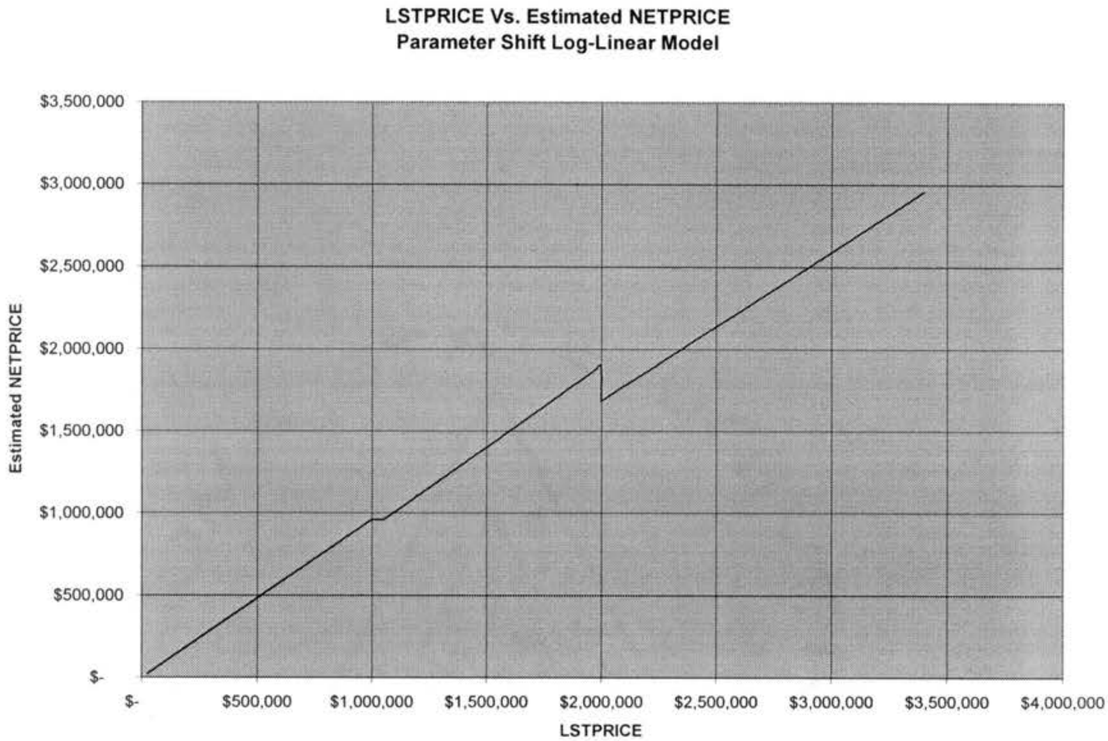
Table 6-7. Results of tests of the null hypotheses from spline function linear model with LSTPRICE equal to or greater than $1,000,000 but less than $2,000,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(6)	3.71	0.17
H_{02}	t	t(6)	3.71	4.46
H_{03}	F	F(1,6)	13.75	19.87
H_{04}	RESET	$X^2(1)$	6.63	1.87
H_{05}	Jarque-Bera	$X^2(2)$	9.21	0.17
H_{06}	White's (nR^2)	$X^2(1)$	6.63	0.89
H_{07}	Chow	F(2,4)	18.00	1.54

Table 6-8. Results of tests of the null hypotheses from spline function linear model with LSTPRICE equal to or greater than $2,000,000.

Parameter Shift (Spline Function) Log-Linear Model

Figure 6-5 shows the regression results for the spline function log-linear model. Tables 6-9 through 6-14 show the results of the null hypotheses for each range of the spline function log-linear model.



Range	Parameter	Coefficient	Standard Error	t Statistic
$0 - $125K	β_0	-0.4580	0.0342	14.13
$0 - $125K	β_1	1.0355	0.0001	14,911.7
125K - 250K	β_0	-0.1255	0.0164	7.67
125K - 250K	β_1	1.0072	0.0014	745.42
250K-500K	β_0	0.0119	0.0378	0.31
250K-500K	β_1	0.9963	0.0030	334.61
500K-1000K	β_0	0.0269	0.1369	0.20
500K-1000K	β_1	0.9953	0.0102	97.20
1000K-2000K	β_0	-0.9636	1.1894	0.81
1000K-2000K	β_1	1.0630	0.0840	12.65
2000K-3500K	β_0	-0.9819	3.6300	0.27
2000K-3500K	β_1	1.0560	0.2457	4.30

Figure 6-5. Regression line of Spline function log-Linear model estimate with coefficients, standard errors, and t-statistics.

According to the t-tests for H_{01}, the constants (β_0) of the spline function log-linear model for the two sections with values below $250,000 are individually statistically significant. The t statistic values are 14.13 and 7.67 respectively and are both greater than the critical value of 2.58. The rest of the t-tests for H_{01} show that the constants (β_0) of the spline function for home values above $250,000 are not statistically significant since the t statistics range from 0.20 to 0.81 and are all less than the critical values of 2.58 to 3.71. For all calculations involving home values equal to or greater than \$250,000, the constant term (β_0) is assumed to be zero. This restriction is applied on all regressions of the spline function log-linear model with values above the \$250,000 level.

According to the t-tests for H_{02}, all coefficients (β_1) are individually statistically significant since the t statistics range from 4.30 to 745.42 and are greater than the critical values of 2.85 to 3.71. According to the F-test for H_{03}, all constants (β_0) and coefficients (β_1) are jointly statistically significant since the F statistics range from 18.47 to 555643.09 and are greater than the critical values of 6.64 to 13.75.

All regressions of the log-linear spline sections show that the log-linear functional form (H_{04}) cannot be rejected. The RESET statistic values range from 0.03 to 5.61 and are all less than the critical value of 6.63. Normality of the disturbances (H_{05}) is rejected in all but the highest home values section of the log-linear spline function. The Jarque-Bera test statistic values range from 1074.77 to 107,291,567.3 and are greater than the critical value of 9.21. For homes with a LSTPRICE greater than \$2,000,000, normality of the disturbances (H_{05}) cannot be rejected since the test statistic value of 0.36 is less than the critical value of 9.21.

The null hypotheses of homoscedasticity (H_{06}) for homes with LSTPRICE less than \$125,000 and between \$500,000 and \$1,000,000 are rejected. The White's test statistic values were 8.22 and 12.94 respectively and are both greater than the critical value of 6.63. For homes with LSTPRICE between \$125,000 and \$500,000 and greater than \$1,000,000, the null hypothesis of homoscedasticity (H_{06}) cannot be rejected. The White's test statistic values range from 0.12 to3.01 and are all less than the 6.63 critical value. All sections of the spline log-linear function show parameter stability since the Chow F statistics range from 0.31 to 4.79 and are all less than their respective critical values of 4.61 to 18.00.

The log-linear spline function regressions of equation 6-6 resulted in R^2 ranging from 0.7112 to 0.9800 showing that the log-linear spline function model explains from 71.12 to 98.00 percent of the variation of NETPRICE, depending on home value.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(3324)	2.58	14.13
H_{02}	t	t(3324)	2.58	364.56
H_{03}	F	F(1, 3324)	6.64	132902.14
H_{04}	RESET	$X^2(1)$	6.63	5.61
H_{05}	Jarque-Bera	$X^2(2)$	9.21	884509.57
H_{06}	White's (nR^2)	$X^2(1)$	6.63	8.22
H_{07}	Chow	F(1, 3324)	6.64	4.79

Table 6-9. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE less than $125,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(11320)	2.58	7.67
H_{02}	t	t(11320)	2.58	745.42
H_{03}	F	F(1, 11320)	6.64	555643.90
H_{04}	RESET	$X^2(1)$	6.63	0.99
H_{05}	Jarque-Bera	$X^2(2)$	9.21	753545.32
H_{06}	White's (nR^2)	$X^2(1)$	6.63	0.12
H_{07}	Chow	F(1, 11320)	6.64	1.31

Table 6-10. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE equal to or greater than $125,000 but less than $250,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(5845)	2.58	0.31
H_{02}	t	t(5845)	2.58	334.61
H_{03}	F	F(1, 5845)	6.64	111962.38
H_{04}	RESET	$X^2(1)$	6.63	1.08
H_{05}	Jarque-Bera	$X^2(2)$	9.21	107291567.3
H_{06}	White's (nR^2)	$X^2(1)$	6.63	0.97
H_{07}	Chow	F(2, 5843)	4.61	0.59

Table 6-11. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE equal to or greater than $250,000 but less than $500,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(829)	2.58	0.20
H_{02}	t	t(829)	2.58	97.19
H_{03}	F	F(1, 829)	6.67	9445.65
H_{04}	RESET	$X^2(1)$	6.63	0.03
H_{05}	Jarque-Bera	$X^2(2)$	9.21	2900.75
H_{06}	White's (nR^2)	$X^2(1)$	6.63	12.94
H_{07}	Chow	F(2, 827)	4.63	0.31

Table 6-12. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE equal to or greater than $500,000 but less than $1,000,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(65)	2.65	0.81
H_{02}	t	t(65)	2.65	12.65
H_{03}	F	F(1,65)	7.04	160.06
H_{04}	RESET	$X^2(1)$	6.63	0.72
H_{05}	Jarque-Bera	$X^2(2)$	9.21	1074.77
H_{06}	White's (nR^2)	$X^2(1)$	6.63	0.39
H_{07}	Chow	F(2,63)	4.96	1.85

Table 6-13. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE equal to or greater than $1,000,000 but less than $2,000,000.

Null	Test	Distribution	Critical Value	Actual Value
H_{01}	t	t(6)	3.71	0.27
H_{02}	t	t(6)	3.71	4.30
H_{03}	F	F(1,6)	13.75	18.47
H_{04}	RESET	$X^2(1)$	6.63	1.55
H_{05}	Jarque-Bera	$X^2(2)$	9.21	0.36
H_{06}	White's (nR^2)	$X^2(1)$	6.63	3.01
H_{07}	Chow	F(2,4)	18.00	1.03

Table 6-14. Results of tests of the null hypotheses from spline function log-linear model with LSTPRICE equal to or greater than $2,000,000.

It is interesting to note that, in both the linear and log-linear spline function cases above, the intercept coefficients are not statistically significant for prices above $250,000 but are significant for prices below that level. For home values equal to or greater than $250,000, the constant term (β_0) is assumed to be zero in both spline function models. Both the linear and log-linear models pass the functional form test at the .01 confidence level with the parameter shifts (spline functions) included. Stability is not a problem when these ranges are used to take account of the parameter shifts. In several of the regressions of the individual spline sections, homoscedasticity is rejected. Where heteroscedasticity exists, the White heteroscedasticity consistent estimator was used to estimate the equations. This estimator uses the heteroscedastic-consistent covariance matrix to estimate each model. Only with the highest value homes could the normality null hypotheses not be rejected. Since the statistical properties of OLS do not depend on normality and there are so many observations, the central limit theorem is used to rely on large sample results and safely assume asymptotic normality of the disturbance terms. [Greene, 2000] All four models (overall linear, spline function linear, overall log-linear, spline function log-linear) will predict NETPRICE using LSTPRICE. Both the overall linear and log-linear models are statistically unacceptable because their assumed functional forms are rejected. The spline function linear and log-linear models have almost identical statistical properties. The only difference between them is that the log-linear model has two more spline sections without heteroscedasticity problems than the linear model. Since both the spline function linear and log-linear models are corrected for heteroscedasticity, they are considered equivalent with regards to the basic statistical test criterion.

Probability of Selling a Home

Now that there are methods to predict the expected net price of a home, the probability of selling a home may be investigated. The observations in the MLS database include a variable for the number of days on the market before selling (DOMPROP). One would suspect that the time on the market before selling would be a function of the listing price or a measure of over/under pricing like the difference between the listing price and the actual market value (sales price). In addition, location and home amenities may have an effect on the time it takes to sell a home. Since the probability of selling a home is derived from the DOMPROP variable, it is important to know if any of these relationships exist.

Regression analysis showed that the coefficient of final listing price (LSTPRICE) is not statistically significant at the .01 confidence level in estimating DOMPROP. LSTPRICE is not a good independent variable for explaining variation in the DOMPROP dependent variable. Using the difference between the actual market value and the original listing price (NETPRICE - ORGPRICE) as an independent variable representing over/under pricing results in a statistically significant increase in 2 days on the market for every $10,000 a home is over-priced. Unfortunately, the explanatory power for this relationship is very low. The R^2 is only 0.0066, so this result is not useful for prediction.

In a regression involving all of the amenity variables available in the MLS data set, there were very few that were statistically significant at explaining variation in DOMPROP. A few variables that were statistically significant resulted in interesting relationships (e.g. an increase in DOMPROP of 4 days for every increase of 10,000 square feet of lot size). Contemporary homes and those with unclassified type (OTHER) stay on the market longer but detached homes stay on the market 46 days less than attached homes. In addition, the month of listing affects how long a home stays on the market. Even though some amenities are statistically significant at explaining variation in the days on market, the explanatory power is low. The R^2 is only 0.0493, so these results are not useful for prediction.

One can conclude that over/under pricing and amenities of a home have a very small effect on the time a home stays on the market, but that the vast majority of this variable is determined randomly. The number of days a home stays on the market is assumed to be largely determined by the individual likes and dislikes of all those who view it. Therefore the probability of selling any home on any particular day is determined by the probability density function derived from the DOMPROP variable.

By sorting the data by number of days on the market, counting the number of homes that sold in each number of days, and dividing by the total number of homes sold, probabilities of selling a home in each possible number of days were assigned. Figures 6-6 and 6-7 show the graphs of the resulting probability density function (pdf) and cumulative density function (cdf) of selling a home during 1998.

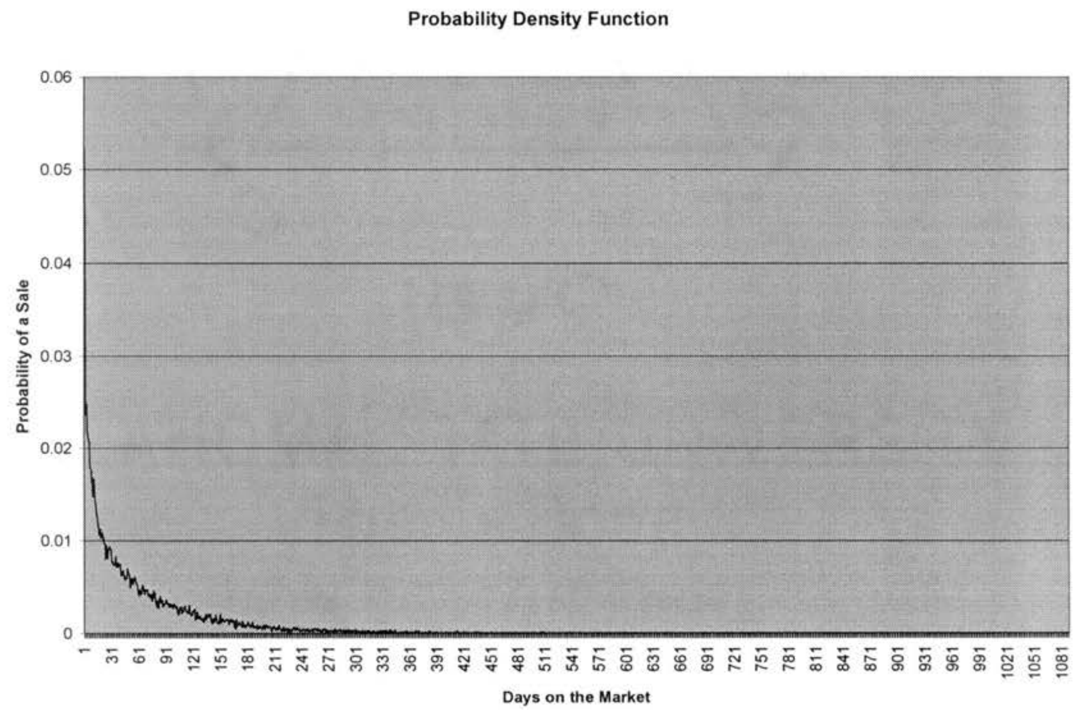


Figure 6-6. Probability Density Function (pdf) of Days on Market.

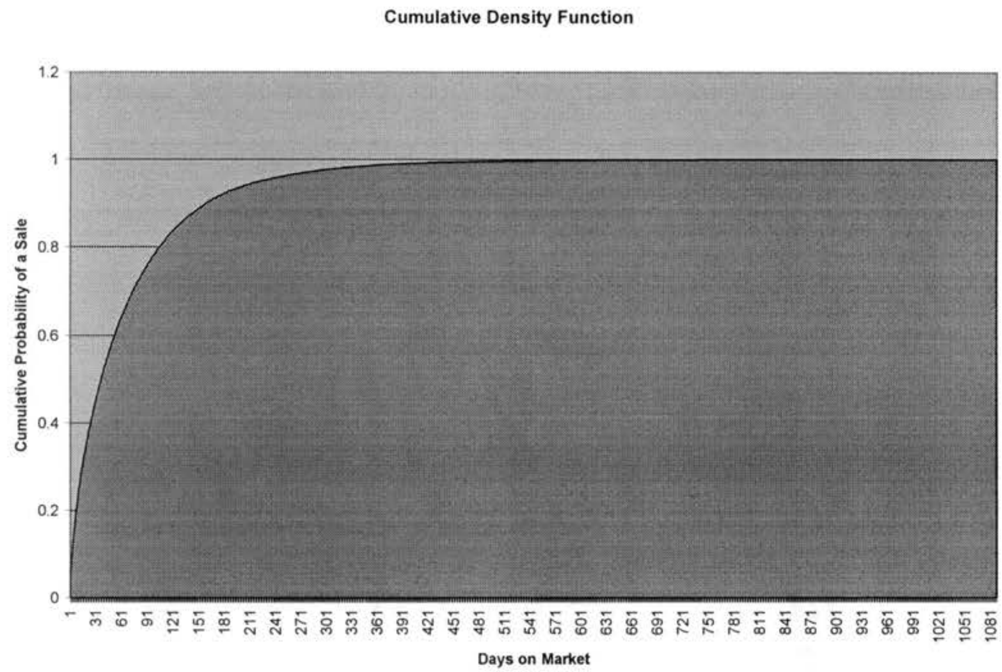


Figure 6-7. Cumulative Density Function (cdf) of Days on Market.

In 1998, a seller had the highest probability (5.2%) of selling their home on the day of listing. The probability of selling decreased exponentially from that day forward and became asymptotically zero. The average number of days on the market before selling was 64. By that time, the cumulative probability of selling a home was 0.662. The median number of days on the market (cumulative probability of 0.500) was 37. The pdf and cdf are not important by themselves, but combined with the discount rate of the seller, lead to an overall discounted probability of selling a home. Equation 6-7 is the same equation as 6-3 and shows that the discounted probability of selling a home depends on the probability of selling in each period and the discount rate used. The DP variable is used to determine the relationship between the expected sales price (S_{MLS}) and the market maker bid price (S^s_{MM}) as shown in equation 6-2.

$$DP = \sum_{\alpha=1}^{A} \frac{P^s_{MLS}}{\left(1+r^s\right)^{\alpha}} \qquad (6-7)$$

Table 6-15 shows four discount rates and the resulting actual discounted probabilities (DP) computed by summing up each individual discounted probability. The 6.0% rate represents the risk-free rate (1998 average 3-month CD rate was 5.5%) [Federal Reserve Bank, 2000]. By carrying a credit card or consumer loan balance, most households reveal that they use a higher discount rate. The 12.0% rate represents a low credit card rate of interest while 18.0% is a high credit card rate.

Discount Rate	0.0%	6.0%	12.0%	18.0%
Discounted Probabilities	1.0000	0.9896	0.9794	0.9696

Table 6-15. Discount rates and corresponding discounted probabilities.

Table 6-16 outlines the combination of commission rates and actual discounted probabilities that lead to the minimum ratios of S^{s}_{MM} to S_{MLS}, ignoring any non-monetary effects. S^{s}_{MM} / S_{MLS} are minimum ratios because any value above these minimums makes the seller monetarily better off by going to a market maker rather than using a realtor. These ratios are important later when calculating the market maker bid prices.

Commission Rate	Discount Rate	Discounted Probability	Minimum S^{s}_{MM} / S_{MLS}
6.0%	0.0%	100.0%	0.9400
6.0%	6.0%	98.96%	0.9302
6.0%	12.0%	97.94%	0.9206
6.0%	18.0%	96.96%	0.9114
5.0%	0.0%	100.0%	0.9500
5.0%	6.0%	98.96%	0.9401
5.0%	12.0%	97.94%	0.9304
5.0%	18.0%	96.96%	0.9211

Table 6-16. Commission rates, discount rates, discounted probabilities, and minimum ratios of S^{s}_{MM} to S_{MLS}.

Bid and Ask Prices

The prevailing real estate commission rate in Northern Virginia was six percent in 1998. A few realtors have started offering discounts of up to one percent. In order to see how robust the results are in the event that commission rates fell, both 6 percent and 5 percent commission rates are used to estimate the results of replacing real estate agents with market makers. To calculate the profitability of a market maker, the rules for setting the market maker's bid and ask prices must be determined.

To obtain the bid price, the coefficients from the regressions of equations 6-4 and 6-6 are used to estimate NETPRICE in each model. Multiplying the estimated NETPRICE by the minimum S^{s}_{MM}/S_{MLS}

ratio for the selected commission rate and discount rate results in the bid price. The four discount rates from table 6-15 are used to show the variation in results for differing assumed discount rates.

The rule for obtaining the ask price takes a little more thought. Rational individuals in a normal market would not usually pay more than the ask price even if they valued the home more and were willing and able to pay a higher price. Since 45% (9,704 out of the 21,401) of Northern Virginia homes sold at a net price greater than the expected net price, using the regression estimate of NETPRICE as the ask price would limit gross revenue on many homes. Asking a higher price than the expected NETPRICE would allow buyers the opportunity to offer less and still result in an acceptable transaction. Making the ask price equal to the LSTPRICE would leave buyers just as well off with a market maker as with a real estate agent. Therefore, the rule used to calculate the ask price of the market maker is to use the higher of the LSTPRICE or expected net price.

In order to compute conservative market maker results, the actual sales price for the market maker are assumed to be the lesser of the ask price or the actual NETPRICE. This allows buyers to act exactly as they would have in the MLS system and provides the opportunity for buyers to offer less than the ask price if their valuation of a home is lower. In this analysis, the market maker is assumed to act exactly as the actual owners did in 1998 and always accept the offer of the actual sales price. In the real world, the market maker would decide whether to accept offers or not. If rejecting an offer, the market maker could wait for another offer or rent the home out and hold it as an alternative income-earning asset. With these assumptions that simulate the 1998 market, the market maker profits may be computed.

Market Maker Gross Profits

Market maker gross profitability is different for each of the four regression models used. The four models used to compute profitability are 1) overall linear, 2) spline function linear, 3) overall log-linear, and 4) spline function log-linear. In addition to computing the gross profits for different commission and discount rate assumptions, sensitivity analysis shows the possible variation of gross profits within the 99 percent confidence interval. Tables 6-17 through 6-28 are all similar. The first of each set of three tables reflects the results using the specific regression coefficients for the model under investigation. The next two tables of each set of three show the gross profit best and worst cases within the

99 percent confidence interval taken from the sensitivity analysis. Each table first lists the assumed commission rates (6.0% and 5.0%), discount rates (0.0%, 6.0%, 12.0%, and 18.0%), and their resulting discounted probabilities taken from table 6-15. Then the total purchase cost of the homes sold in 1998 and the market maker's sales revenue, gross profit, and percent profit (as a percent of purchase cost) are shown. In each table, higher assumed commission and discount rates in the MLS market lead to higher gross profit to a market maker. This is because the bid prices are lower when the commission or discount rates in the MLS market are higher. Notice that the sales revenue are the same in each table regardless of the commission or discount rates. This is because ask prices do not depend on the commission or discount rates assumed.

Table 6-17 shows the gross profit results of the overall linear model using the estimated coefficients from equation 6-4. At 6.0 percent commission and discount rates, a market maker would have paid $4.49 billion to purchase homes in 1998. Sales revenue for these homes would have been $4.81 billion, leaving gross profit of $326.5 million or 7.28 percent of the total cost of homes sold. If the commission rate had been 5.0 percent rather than 6.0 percent, then gross profit would have dropped to $278.8 million or 6.15 percent of the cost of homes sold.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,533,962,239	$4,813,297,275	$279,335,036	6.16%
6.0%	6.0%	98.96%	$4,486,809,032	$4,813,297,275	$326,488,243	7.28%
6.0%	12.0%	97.94%	$4,440,562,617	$4,813,297,275	$372,734,658	8.39%
6.0%	18.0%	96.96%	$4,396,129,787	$4,813,297,275	$417,167,488	9.49%
5.0%	0.0%	100.0%	$4,582,195,880	$4,813,297,275	$231,101,395	5.04%
5.0%	6.0%	98.96%	$4,534,541,043	$4,813,297,275	$278,756,232	6.15%
5.0%	12.0%	97.94%	$4,487,802,645	$4,813,297,275	$325,494,630	7.25%
5.0%	18.0%	96.96%	$4,442,897,125	$4,813,297,275	$370,400,150	8.34%

Table 6-17. Estimation results from overall linear model equation 6-4.

Tables 6-18 and 6-19 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the overall linear model. Table 6-18 shows that the highest gross profit within the 99% confidence interval is $345.1 million for commission and discount rates of 6.0 percent. Table 6-19 shows that the lowest gross profit within the 99% confidence interval is $307.9 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,515,167,271	$4,813,292,846	$298,125,575	6.60%
6.0%	6.0%	98.96%	$4,468,209,531	$4,813,292,846	$345,083,315	7.72%
6.0%	12.0%	97.94%	$4,422,154,825	$4,813,292,846	$391,138,021	8.84%
6.0%	18.0%	96.96%	$4,377,906,186	$4,813,292,846	$435,386,660	9.95%
5.0%	0.0%	100.0%	$4,563,200,965	$4,813,292,846	$250,091,881	5.48%
5.0%	6.0%	98.96%	$4,515,743,675	$4,813,292,846	$297,549,171	6.59%
5.0%	12.0%	97.94%	$4,469,199,025	$4,813,292,846	$344,093,821	7.70%
5.0%	18.0%	96.96%	$4,424,479,656	$4,813,292,846	$388,813,190	8.79%

Table 6-18. Best-case estimation results of sensitivity analysis from overall linear model equation 6-4.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,552,757,207	$4,813,303,099	$260,545,891	5.72%
6.0%	6.0%	98.96%	$4,505,408,533	$4,813,303,099	$307,894,566	6.83%
6.0%	12.0%	97.94%	$4,458,970,409	$4,813,303,099	$354,332,690	7.95%
6.0%	18.0%	96.96%	$4,414,353,388	$4,813,303,099	$398,949,710	9.04%
5.0%	0.0%	100.0%	$4,601,190,795	$4,813,303,099	$212,112,304	4.61%
5.0%	6.0%	98.96%	$4,553,338,411	$4,813,303,099	$259,964,688	5.71%
5.0%	12.0%	97.94%	$4,506,406,264	$4,813,303,099	$306,896,834	6.81%
5.0%	18.0%	96.96%	$4,461,314,595	$4,813,303,099	$351,988,504	7.89%

Table 6-19. Worst-case estimation results of sensitivity analysis from overall linear model equation 6-4.

Tables 6-17 through 6-19 show that, for commission and discount rates of 6.0 percent, gross profits for a market maker using the overall linear model would have been between $307.9 million and $345.1 million (99 percent confidence interval) with the point estimate being $326.5 million. Gross profits would have been between 6.83 and 7.72 percent of cost (within the 99 percent confidence interval) with the point estimate being 7.28 percent.

Table 6-20 shows the gross profit results of the spline function linear model using the estimated coefficients from equation 6-4. At 6.0 percent commission and discount rates, a market maker would have paid $4.49 billion to purchase homes in 1998. Sales revenue for these homes would have been $4.81 billion, leaving gross profit of $326.8 million or 7.28 percent of the total cost of homes sold. If the commission rate had been 5.0 percent rather than 6.0 percent, then gross profit would have dropped to $279.0 million or 6.15 percent of the cost of homes sold.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,533,667,961	$4,813,267,818	$279,599,856	6.17%
6.0%	6.0%	98.96%	$4,486,517,815	$4,813,267,818	$326,750,003	7.28%
6.0%	12.0%	97.94%	$4,440,274,401	$4,813,267,818	$372,993,417	8.40%
6.0%	18.0%	96.96%	$4,395,844,455	$4,813,267,818	$417,423,363	9.50%
5.0%	0.0%	100.0%	$4,581,898,472	$4,813,267,818	$231,369,346	5.05%
5.0%	6.0%	98.96%	$4,534,246,728	$4,813,267,818	$279,021,090	6.15%
5.0%	12.0%	97.94%	$4,487,511,363	$4,813,267,818	$325,756,455	7.26%
5.0%	18.0%	96.96%	$4,442,608,758	$4,813,267,818	$370,659,060	8.34%

Table 6-20. Estimation results from spline function linear model equation 6-4.

Tables 6-21 and 6-22 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the spline function linear model. Table 6-21 shows that the highest gross profit within the 99% confidence interval is $343.9 million for commission and discount rates of 6.0 percent. Table 6-22 shows that the lowest gross profit within the 99% confidence interval is $309.6 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,516,367,069	$4,813,265,753	$296,898,683	6.57%
6.0%	6.0%	98.96%	$4,469,396,852	$4,813,265,753	$343,868,901	7.69%
6.0%	12.0%	97.94%	$4,423,329,908	$4,813,265,753	$389,935,845	8.82%
6.0%	18.0%	96.96%	$4,379,069,510	$4,813,265,753	$434,196,242	9.92%
5.0%	0.0%	100.0%	$4,564,413,528	$4,813,265,753	$248,852,225	5.45%
5.0%	6.0%	98.96%	$4,516,943,627	$4,813,265,753	$296,322,126	6.56%
5.0%	12.0%	97.94%	$4,470,386,609	$4,813,265,753	$342,879,144	7.67%
5.0%	18.0%	96.96%	$4,425,655,356	$4,813,265,753	$387,610,396	8.76%

Table 6-21. Best-case estimation results of sensitivity analysis from spline function linear model equation 6-4.

Com-mission Rate	Dis-count Rate	Dis-counted Prob-abilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,550,968,854	$4,813,269,883	$262,301,030	5.76%
6.0%	6.0%	98.96%	$4,503,638,777	$4,813,269,883	$309,631,106	6.88%
6.0%	12.0%	97.94%	$4,457,218,895	$4,813,269,883	$356,050,988	7.99%
6.0%	18.0%	96.96%	$4,412,619,400	$4,813,269,883	$400,650,483	9.08%
5.0%	0.0%	100.0%	$4,599,383,416	$4,813,269,883	$213,886,467	4.65%
5.0%	6.0%	98.96%	$4,551,549,828	$4,813,269,883	$261,720,055	5.75%
5.0%	12.0%	97.94%	$4,504,636,117	$4,813,269,883	$308,633,766	6.85%
5.0%	18.0%	96.96%	$4,459,562,160	$4,813,269,883	$353,707,723	7.93%

Table 6-22. Worst-case estimation results of sensitivity analysis from spline function linear model equation 6-4.

Tables 6-20 through 6-22 show that, for commission and discount rates of 6.0 percent, gross profits for a market maker using the spline function linear model would have been between $309.6 million and $343.9 million (99 percent confidence interval) with the point estimate being $326.8 million. Gross profits would have been between 6.88 and 7.69 percent of cost (within the 99 percent confidence interval) with the point estimate being 7.28 percent.

Table 6-23 shows the gross profit results of the overall log-linear model using the estimated coefficients from equation 6-6. At 6.0 percent commission and discount rates, a market maker would have paid $4.49 billion to purchase homes in 1998. Sales revenue for these homes would have been $4.81 billion, leaving gross profit of $326.0 million or 7.27 percent of the total cost of homes sold. If the commission rate had been 5.0 percent rather than 6.0 percent, then gross profit would have dropped to $278.3 million or 6.14 percent of the cost of homes sold.

Com-mission Rate	Dis-count Rate	Dis-counted Prob-abilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,534,397,876	$4,813,278,872	$278,880,996	6.15%
6.0%	6.0%	98.96%	$4,487,240,138	$4,813,278,872	$326,038,734	7.27%
6.0%	12.0%	97.94%	$4,440,989,280	$4,813,278,872	$372,289,592	8.38%
6.0%	18.0%	96.96%	$4,396,552,180	$4,813,278,872	$416,726,692	9.48%
5.0%	0.0%	100.0%	$4,582,636,151	$4,813,278,872	$230,642,721	5.03%
5.0%	6.0%	98.96%	$4,534,976,735	$4,813,278,872	$278,302,137	6.14%
5.0%	12.0%	97.94%	$4,488,233,846	$4,813,278,872	$325,045,026	7.24%
5.0%	18.0%	96.96%	$4,443,324,012	$4,813,278,872	$369,954,860	8.33%

Table 6-23. Estimation results from overall log-linear model equation 6-6.

Tables 6-24 and 6-25 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the overall log-linear model. Table 6-24 shows that the highest gross profit within the 99% confidence interval is $451.2 million for commission and discount rates of 6.0 percent. Table 6-25 shows that the lowest gross profit within the 99% confidence interval is $197.4 million for commission and discount rates of 6.0 percent.

Com-mission Rate	Dis-count Rate	Dis-counted Prob-abilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,407,933,974	$4,813,278,872	$405,344,898	9.20%
6.0%	6.0%	98.96%	$4,362,091,460	$4,813,278,872	$451,187,412	10.34%
6.0%	12.0%	97.94%	$4,317,130,534	$4,813,278,872	$496,148,338	11.49%
6.0%	18.0%	96.96%	$4,273,932,781	$4,813,278,872	$539,346,091	12.62%
5.0%	0.0%	100.0%	$4,454,826,888	$4,813,278,872	$358,451,984	8.05%
5.0%	6.0%	98.96%	$4,408,496,689	$4,813,278,872	$404,782,183	9.18%
5.0%	12.0%	97.94%	$4,363,057,454	$4,813,278,872	$450,221,418	10.32%
5.0%	18.0%	96.96%	$4,319,400,151	$4,813,278,872	$493,878,721	11.43%

Table 6-24. Best-case estimation results of sensitivity analysis from overall log-linear model equation 6-6.

Com-mission Rate	Dis-count Rate	Dis-counted Prob-abilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,664,492,183	$4,813,405,319	$148,913,136	3.19%
6.0%	6.0%	98.96%	$4,615,981,464	$4,813,405,319	$197,423,854	4.28%
6.0%	12.0%	97.94%	$4,568,403,644	$4,813,405,319	$245,001,675	5.36%
6.0%	18.0%	96.96%	$4,522,691,621	$4,813,405,319	$290,713,698	6.43%
5.0%	0.0%	100.0%	$4,714,114,440	$4,813,405,319	$99,290,878	2.11%
5.0%	6.0%	98.96%	$4,665,087,650	$4,813,405,319	$148,317,669	3.18%
5.0%	12.0%	97.94%	$4,617,003,683	$4,813,405,319	$196,401,636	4.25%
5.0%	18.0%	96.96%	$4,570,805,361	$4,813,405,319	$242,599,957	5.31%

Table 6-25. Worst-case estimation results of sensitivity analysis from overall log-linear model equation 6-6.

Tables 6-23 through 6-25 show that, for commission and discount rates of 6.0 percent, gross profits for a market maker using the overall log-linear model would have been between $197.4 million and $451.2 million (99 percent confidence interval) with the point estimate being $326.0 million. Gross profits would have been between 4.28 and 10.34 percent of cost (within the 99 percent confidence interval) with the point estimate being 7.27 percent.

Table 6-26 shows the gross profit results of the spline function log-linear model using the estimated coefficients from equation 6-6. At 6.0 percent commission and discount rates, a market maker would have paid $4.48 billion to purchase homes in 1998. Sales revenue for these homes would have been $4.81 billion, leaving gross profit of $329.1 million or 7.34 percent of the total cost of homes sold. If the commission rate had been 5.0 percent rather than 6.0 percent, then gross profit would have dropped to $281.4 million or 6.21 percent of the cost of homes sold.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,531,317,196	$4,813,278,872	$281,961,676	6.22%
6.0%	6.0%	98.96%	$4,484,191,498	$4,813,278,872	$329,087,374	7.34%
6.0%	12.0%	97.94%	$4,437,972,062	$4,813,278,872	$375,306,810	8.46%
6.0%	18.0%	96.96%	$4,393,565,154	$4,813,278,872	$419,713,718	9.55%
5.0%	0.0%	100.0%	$4,579,522,698	$4,813,278,872	$233,756,174	5.10%
5.0%	6.0%	98.96%	$4,531,895,662	$4,813,278,872	$281,383,210	6.21%
5.0%	12.0%	97.94%	$4,485,184,531	$4,813,278,872	$328,094,341	7.32%
5.0%	18.0%	96.96%	$4,440,305,208	$4,813,278,872	$372,973,664	8.40%

Table 6-26. Estimation results from spline function log-linear model equation 6-6.

Tables 6-27 and 6-28 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the spline function log-linear model. Table 6-27 shows that the highest gross profit within the 99% confidence interval is $513.0 million for commission and discount rates of 6.0 percent. Table 6-28 shows that the lowest gross profit within the 99% confidence interval is $129.8 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Discounted Probabilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,345,487,276	$4,813,278,872	$467,791,596	10.76%
6.0%	6.0%	98.96%	$4,300,294,208	$4,813,278,872	$512,984,664	11.93%
6.0%	12.0%	97.94%	$4,255,970,238	$4,813,278,872	$557,308,634	13.09%
6.0%	18.0%	96.96%	$4,213,384,462	$4,813,278,872	$599,894,410	14.24%
5.0%	0.0%	100.0%	$4,391,715,864	$4,813,278,872	$421,563,008	9.60%
5.0%	6.0%	98.96%	$4,346,042,019	$4,813,278,872	$467,236,853	10.75%
5.0%	12.0%	97.94%	$4,301,246,517	$4,813,278,872	$512,032,355	11.90%
5.0%	18.0%	96.96%	$4,258,207,701	$4,813,278,872	$555,071,171	13.04%

Table 6-27. Best-case estimation results of sensitivity analysis from spline function log-linear model equation 6-6.

Com-mission Rate	Dis-count Rate	Dis-counted Prob-abilities	Purchase Cost	Sales Revenue	Gross Profit	% Gross Profit (Cost)
6.0%	0.0%	100.0%	$4,733,527,988	$4,814,095,374	$80,567,386	1.70%
6.0%	6.0%	98.96%	$4,684,299,297	$4,814,095,374	$129,796,077	2.77%
6.0%	12.0%	97.94%	$4,636,017,311	$4,814,095,374	$178,078,063	3.84%
6.0%	18.0%	96.96%	$4,589,628,737	$4,814,095,374	$224,466,637	4.89%
5.0%	0.0%	100.0%	$4,783,884,669	$4,814,095,374	$30,210,706	0.63%
5.0%	6.0%	98.96%	$4,734,132,268	$4,814,095,374	$79,963,106	1.69%
5.0%	12.0%	97.94%	$4,685,336,645	$4,814,095,374	$128,758,730	2.75%
5.0%	18.0%	96.96%	$4,638,454,575	$4,814,095,374	$175,640,800	3.79%

Table 6-28. Worst-case estimation results of sensitivity analysis from spline function log-linear model equation 6-6.

Tables 6-26 through 6-28 show that, for commission and discount rates of 6.0 percent, gross profits for a market maker using the spline function log-linear model would have been between $129.8 million and $513.0 million (99 percent confidence interval) with the point estimate being $329.1 million. Gross profits would have been between 2.77 and 11.93 percent of cost (within the 99 percent confidence interval) with the point estimate being 7.34 percent.

Gross profits are higher with higher commission and discount rates because of their effect on bid prices and purchase costs. With commission and discount rates at 6.0 percent, gross profits in all four models are within one percent of each other. The spline function log-linear model tops the list with $329.1 million, but the others are close behind with the spline function linear model grossing $326.8 million, the overall linear model with $326.5 million, and the overall log-linear function with $326.0 million gross profit. Even though gross profits are very similar, the amount of variation within the 99 percent confidence interval for each model is quite different. The 99 percent confidence band for the spline function linear model is only $34.2 million wide. In contrast, the width for the overall linear model is $37.2 million. The confidence band for the overall log-linear model is even wider at $253.8 million. The confidence band for the overall log-linear model is wider still at $383.2 million. Now that the gross profits are known, net profits must be calculated.

Market Maker Operating Costs

To move from gross profit to net profit, the total costs of a market maker must be computed. As shown by the gross profit results of the four models above, the total paid by the market maker for Northern Virginia homes in 1998 would have ranged from $4.30 to $4.68 billion with an average of $4.49 billion. Of course, the market maker incurs costs in addition to paying for the homes.

The cost of capital is one important cost of being a market maker. Because most homes don't take a year to sell and are not all on the market at the same time, the market maker would not need the total $4.49 billion cost of homes all at once. To calculate the capital requirement of a market maker, the timing of the market maker's transactions in 1998 had to be simulated. The original listing date of each home was assumed to be the market maker's purchase date. A conservative approach was taken to assign the expected contract and settlement dates for buyers. Taking into account the average time on market of 64 days, the expected contract dates were computed. Thirty days were added to each expected contract date to obtain the market maker's expected settlement date. Since some homes stayed on the market long after the 64-day average, the simulated settlement date between the buyer and market maker was conservatively assumed to be the later of the expected or actual settlement dates. This results in a minimum of 94 days holding period (vice 64 days with the MLS) between the market maker's purchase and sale of each home in the simulation of transaction timing. After sorting the simulated buy and sell transactions by date, the cumulative daily capital requirement was calculated. The 1998 maximum capital requirement using this conservative simulation approach would have been $541 million, with an average daily requirement of $482 million. The cost of capital at a 10 percent annual rate (1998 Bank prime rate of 8.5% plus 1.5%) [Federal Reserve Bank, 2000] on an average capital requirement of $482 million would be approximately $48.2 million.

Buyer and seller closing costs are also important and are divided into fixed and variable costs. Fixed costs per transaction average $1,065 and include document preparation, closing fees, title examination, recording fees, and pest inspection. [Russell, 1999] Thus the total fixed closing costs equal $22.8 million ($1,065*21,401). The variable costs consist of 0.475 percent of the market maker's purchase price and 0.1 percent of the market maker's sales revenue. These costs include property taxes, insurance, tax stamps, and grantor tax. [Russell, 1999] Total variable closing costs equal $26.2 million

(0.00475*$4.49 billion + 0.001*$4.81 billion). Total closing costs, therefore, add to $49.0 million ($22.8 + $26.2).

The biggest expense for the market maker will be personnel costs associated with buying and selling of homes. The market maker could use both part- and full-time professionals that are experts at using current technologies to find the best home for each individual purchaser. Also needed, would be a small number of experts in appraisal and inspection of homes to offer sellers the correct bid prices. In 1998 there were just fewer than 6,000 licensed real estate agents in the northern Virginia market [Feikema, 00]. Assuming conservatively that it takes a full week to help a buyer find the right home, the amount of work currently required for 22,000 home sales could be done by less than 500 (22,000/48) full-time equivalent workers including 4 weeks vacation per year. At average annual earnings of $75,000, these professionals would cost the market maker a total of $37.5 million. These home search experts would be equivalent to today's buyer's agents. Assuming conservatively that each appraisal and inspection takes one day, less than 100 (22,000/48/5) professionals would be required to inspect, appraise, and offer sellers the appropriate bid prices. At an average annual salary of $75,000, these full-time professionals would cost $7.5 million. Other personnel costs such as payroll taxes, retirement plan, fringe benefits, etc. would add no more than $25,000 each and cost the market maker $15 million (600*$25,000). Thus, total personnel costs would not exceed $60 million ($37.5 + 7.5 + 15).

The office and administrative costs of running the market maker business cannot be ignored. In Northern Virginia, office and administrative costs would be no more than $1,000 per month per professional [Feikema, 00]. This would cost $7.2 million (600*12*$1,000).

Total operating costs of a market maker would have been approximately $164.4 million ($48.2 + $49.0 + 60.0 + 7.2) in 1998. The next step in the analysis is to use the costs that market makers would incur along with the previous gross profit calculations and compute net profits for the four models under investigation. Since the variable costs depend on the purchase and sale prices, costs are different in each situation.

Market Maker Net Profits

Market maker net profitability is different for each of the four regression models used. The four models used to compute profitability are 1) overall linear, 2) spline function linear, 3) overall log-linear, and 4) spline function log-linear. In addition to computing the net profits for different commission and discount rate assumptions, sensitivity analysis shows the possible variation of net profits within the 99 percent confidence interval. Tables 6-29 through 6-40 are all similar. The first of each set of three tables reflects the results using the specific regression coefficients for the model under investigation. The next two tables of each set of three show the net profit best and worst cases within the 99 percent confidence interval taken from the sensitivity analysis. Each table first lists the assumed commission rates (6.0% and 5.0%), discount rates (0.0%, 6.0%, 12.0%, and 18.0%), and their respective gross profits. Then the total operating costs of the market maker and the market maker's net profit, percent profit (as a percent of purchase cost), and return on capital (as a percent of the $482 million average capital required) are shown. In each table, higher assumed commission and discount rates in the MLS market lead to higher net profit to a market maker. This is because the bid prices are lower when the commission or discount rates in the MLS market are higher.

Table 6-29 shows the net profit results of the overall linear model using the results from equation 6-4. At 6.0 percent commission and discount rates, a market maker would have had a gross profit of $326.5 million in 1998. Operating costs would have been $164.3 million, leaving net profits of $162.2 million or 3.61 percent of the total cost of homes sold. The return on invested capital would have been 33.64 percent. If the commission rate had been 5.0 percent rather than 6.0 percent, then net profit would have dropped to $114.2 million, 2.52 percent of the cost of homes sold or 23.69 percent of invested capital.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$279,335,036	$164,545,943	$114,789,093	2.53%	23.82%
6.0%	6.0%	$326,488,243	$164,321,965	$162,166,278	3.61%	33.64%
6.0%	12.0%	$372,734,658	$164,102,295	$208,632,363	4.70%	43.28%
6.0%	18.0%	$417,167,488	$163,891,239	$253,276,249	5.76%	52.55%
5.0%	0.0%	$231,101,395	$164,775,053	$66,326,342	1.45%	13.76%
5.0%	6.0%	$278,756,232	$164,548,692	$114,207,540	2.52%	23.69%
5.0%	12.0%	$325,494,630	$164,326,685	$161,167,945	3.59%	33.44%
5.0%	18.0%	$370,400,150	$164,113,384	$206,286,766	4.64%	42.80%

Table 6-29. Profitability estimation results from the overall linear model equation 6-4.

Tables 6-30 and 6-31 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the overall linear model. Table 6-30 shows that the highest net profit within the 99% confidence interval is $180.8 million for commission and discount rates of 6.0 percent. Table 6-31 shows that the lowest net profit within the 99% confidence interval is $143.5 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$298,125,575	$164,456,662	$133,668,913	2.96%	27.73%
6.0%	6.0%	$345,083,315	$164,233,613	$180,849,702	4.05%	37.52%
6.0%	12.0%	$391,138,021	$164,014,853	$227,123,168	5.14%	47.12%
6.0%	18.0%	$435,386,660	$163,804,672	$271,581,988	6.20%	56.34%
5.0%	0.0%	$250,091,881	$164,684,822	$85,407,059	1.87%	17.72%
5.0%	6.0%	$297,549,171	$164,459,400	$133,089,771	2.95%	27.61%
5.0%	12.0%	$344,093,821	$164,238,313	$179,855,508	4.02%	37.31%
5.0%	18.0%	$388,813,190	$164,025,896	$224,787,294	5.08%	46.64%

Table 6-30. Best-case profitability estimation using sensitivity analysis for overall linear model equation 6-4.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$260,545,891	$164,635,225	$95,910,667	2.11%	19.90%
6.0%	6.0%	$307,894,566	$164,410,319	$143,484,248	3.18%	29.77%
6.0%	12.0%	$354,332,690	$164,189,738	$190,142,952	4.26%	39.45%
6.0%	18.0%	$398,949,710	$163,977,807	$234,971,904	5.32%	48.75%
5.0%	0.0%	$212,112,304	$164,865,284	$47,247,020	1.03%	9.80%
5.0%	6.0%	$259,964,688	$164,637,986	$95,326,703	2.09%	19.78%
5.0%	12.0%	$306,896,834	$164,415,058	$142,481,777	3.16%	29.56%
5.0%	18.0%	$351,988,504	$164,200,872	$187,787,632	4.21%	38.96%

Table 6-31. Worst-case profitability estimation using sensitivity analysis for overall linear model equation 6-4.

Tables 6-29 through 6-31 show that, for commission and discount rates of 6.0 percent, net profits for a market maker using the overall linear model would have been between $143.5 million and $180.8 million (99 percent confidence interval) with the point estimate being $162.2 million. Net profits would have been between 3.18 and 4.05 percent of cost (within the 99 percent confidence interval) with the point estimate being 3.61 percent. The return on invested capital would have been between 29.77 and 37.52 percent (within the 99 percent confidence interval) with the point estimate being 33.64 percent.

Table 6-32 shows the net profit results of the spline function linear model using the results from equation 6-4. At 6.0 percent commission and discount rates, a market maker would have had a gross profit of $326.8 million in 1998. Operating costs would have been $164.3 million, leaving net profits of $162.4 million or 3.62 percent of the total cost of homes sold. The return on invested capital would have been 33.70 percent. If the commission rate had been 5.0 percent rather than 6.0 percent, then net profit would have dropped to $114.5 million, 2.52 percent of the cost of homes sold or 23.75 percent of invested capital.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$279,599,856	$164,544,516	$115,055,341	2.54%	23.87%
6.0%	6.0%	$326,750,003	$164,320,552	$162,429,451	3.62%	33.70%
6.0%	12.0%	$372,993,417	$164,100,896	$208,892,520	4.70%	43.34%
6.0%	18.0%	$417,423,363	$163,889,854	$253,533,509	5.77%	52.60%
5.0%	0.0%	$231,369,346	$164,773,611	$66,595,736	1.45%	13.82%
5.0%	6.0%	$279,021,090	$164,547,265	$114,473,826	2.52%	23.75%
5.0%	12.0%	$325,756,455	$164,325,272	$161,431,183	3.60%	33.49%
5.0%	18.0%	$370,659,060	$164,111,984	$206,547,075	4.65%	42.85%

Table 6-32. Profitability estimation results from the spline function linear model equation 6-4.

Tables 6-33 and 6-34 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the spline function linear model. Table 6-33 shows that the highest net profit within the 99% confidence interval is $179.6 million for commission and discount rates of 6.0 percent. Table 6-34 shows that the lowest net profit within the 99% confidence interval is $145.2 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$296,898,683	$164,462,334	$132,436,349	2.93%	27.48%
6.0%	6.0%	$343,868,901	$164,239,226	$179,629,675	4.02%	37.27%
6.0%	12.0%	$389,935,845	$164,020,408	$225,915,437	5.11%	46.87%
6.0%	18.0%	$434,196,242	$163,810,171	$270,386,071	6.17%	56.10%
5.0%	0.0%	$248,852,225	$164,690,555	$84,161,670	1.84%	17.46%
5.0%	6.0%	$296,322,126	$164,465,073	$131,857,053	2.92%	27.36%
5.0%	12.0%	$342,879,144	$164,243,927	$178,635,217	4.00%	37.06%
5.0%	18.0%	$387,610,396	$164,031,454	$223,578,943	5.05%	46.39%

Table 6-33. Best-case profitability estimation using sensitivity analysis for spline function linear model equation 6-4.

Com-mission Rate	Dis-count Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$262,301,030	$164,626,697	$97,674,333	2.15%	20.26%
6.0%	6.0%	$309,631,106	$164,401,879	$145,229,227	3.22%	30.13%
6.0%	12.0%	$356,050,988	$164,181,385	$191,869,603	4.30%	39.81%
6.0%	18.0%	$400,650,483	$163,969,537	$236,680,946	5.36%	49.10%
5.0%	0.0%	$213,886,467	$164,856,666	$49,029,801	1.07%	10.17%
5.0%	6.0%	$261,720,055	$164,629,457	$97,090,598	2.13%	20.14%
5.0%	12.0%	$308,633,766	$164,406,616	$144,227,149	3.20%	29.92%
5.0%	18.0%	$353,707,723	$164,192,515	$189,515,208	4.25%	39.32%

Table 6-34. Worst-case profitability estimation using sensitivity analysis for spline function linear model equation 6-4.

Tables 6-32 through 6-34 show that, for commission and discount rates of 6.0 percent, net profits for a market maker using the spline function linear model would have been between $145.2 million and $179.6 million (99 percent confidence interval) with the point estimate being $162.4 million. Net profits would have been between 3.22 and 4.02 percent of cost (within the 99 percent confidence interval) with the point estimate being 3.62 percent. The return on invested capital would have been between 30.13 and 37.27 percent (within the 99 percent confidence interval) with the point estimate being 33.70 percent.

Table 6-35 shows the net profit results of the overall log-linear model using the results from equation 6-6. At 6.0 percent commission and discount rates, a market maker would have had a gross profit of $326.0 million in 1998. Operating costs would have been $164.3 million, leaving net profits of $161.7 million or 3.60 percent of the total cost of homes sold. The return on invested capital would have been 33.55 percent. If the commission rate had been 5.0 percent rather than 6.0 percent, then net profit would have dropped to $113.8 million, 2.51 percent of the cost of homes sold or 23.60 percent of capital.

Com-mission Rate	Dis-count Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$278,880,996	$164,547,994	$114,333,002	2.52%	23.72%
6.0%	6.0%	$326,038,734	$164,323,995	$161,714,740	3.60%	33.55%
6.0%	12.0%	$372,289,592	$164,104,303	$208,185,290	4.69%	43.19%
6.0%	18.0%	$416,726,692	$163,893,227	$252,833,465	5.75%	52.46%
5.0%	0.0%	$230,642,721	$164,777,126	$65,865,595	1.44%	13.67%
5.0%	6.0%	$278,302,137	$164,550,743	$113,751,394	2.51%	23.60%
5.0%	12.0%	$325,045,026	$164,328,715	$160,716,311	3.58%	33.34%
5.0%	18.0%	$369,954,860	$164,115,393	$205,839,467	4.63%	42.71%

Table 6-35. Profitability estimation results for overall log-linear model equation 6-6.

Tables 6-36 and 6-37 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the overall log-linear model. Table 6-36 shows that the highest net profit within the 99% confidence interval is $287.5 million for commission and discount rates of 6.0 percent. Table 6-37 shows that the lowest net profit within the 99% confidence interval is $32.5 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$405,344,898	$163,947,290	$241,397,608	5.48%	50.08%
6.0%	6.0%	$451,187,412	$163,729,538	$287,457,873	6.59%	59.64%
6.0%	12.0%	$496,148,338	$163,515,974	$332,632,364	7.70%	69.01%
6.0%	18.0%	$539,346,091	$163,310,785	$376,035,307	8.80%	78.02%
5.0%	0.0%	$358,451,984	$164,170,032	$194,281,952	4.36%	40.31%
5.0%	6.0%	$404,782,183	$163,949,963	$240,832,220	5.46%	49.97%
5.0%	12.0%	$450,221,418	$163,734,127	$286,487,291	6.57%	59.44%
5.0%	18.0%	$493,878,721	$163,526,755	$330,351,966	7.65%	68.54%

Table 6-36. Best-case profitability estimation using sensitivity analysis for overall log-linear model equation 6-6.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$148,913,136	$165,166,068	$(16,252,932)	-0.35%	-3.37%
6.0%	6.0%	$197,423,854	$164,935,642	$32,488,212	0.70%	6.74%
6.0%	12.0%	$245,001,675	$164,709,648	$80,292,027	1.76%	16.66%
6.0%	18.0%	$290,713,698	$164,492,516	$126,221,183	2.79%	26.19%
5.0%	0.0%	$99,290,878	$165,401,774	$(66,110,895)	-1.40%	-13.72%
5.0%	6.0%	$148,317,669	$165,168,897	$(16,851,228)	-0.36%	-3.50%
5.0%	12.0%	$196,401,636	$164,940,498	$31,461,138	0.68%	6.53%
5.0%	18.0%	$242,599,957	$164,721,056	$77,878,902	1.70%	16.16%

Table 6-37. Worst-case profitability estimation using sensitivity analysis for overall log-linear model equation 6-6.

Tables 6-35 through 6-37 show that, for commission and discount rates of 6.0 percent, net profits for a market maker using the overall linear model would have been between $32.5 million and $287.5 million (99 percent confidence interval) with the point estimate being $161.7 million. Net profits would have been between 0.70 and 6.59 percent of cost (within the 99 percent confidence interval) with the point estimate being 3.60 percent. The return on invested capital would have been between 6.74 and 59.64 percent (within the 99 percent confidence interval) with the point estimate being 33.55 percent.

Table 6-38 shows the net profit results of the spline function log-linear model using the results from equation 6-6. At 6.0 percent commission and discount rates, a market maker would have had a gross profit of $329.1 million in 1998. Operating costs would have been $164.3 million, leaving net profits of $164.8 million or 3.67 percent of the total cost of homes sold. The return on invested capital would have been 34.19 percent. If the commission rate had been 5.0 percent rather than 6.0 percent, then net profit would have dropped to $116.8 million, 2.58 percent of the cost of homes sold or 24.24 percent of capital.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$281,961,676	$164,533,361	$117,428,315	2.59%	24.36%
6.0%	6.0%	$329,087,374	$164,309,513	$164,777,861	3.67%	34.19%
6.0%	12.0%	$375,306,810	$164,089,971	$211,216,839	4.76%	43.82%
6.0%	18.0%	$419,713,718	$163,879,038	$255,834,680	5.82%	53.08%
5.0%	0.0%	$233,756,174	$164,762,337	$68,993,837	1.51%	14.31%
5.0%	6.0%	$281,383,210	$164,536,108	$116,847,101	2.58%	24.24%
5.0%	12.0%	$328,094,341	$164,314,230	$163,780,111	3.65%	33.98%
5.0%	18.0%	$372,973,664	$164,101,054	$208,872,610	4.70%	43.33%

Table 6-38. Profitability estimation results for spline function log-linear model equation 6-6.

Tables 6-39 and 6-40 are the best and worst cases from the sensitivity analysis using the extreme values for the coefficients within the 99% confidence intervals for the spline function log-linear model. Table 6-39 shows that the highest net profit within the 99% confidence interval is $349.5 million for commission and discount rates of 6.0 percent. Table 6-40 shows that the lowest net profit within the 99% confidence interval is negative $35.5 million for commission and discount rates of 6.0 percent.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$467,791,596	$163,650,668	$304,140,928	7.00%	63.10%
6.0%	6.0%	$512,984,664	$163,436,001	$349,548,663	8.13%	72.52%
6.0%	12.0%	$557,308,634	$163,225,463	$394,083,172	9.26%	81.76%
6.0%	18.0%	$599,894,410	$163,023,180	$436,871,230	10.37%	90.64%
5.0%	0.0%	$421,563,008	$163,870,254	$257,692,754	5.87%	53.46%
5.0%	6.0%	$467,236,853	$163,653,303	$303,583,550	6.99%	62.98%
5.0%	12.0%	$512,032,355	$163,440,525	$348,591,830	8.10%	72.32%
5.0%	18.0%	$555,071,171	$163,236,090	$391,835,080	9.20%	81.29%

Table 6-39. Best-case profitability estimation using sensitivity analysis for spline function log-linear model equation 6-6.

Commission Rate	Discount Rate	Gross Profit	Operating Costs	Net Profit	% Net Profit (Cost)	Return On Capital
6.0%	0.0%	$80,567,386	$165,494,678	$(84,927,292)	-1.79%	-17.62%
6.0%	6.0%	$129,796,077	$165,260,842	$(35,464,765)	-0.76%	-7.36%
6.0%	12.0%	$178,078,063	$165,031,503	$13,046,560	0.28%	2.71%
6.0%	18.0%	$224,466,637	$164,811,157	$59,655,480	1.30%	12.38%
5.0%	0.0%	$30,210,706	$165,733,873	$(135,523,167)	-2.83%	-28.12%
5.0%	6.0%	$79,963,106	$165,497,549	$(85,534,442)	-1.81%	-17.75%
5.0%	12.0%	$128,758,730	$165,265,769	$(36,507,040)	-0.78%	-7.57%
5.0%	18.0%	$175,640,800	$165,043,080	$10,597,720	0.23%	2.20%

Table 6-40. Worst-case profitability estimation using sensitivity analysis for spline function log-linear model equation 6-6.

Tables 6-38 through 6-40 show that, for commission and discount rates of 6.0 percent, net profits for a market maker using the overall linear model would have been between -$35.5 million and $349.5 million (99 percent confidence interval) with the point estimate being $164.8 million. Net profits would have been between -0.76 and 8.13 percent of cost (within the 99 percent confidence interval) with the point estimate being 3.67 percent. The return on invested capital would have been between -7.36 and 72.52 percent (within the 99 percent confidence interval) with the point estimate being 34.19 percent.

Net profits are higher with higher commission and discount rates because of their effect on bid prices and purchase costs. Since operating costs are so close and gross profits for the models are all within one percent of each other, estimated net profits for these models are also similar. With commission and discount rates at 6.0 percent, net profits in all four models are within two percent of each other. The spline function log-linear model tops the list with $164.8 million, but the others are close behind with the spline function linear model netting $162.4 million, the overall linear model with $162.2 million and the overall log-linear function with $161.7 million net profit. Even though net profits are very similar, the amount of variation in net profit within the 99 percent confidence interval for each model is quite different. The 99 percent confidence band for the spline function linear model is only $34.4 million wide. In contrast, the width for the overall linear model is $37.4 million. The confidence band for the overall log-linear model is even wider at $255.0 million. The confidence band for the spline function log-linear model is wider still at $385.0 million. The spline function log-linear model is the only one of the four to show possible negative results. Even though the expected net profit is the highest at $164.8 million, the 99 percent confidence band is quite wide and includes possible losses of $35.5 million and profits of $345.9 million. Even though the estimated profit of the spline function log-linear model is $2.4 million higher than the spline function linear model, the spline function linear model is preferred because of its narrow 99 percent confidence band compared to the spline function log-linear band.

Model Selection

Now that the models' results have been summarized, evaluation can take place to choose which one is best according to the three criteria outlined earlier. Only with the spline function linear and log-linear models can one fail to reject the functional form and stability null hypotheses. The overall linear and log-linear models are unacceptable because their assumed functional forms cannot be accepted. The higher value sections of the spline function models passed the normality and homoscedasticity tests. The few sections with rejected homoscedasticity null hypotheses were corrected using the White heteroscedasticity consistent estimator. In addition, the sections with rejected normality null hypotheses have so many observations that asymptotic normality of the residuals may be safely assumed. The spline function models are statistically equally acceptable.

There are two parts to the monetary risk criteria. With the commission and discount rates at 6.0%, tables 6-32 and 6-38 show that the spline function log-linear model has an estimated profit of $164.8 million, $2.4 million higher than the $162.4 million of the spline function linear model. On the other hand, tables 6-33, 6-34, 6-39, and 6-40 show that the spline function linear model far outperforms the spline function log-linear model when it comes to the profit variation within the 99% confidence interval. The confidence interval for the spline function linear model includes best-case profits of $179.6 million and worst- case profits of $145.2 million. The confidence interval for the spline function log-linear model includes large best-case profits of $349.5 million but also worst-case losses of $35.5 million. The $2.4 million gain in expected profits using the spline function log-linear model does not compensate for the risk involved with such a wide 99 percent confidence band. Therefore, the spline function linear model is best from the monetary risk standpoint.

For the explanatory power criteria, weighted R^2 for each of the spline function models were computed and compared to the R^2 of the overall linear and log-linear models. Even though the overall linear and log-linear models had R^2 of .9862 and .9951 respectively, they were eliminated as statistically insufficient above. The spline function linear model has a weighted R^2 of .9785 while the spline function log-linear model's weighted R^2 is .9679. The spline function linear model explains more of the variation in NETPRICE than the spline function log-linear model.

The results of the three criteria lead to the conclusion that the best model to explain NETPRICE is the spline function linear model. This model is statistically acceptable and results in a high estimated profit and a moderate variation within the 99% net profit confidence interval while explaining 97.85 percent of the variation in NETPRICE. The spline function linear model consists of equations 6-8 to 6-12.

$$NETPRICE_t = -1842.34 + 0.9723(LSTPRICE_t) + \varepsilon_t; \quad \text{Value} < \$250K \tag{6-8}$$

$$NETPRICE_t = 0.0 + 0.9667(LSTPRICE_t) + \varepsilon_t; \quad \$250K \leq \text{Value} < \$500K \tag{6-9}$$

$$NETPRICE_t = 0.0 + 0.9654(LSTPRICE_t) + \varepsilon_t; \quad \$500K \leq \text{Value} < \$1000K \tag{6-10}$$

$$NETPRICE_t = 0.0 + 0.9420(LSTPRICE_t) + \varepsilon_t; \quad \$1000K \leq \text{Value} < \$2000K \tag{6-11}$$

$$NETPRICE_t = 0.0 + 0.8615(LSTPRICE_t) + \varepsilon_t; \quad \$2000K \leq \text{Value} \tag{6-12}$$

Results

A market maker using the spline function linear model in Northern Virginia during 1998 would have been a profitable enterprise. Total operating costs to run a market maker operation in the Northern Virginia real estate market would not have exceeded $165 million per year. Using the current commission rate of 6.0 percent and a discount rate of 6.0 percent, 1998 net profits would have been $162.4 million (3.62% of home acquisition costs). Using the 99% confidence interval, this net profit would have been between $145.2 million and $179.6 million. With the average cash requirement of $482 million, the return on capital would have been a hefty 33.70% with a 99% confidence interval of 30.13% to 37.27%. Even if commission rates were 5.0 percent rather than 6.0 percent, a market maker would have earned $114.5 million with a 99 percent confidence interval of $97.1 to $131.9 million. In fact, with a discount rate of 6.0 percent, the commission rate can be as low as 2.98 percent and still ensure positive market maker profits with 99 percent certainty.

A market maker would have been a viable alternative to real estate agents in the 1998 Northern Virginia residential real estate market. A market maker could have provided buyers and sellers higher value liquidity services than currently provided by the MLS system and would have made a sizeable profit in the process. The market making process outlined above assumes that sellers would have received no less (in monetary terms) than they received working through real estate agents. What they would have received were risk free, certain, and relatively stress-free transactions on the exact dates of their choosing. Sellers would never have had to worry about their home selling in time to move to their next location. They would not have had to list their homes months in advance or experience family separations while waiting to sell. Sellers could have received their money sooner rather than later! So, while being indifferent monetarily, sellers would have enjoyed increased liquidity and lower stress in selling their home. Likewise, buyers using a market maker in 1998 would have paid no more than they paid for their homes working through a real estate agent. Yet, each buyer would have been assured that, at anytime in the future, they could also sell their home to a market maker for terms as good as or better than working through a realtor.

In the next chapter, the results will be summarized and the question of why market makers do not exist today will be addressed. The obstacles that market makers encounter will also be explained. Recommendations for future extensions of market maker research in real estate will be made. Finally, conclusions will be made to close this research.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the results of this study, draws some conclusions from those results, and recommends future avenues for expanding the knowledge of market making in real estate.

Summary

A market maker using a linear spline regression function to establish bid and ask prices could have replaced real estate agents and the multiple listing service in the 1998 Northern Virginia residential real estate market. The obvious question is if market makers could have replaced realtors and been profitable, why are there none in existence today? There are good reasons why no one has yet taken on the role of market maker in real estate markets. Even though a market maker could replace realtors, a market maker may never have the opportunity to get off the ground in today's real estate market simply because of barriers to entry. There are obstacles that any would-be market maker will have to overcome to be successful.

The initial and continuing capital requirement to have an impact in the market is enormous. Typically, a commercial real estate lender requires a 20 percent down payment on any non-owner-occupied home. A market maker would quickly run out of cash with this down payment requirement and even a small inventory. One way to reduce the capital required would be to securitize loans made to the market maker and require a lower down payment similar to Fannie Mae and Freddie Mac programs. Just as it would be quite expensive for a market maker to enter the market, it is quite inexpensive for an individual to become a licensed real estate agent. This is one reason why the market is flooded with real estate agents but there are no market makers to be found.

Besides the huge capital requirement, the fact that each home is a unique asset makes it difficult to establish values with certainty. As shown in this research, a market maker will have to use more sophisticated numerical methods than the traditional home loan appraiser to determine expected market value of residential real estate. In addition to the valuation problem, a market maker would have to be very good at setting bid and ask prices in relation to each individual home's value in order to avoid unexpected shortages or inventories. Inventories should not be a problem per-se as long as the homes have income-producing alternative uses (e.g. rental property), but financial arrangements may limit a market maker's inventory capacity.

A relatively easy obstacle for a market maker to overcome is transaction costs. A market maker would substitute two transactions (one buy and one sell) for what is currently one transaction in the MLS market. It may be possible to have buyers and/or sellers pay transaction costs, or the market maker, as shown in this research, may be able to absorb them. The market maker would have an incentive to reduce these costs through changes in the laws that impose them. An arrangement similar to the one with used-car dealers could develop since real estate market makers would be equivalent to "used-home" dealers. Retailers typically are not required to pay transfer taxes if they buy products with the intention of re-selling them in the near future. Another legal change that may merit more research is title requirements. It is expensive (compared to automobiles) to transfer title to real estate. There may be ways to reduce the cost without reducing the confidence upheld by the current title transfer process.

A large hurdle for any market maker to overcome in the real estate market is access to buyers and sellers. Historically, realtors have had exclusive access to the information needed by buyers and sellers to find a trading partner. The Multiple Listing Service owns this information and access is granted only to licensed real estate agents. This leads most buyers and sellers to real estate agents because the expected search time of buyers is quicker and probability of a sale is higher than buying or selling on their own. There are two possibilities to overcome this obstacle. First, a market maker could compete with real estate agents by having exclusive access to homes that people want and soliciting customers through advertising and word of mouth. This would be a slow and potentially expensive process. The other way to deal with this access problem is to acquire the MLS system by merging with or taking control of the association of realtors that owns the MLS system.

In any event, as long as market makers had a way to compete or merge with the MLS system, they could provide valuable liquidity services to existing and future homeowners while earning profits to compensate for the costs and capital requirements of operations.

Recommended Future Research

There are several possibilities available for future research to extend the knowledge of market making in the real estate market. The most obvious is to extend the current research to more current years. More could be done to model the transition from the MLS to a market maker system or coexistence of both in the market. Even though a market maker should be profitable using any discount rate, a better idea of the prevailing rate used by sellers would help narrow the possible range of expected profits.

The most interesting extension of this research would be to analyze an actual market maker operation in the real estate market. In the 1998 Northern Virginia market, it would have been possible to buy and sell all 21,401 homes with a capital reserve of less than $30 million if loans could have been obtained with a 95% loan to value ratio. Of course, a market maker could start much smaller and still provide sufficient data to tell with certainty if this market mechanism is preferable to the present system.

Research into the feasibility and effect of re-purchase and price guarantees could lead to some interesting results. Once a market maker takes control of the appraisal and data collection process, the variation of expected profits should narrow significantly. This increase in precision should lead to better financing terms and expanded use of the market maker. Higher liquidity in the real estate market will come from the expanded use of the market maker. Increased liquidity in the market will attract more people to home ownership and would lead to rising home prices. This would open the door for a market maker to offer re-purchase and price guarantees to reduce risk and raise liquidity even more.

Conclusions

As Peter Drucker said, "Markets are not created by God, nature or economic forces, but by businessmen." [Thompson, 1999] Just because past real estate businessmen have chosen to use an agency market mechanism in the past, does not mean that it is the most efficient or beneficial arrangement for buyers and sellers. In fact, if allowed to develop, a market maker mechanism will leave home buyers and sellers better off by reducing uncertainty, risk, and non-monetary costs while expanding liquidity and home ownership in the market.

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VITA

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