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Money Supply and Housing Price Bubbles: Evidence from Micro-Experiments

By Yang Zhang, Dongyue Mao, Baoyi Shi, and Michael Seiler

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Many macro models exist in the extant literature suggesting an increase in the money supply will induce rising home prices. These models insist that aggressive monetary policy will increase housing affordability for potential buyers who need, but cannot afford, the down payment on a home. Then more demand will be released by a moderately loose monetary policy, such as easy to borrow money from banks, low rates and so on, and will thus lead to increasing home prices, potentially causing a housing bubble. However, many non-academic observers who have argued that money supply not only impacts the housing price by increasing the newly added effective demand, but also results in high housing prices by impacting existing traders' trading behaviors. This article examines whether a high money supply will increase home prices. Moreover, we study how traders' behavior changes between high and low money supply environments.

The relation between money and prices historically is associated with the quantity theory of money. There is strong empirical evidence of a direct relation between money-supply growth and long-term price inflation, at least for rapid increases in the amount of money in the economy. In economics, the money supply or money stock is the total amount of monetary assets available in an economy at a specific time. There are several ways to define "money," but standard measures usually include currency in circulation and demand deposits (depositors' easily accessed assets on the books of financial institutions). Money supply data are recorded and published, usually by the government or the central bank of the country. Public and private sector analysts have long monitored changes in the money supply because of its effects on price levels, inflation, the exchange rate, and the business cycle.

To explore the effects of money supply on home prices from the perspective of traders' micro-behaviors, we must isolate the influence of newly added buyers who can afford houses with help from banks. It is very hard to find an environment that fits our research requirements perfectly. As such, we use a control experiment to simulate the housing trading process in a micro market setting. Within the experiment, the number of buyers is controlled and the affordability of buyers is adjusted. As a result, the impacts of money supply are easy to identify in the experiment. Another experimental metric is the behavior of traders as the entire process of trading can be observed and recorded by experimental software. In contrast, in an actual market, it is almost impossible to follow the home trading process which often spans different regions over several months.

Our experimental evidence shows that the traders' bid, offer, and trading price in low money supply sessions are significantly lower than those in high money supply environments. When increasing the money supply, housing price bubbles are larger holding other factors constant, even though the quantity of bids and offers do not change significantly. As to traders' earnings, the finding is that there

is no significant difference between high and low money supply sessions.

The remainder of the article is structured as follows: first the literature review is presented, then the experimental design is described and the analyses of the experimental results are presented. Finally conclusions are given.

LITERATURE REVIEW

Alchian and Klein[1] argue that monetary authorities should be concerned about asset prices for their own sake. In their view, price indices such as the consumer price index (CPI) or the gross domestic product (GDP) deflator are deficient because they consider only the price of goods consumed today. A complete measure of the cost of living also would include changes in the prices of future goods. If, for example, housing prices rise while rents remain unchanged, they would argue that the purchasing power of money had fallen even though the CPI would show no effects. Shibuya[2] shows that under certain conditions the Alchian and Klein measure of inflation can be summarized as a weighted sum of consumer price inflation and asset price inflation. While the theoretical validity of the Alchian and Klein argument is debatable, two practical issues doom the approach. First, the link between asset prices such and Arrow-Debreu prices required by the theory often is tenuous. Asset prices change for many reasons, not all relating to the cost of future consumption. For example, when expected profits rise, share prices may rise with no change in interest rates. Each share purchases a greater amount of future consumption. In this case, asset prices confuse changes in the price of future consumption with changes in the quantity of future consumption.

Many proponents of broader measures of inflation favor the inclusion of asset prices not because they belong in a measure of the cost of living or the cost of inflation, but because they predict future movements in the CPI. The argument that movements in asset prices are useful in forecasting inflation goes at least back to Fisher[3] who argued that increases in the money supply were first manifested in rising asset prices and only later in the prices of consumer goods. This view has been taken up by the *Economist* magazine and by Goodhart and Hufmann.[4] Do asset prices predict inflation? There seems to be very little evidence that stock prices do. Stock and Watson[5] consider the ability of 168 economic indicators to forecast US inflation at a one year horizon. They conclude that measures of real economic activity perform best. Stock prices and exchange rates perform poorly relative to a traditional Phillips curve. Interest rates appear to contain some information.

Several authors previously used other identification schemes to study the impact of monetary policy shocks and money supply shocks on the housing market using values at risk (VARs). Lastrapes[6] studied the effect of money supply shocks on the housing market using two identification procedures. First, he assumed that money supply shocks were neutral in the long-run (long-run restrictions as in Blanchard and Gertler[7]). Second, he assumed a block-recursive structure in which housing variables do not affect monetary policy contemporaneously. The results suggest that money supply shocks have a positive impact on different measures of house sales. The results are robust to the use of different identification schemes. Wheeler and Chowdhury[8] and Hasan and Taghavi[9] used a recursive structure with the monetary policy variable before residential investment in the ordering to study the impact of macroeconomic variables in the housing market. Results, based on variance decompositions and historical decompositions, suggest that monetary policy has important effects on residential investment.

AU: Is this correct?

EXPERIMENTAL DESIGN

We used the programs in the Veconalab Web platform[10] to design and conduct our experiments. The programs have been designed and written by Charles Holt in consultation with coauthors and users. This program establishes a housing market in which traders are given endowments of cash and houses with rents that correspond to consumption values. Cash may be kept in a safe account with a fixed interest rate. Final-period redemption values for the houses are known. Traders submit buy or sell limit orders that are ranked and "crossed" to determine a uniform market-clearing price. Traders are allowed to buy on margin, by putting up a specified fraction of the purchase price of the houses that they bid for, with the rest being borrowed. Loans are called and the houses must be sold if the market price in the previous period falls enough to wipe out the initial equity provided by the trader at the time of purchase. The interest rate for cash induces a time preference and that determines the fundamental (present) value of a share. Trading prices can be compared with the fundamental values to identify bubbles or crashes driven by expectations.

Housing Market

To isolate the relation between money supply and housing price bubbles, we assume all assets (homes) within the

experimental market are identical. The elements of the experiments include:

Market Setup: There will be 14 participants in this market. Each person is endowed with 4 or 8 million experimental currencies in cash and 3 houses that can be bought or sold.

Periods: This part of the experiment consists of exactly 10 trading periods, and all houses owned at the end of the final trading period (from the endowment or obtained by purchase) will be redeemed for 1,000,000 experimental currencies each.

Rents and Interest: All houses owned at the end of each period will pay a rent (explained below). Each experimental currency in retained cash (from the endowment or obtained from house sales) will earn a fixed interest rate. The rents are unknown in advance, but the interest rate is known.

Earnings: In addition to earnings from interest and rents, your cash balance will be altered as you buy and/or sell houses. Transactions will be executed for you based on "limit orders" to buy or sell that you may submit at the beginning of a trading period, as explained below.

Earnings on Investments: Rents will be paid on all houses owned after trading in a round is complete. This includes houses previously owned and not sold, plus any houses purchased in the round. Interest is paid on cash balances after trading has taken place in a round (but before rent is paid).

Rents: Each house held at the end of a trading period will pay a rent that depends on the outcome of a random process. The computer will select a random number from 1 to 10, with each integer within this interval being equally likely. This random "state" determines which column of the Rent Table shown in Exhibit 1 is relevant. Thus, each of the rent amounts listed in the bottom row of the table is equally likely to be earned on each house owned.

Interest: Currency held after trading for the round is complete (but prior to the payment of rents) will earn 3 percent interest.

Differences: Note that rents are random, whereas interest payments are known in advance. Another difference is that interest is paid on currency not used to purchase houses, whereas rents are paid on each house, the price of which is determined in the trading process, as explained next.

Trading Rules

Limit Orders to Buy or Sell: At the beginning of a trading period, those who wish to purchase houses will indicate the number of houses desired and the maximum or "limit" price they are willing to pay. Similarly, those who wish to sell houses will indicate the number of houses offered and the minimum "limit" price they are willing to accept.

Buy and Sell Orders: The same person may offer to buy and sell houses, but the buy price or "bid" must be below the sell price or "ask," so you cannot sell to yourself.

Arranging Trades: Trades are possible if some of the sell order prices (asks) are below some of the buy order prices (bids). The market maker is a computer program that will organize the buy and sell orders and use these to determine a market-clearing price. Ask prices above this level and bid prices below this level will be rejected.

Market Clearing: All transactions will be at the same "market-clearing" price. This will be a price such that the number of houses that traders wish to buy is equal to the number of houses that traders wish to sell. In other words, the number of houses with limit sell prices (asks) at or below this clearing price is equal to the number of houses with limit buy prices (bids) at or above this clearing price. Thus, those who are willing to pay the most will buy from those who are willing to sell for the least, but all trades will be at the same price. The mechanics of determining the clearing price will be explained next.

Suppose that the only bids submitted in a round are 600,000 for one house and 200,000 for another, and the only asks are 100,000 for one house and 400,000 for another. The clearing price cannot be above 400,000 since there would be two houses offered for sale, but only one house buyers are willing to purchase. Conversely, at any price below 200,000, there are two houses demanded, but only one house is offered for sale. Notice that any price between 200,000 and 400,000 could be a market-clearing price, and when this happens the market maker will use the midpoint of the interval, which is 300,000 in this case. Thus, the person who offered to pay 600,000 would only have to pay 300,000 and the person who offered to take 100,000 would actually receive 300,000 for the sold home.

Exhibit 1—Random Determination of Rents per House

Random State	1	2	3	4	5	6	7	8	9	10
House's rents	4,000	4,000	5,000	5,000	6,000	6,000	7,000	7,000	8,000	8,000

The numbers used in the actual experiment to follow may be much larger than the amounts used here, which are for illustrative purposes only.

Suppose a person begins a round with 200,000 in cash and three houses. If this person makes no purchases or sales, then the interest earnings would be 0.03 on each currency in cash, *i.e.*, 200,000 × 0.03 = 6,000 in interest. If the randomly determined rents turned out to be 4,000, then the total rental income would be 3 × 4,000 = 12,000. Similarly, if the randomly determined rents turned out to be 8,000, then the total dividend income would be 3 × 8,000 = 24,000. If the person who started with three houses and 200,000 were to purchase a house for P in the trading period, then this person would earn interest on 200,000-P and would earn a rent on 4,000, and these four houses would make up the person's stock portfolio at the start of the next period. The amount of cash carried over to the next period would be the initial cash minus the cost of the purchase plus the interest in cash remaining, plus the rents on the four houses. The numbers used in these examples were selected for illustrative purposes only.

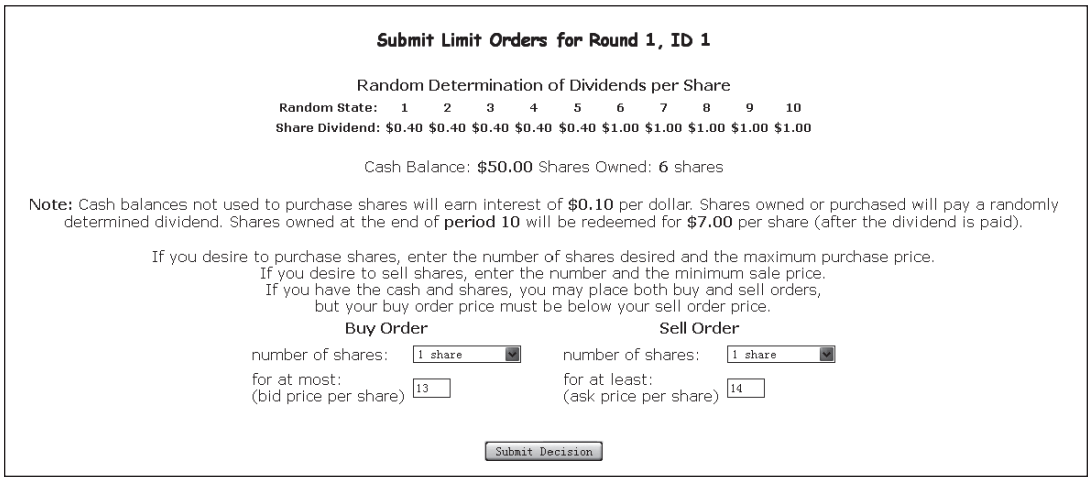
Participants begin with an initial cash account of 4,000,000 and with three houses with rents determined by a randomly generated number as shown above, with each of the 10 columns in Exhibit 1 being equally likely. Houses can be bought or sold by placing limit orders, which are executed at a single market-clearing price selected to equalize the number of houses demanded (with bids above the price) and the number of houses offered (with asks below the price). Exhibit 2 reveals a screen capture of the decision page the participant sees.

At the beginning of the trading period, those who wish to purchase a home indicate the number of houses desired and the maximum price they are willing to pay. Similarly, those who wish to sell shares will indicate the number of homes offered and the minimum price they are willing to accept. All transactions are at the same "market-clearing" equilibrium price, a price such that the number of houses traders wish to buy equals the number of houses traders wish to sell. In other words, the numbers of shares with sell prices (asks) at or below this clearing price equal the number of houses with a buy price (bids) at or above this clearing price. Thus, those who are willing to pay the most will buy from those who are willing to sell for the least, but all trades will be at the same price.

Incentive Rules

This part of the experiment consists of exactly 10 trading periods, and all houses owned at the end of the final trading period (from the endowment or obtained by purchase) will be redeemed for 1,000,000 each. Each house owned at the end of a period (after trades have been executed) will pay a randomly determined rent, and each currency in retained cash (from the endowment or obtained from stock sales) will earn a fixed interest of 3 percent. A participant's cash balance will decrease if he purchases houses and will increase as he earns interest and rents, and as he sells houses or redeems them in the final period. The computer keeps track of his cash and house accounts, and final earnings will equal the cash balance in the final period after any owned houses are redeemed. Each 1,000,000 in earnings for the

EXHIBIT 2—SCREEN CAPTURE OF THE DECISION PAGE



experiment are converted into 1.00 China Yuan in cash and paid to participants.

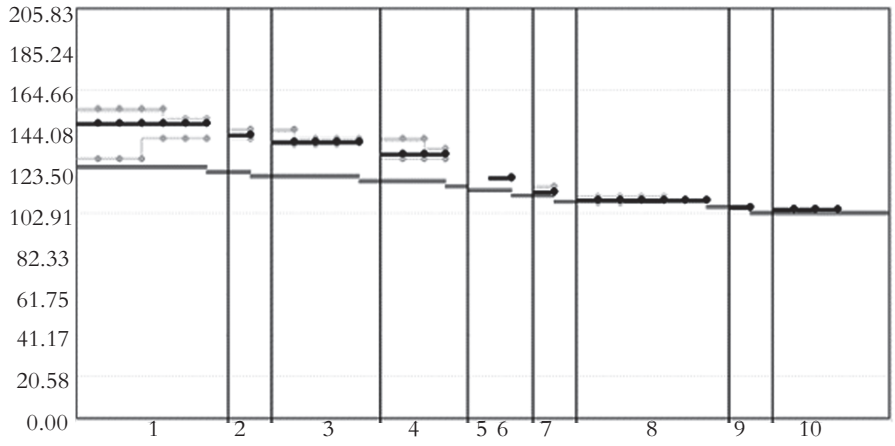
Experimental Sessions

To isolate the effects of money supply on home prices, we build comparative experiments to collect experimental data. The experiment includes two sessions. The two sessions have the same parameters, instructions, and procedural details except the initial endowments of the trader. In Session 1, all traders are given 8,000,000 in experimental currency and three houses; while in Session 2 the initial endowments for traders are 4,000,000 in experimental currency and three houses.

EXPERIMENTAL RESULTS

All the experimental data are automatically collected by the Web site. In this section, we discuss the effects of money supply on housing price bubbles. Moreover, to deeply

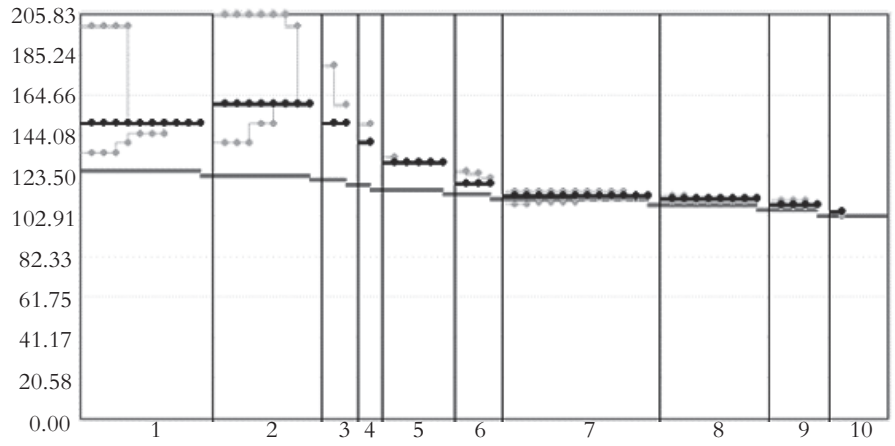
EXHIBIT 3—EXPERIMENTAL RESULTS FROM THE LOW MONEY SUPPLY SESSION



Note: The red lines represent the present value of the house in each round. The blue lines represent the trading price in each round. The up and down gray lines represent traders' bids and asks in each round.

AU: Please check the colors mentioned in the notes here and below.

EXHIBIT 4—EXPERIMENTAL RESULTS OF HIGH MONEY SUPPLY SESSION



Note: The red lines represent the present value of the house in each round. The blue lines represent the trading price in each round. The up and down gray lines represent traders' bids and asks in each round.

understand the mechanism of how money supply impacts home prices and how the housing price bubbles were generated, the effects of money supply on the traders' bid and offer, trading volumes, traders' earnings are analyzed.

The Effects of Money Supply on Home Prices

The Web site provides the experimental data in several different forms.

According to the concept of real estate asset pricing bubbles, the degree of housing price bubbles can be indicated by the distance between the trading price and the theoretical price. The greater the distance the larger the price bubble. Exhibit 3 and Exhibit 4 show that the trading price in both high and low money supply sessions are higher than the present value of the house. It shows that pricing bubbles occurred in both sessions. The price bubble is significantly larger in the high money supply session than in the low money supply session. In addition, as trading rounds progress, home price bubbles gradually reduce.

The Effects of Money Supply on the Trading Process

Home price bubbles in the high and low money supply sessions are different. To learn why this difference occurred and how the money supply impacts home price bubbles, we next discuss the effects of money supply on the traders' bid and offer, trading volume, and traders' earnings. Exhibit 5

EXHIBIT 5—STATISTICAL DESCRIPTION OF MONEY SUPPLY SESSIONS

Panel A: The Statistical Description of High Money Supply Session

Round	Bid Price	Bid Quantity	Offer Price	Offer Quantity	Market Price	Fundamental Value	Quantity Bought	Quantity Sold	Rents	Earnings
1	138.54	2.69	202.22	2.11	150.00	125.59	0.71	0.71	7.00	1583.91
2	154.72	2.93	170.00	2.00	160.00	123.36	0.57	0.57	8.00	1428.74
3	139.27	2.90	169.38	1.50	150.00	121.06	0.14	0.14	7.00	1650.22
4	128.73	2.73	152.10	1.56	140.00	118.69	0.07	0.07	4.00	1412.97
5	123.94	2.90	137.00	1.88	130.00	116.25	0.36	0.36	4.00	1521.67
6	116.88	2.78	124.50	3.17	119.00	113.74	0.21	0.21	4.00	1665.01
7	110.44	3.13	116.31	2.33	113.00	111.15	0.86	0.86	4.00	1528.66
8	109.64	3.09	111.53	3.83	111.40	108.49	0.57	0.57	4.00	1519.63
9	106.49	3.33	109.04	4.20	108.49	105.74	0.29	0.29	4.00	1683.31
10	103.20	4.13	104.98	4.80	104.50	102.91	0.07	0.07	8.00	1680.49

Panel B: The Statistical Description of Low Money Supply Session

Round	Bid Price	Bid Quantity	Offer Price	Offer Quantity	Market Price	Fundamental Value	Quantity Bought	Quantity Sold	Rents	Earnings
1	136.50	1.80	155.50	2.50	147.50	125.59	0.43	0.43	7.00	1132.91
2	131.00	1.70	150.67	2.22	142.00	123.36	0.07	0.07	8.00	1102.69
3	131.25	1.88	141.43	2.57	138.00	121.06	0.29	0.29	7.00	1132.18
4	127.17	2.00	138.00	2.38	132.00	118.69	0.21	0.21	4.00	982.27
5	118.40	2.20	132.37	2.00	-	116.25	0.00	0.00	4.00	1012.57
6	113.17	2.17	127.00	3.00	120.00	113.74	0.07	0.07	4.00	947.25
7	112.13	3.25	119.43	3.14	113.00	111.15	0.07	0.07	4.00	920.41
8	109.33	4.00	111.43	3.57	109.00	108.49	0.43	0.43	4.00	1022.45
9	104.00	2.00	109.33	2.83	105.00	105.74	0.07	0.07	4.00	1025.09
10	103.00	4.80	109.50	4.00	104.00	102.91	0.21	0.21	8.00	1062.38

EXHIBIT 6—IMPACT OF MONEY SUPPLY ON THE TRADERS' DECISIONS

Variable	High Money Supply Sessions		Low Money Supply Sessions		Is There Significant Difference Between High and Low Money Supply Sessions? (p-value)
	Mean	Std. Deviation	Mean	Std. Deviation	
Trader's Bid Price	123.19	418.85	118.60	403.24	Yes (0.000)
Trader's Bid Quantity	3.06	10.40	2.58	8.77	No (0.154)
Trader's Offer Price	139.71	475.01	129.47	440.20	Yes (0.000)
Trader's Offer Quantity	2.74	9.32	2.82	9.59	No (0.200)
Market Price	128.64	437.38	123.39	419.53	Yes (0.002)
Trading Volume	0.39	1.33	0.19	0.65	Yes (0.002)
Trader's Earnings	1567.46	5329.36	1034.02	3515.67	Yes (0.000)

Notes: 1. The grouping variable is the Money Supply. 2. P-value is the Asymp. Sig. (2-tailed) of the Mann-Whitney U test results.

reports brief descriptive statistics of the seven variables in both high and low money supply sessions.

To understand the effects of money supply on traders' decisions, we use non-parameters tests to examine if there are significant differences in trader's bid price, bid quantity, offer price, offer quantity, market price, trading volume, and traders' earnings between high and low money supply sessions. The results are shown in Exhibit 6.

We make use of the Mann-Whitney U test to quantify the impact of money supply on traders' decisions. From Exhibit 6, we observe that the trader's bid price and offer price in the high money supply session are significantly higher (99 percent confidence level) than the bid and offer price in the low money supply session. As a result, the market price in the high money supply session is higher than the market price in the low money supply session. Hence, we conclude that housing price bubbles were produced from the bid and offer phase or earlier. The high money supply may lead people to have a high expectation or evaluation of the home price before trading.

As to the effects of money supply on traders' volume, we compare and analyze the traders' bid quantity, offer quantity, and trading volume between the high and low money supply sessions. We find there is no significant difference in bid quantity and offer quantity between high and low money supply sessions. However, trading volume in the high money supply session is higher than trading volume in the low money supply session.

Lastly, we use this non-parameter test to check if traders in the high money supply session earn more money than in the low money supply session. If we take the trader's earnings in the high money supply setting minus the initial distance (*i.e.*, 8,000,000–4,000,000), the difference between two sessions is not significant.

CONCLUSIONS

Through the implementation of an experimental design, this study examines the effect of money supply on housing price bubbles and traders' behavior. We find that under a high money supply environment, traders' bid, offer, and trading price are significantly higher than those in a low money supply session. As a result, housing price bubbles are larger when increasing the money supply, holding all else constant. Trading volume increases under high money supply environments, even though the quantity of bids and offers do not change significantly. As to traders' earnings, the finding is that there is no significant difference between high and low money supply sessions.

The contributions of this study involve enriching the research methods in the field of housing economics and expanding the application scope of experimental economics tools. The limitation of this study is that we take the house as a homogeneous asset. One extension of our analysis would be to consider a variety of differentiating home characteristics that exist in the natural environment.

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10. The address of Veconalab is *http://veconlab.econ.virginia.edu/admin.php*. This site provides around 60 online programs, each of which lets you run a particular type of market or game. The experiments can be used for teaching or research. For each game, there is a wide variety of setup options (numbers of players and rounds, payoff parameters, information conditions, auction rules, context and terminology, etc.). Default settings are provided, and participant instructions are automatically configured to the selected setup options. Results are presented in graphs and color-coded tables that can be copied into a spreadsheet for further analysis. The programs use a server-side PHP/MYSQL combination, and there is no need to download any software. All you need is one or more computers that are connected to the internet, anywhere in the world, via any standard browser such as Internet Explorer, Safari, Chrome, or Firefox.

Analyzing Neighborhood Amenities: Willingness-to-Pay among Parents of Elementary School Students

By Jesse Saginor, Chanam Lee, and Minjie Xu

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Chanam Lee, *PhD is a Professor at Texas A&M University.*

Minjie Xu, *PhD is a Research Associate at Texas A&M University.*

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The prevalence of physical inactivity and increasing rates of obesity are one of the most important public health issues in the United States. While obesity in general is a contributing factor to a host of health issues ranging from diabetes to heart disease, the increase in rates of childhood obesity are a growing concern. Increasingly, the environmental and health benefits of active living demonstrate that various elements of the built and natural environment can positively impact physical activity. The economics underlying active living have, to some extent, not been examined extensively. The importance of studying the economics of active living environments provides insight into better future planning and development to ensure that the proper environments are created to match the surrounding population. An active living environment preferred by people with children in urban areas may be completely different from the active living preferences for people with children in rural areas. One aim of this research is to determine how people with children in different geographic areas rate the importance of different neighborhood amenities on active living characteristics.

To assess the economic values for built and natural environmental amenities, a stated preferences approach employing contingent valuation methods (CVM) measured the degree of willingness-to-pay (WTP) for 15 different types of neighborhood amenities. These 15 different amenities are largely derived from the extensive literature review in the following section. While various amenities included in this research have been studied, this research is the only known study to include all of these amenities in a single survey instrument. This research targeted parents with an elementary school child to further assess how parents value those environmental interventions commonly proposed to promote children's walking to school as part of the federal Safe Routes to School (STRS) program. This research attempts to evaluate physical activity related to sociodemographic characteristics and the relationships between the willingness-to-pay and the willingness-to-use these 15 somewhat common amenities most likely to exist in neighborhoods.

LITERATURE REVIEW

The literature review is varied in terms of how neighborhood amenities have been measured, whether through contingent valuation/willingness-to-pay methods, hedonic or other regression, or travel cost methods. Given the diverse range of the literature and related methodologies, this section aims to discuss the costs and benefits of each amenity to provide some insight into the logic that a typical respondent may weigh when personally determining willingness to pay for certain neighborhood amenities. In other words, an amenity that may seem to only have positive attributes may in fact have a few negative attributes

that have successfully been identified in the peer-reviewed literature. The summarized literature covers the 15 amenities examined in this research. These 15 amenities are parks and natural areas, trails or greenways, playgrounds, sports fields or courts, water features, public plazas or squares, public schools, bus or other public transit, views, bike lanes, sidewalks, street trees, street lighting, crosswalks, and traffic calming devices.

Urban open spaces could include anything from fields and recreation areas to public plazas and squares to parks. Parks typically are considered to be a positive amenity due to the promotion of physical activity, improvement of quality of life, and higher real estate values, but also can have several negative attributes such as the impact of lighting shining into nearby homes and crime.[1] Other benefits include aesthetics and air quality improvements, as well as facilitating formal and informal social interactions. On the other hand, because open space is attractive, it can generate noise, traffic, and possibly crime. In the case of urban parks, homeless populations may be attracted to the parks. Depending on the attributes and perceptions of that urban open space, then, a respondent may have either a negative or a positive reaction to willingness-to-pay to have or keep a park in the neighborhood.

Similar to parks, trails have been shown to promote physical activity and healthy lifestyles, as well as improving property values, but they are not without their own problems, ranging from noise and litter to bike traffic interfering or infringing on pedestrian traffic, especially in regards to older populations or young children.[2] Similar to trails in terms of benefits and issues, bike lanes along roads provide dedicated space to bicyclists, serving both utilitarian (*e.g.*, bike commuters) and exercise and recreational purposes. However, there also tend to be more car-bike accidents compared to similar areas without bike lanes.[3] Krizek even found that bike trails on suburban roads actually impacted home values negatively.

Greenways could include street trees within a greenbelt. The aesthetic properties of greenways and street trees provide everything from improved activity for people who enjoy outdoor activities to improving property values. At the same time, the root systems of trees, especially when placed near or between a sidewalk and the street, may cause a host of infrastructure and/or property damage.[4] Orland found that the size of the tree did not have any significant effect on property value while the Council of Tree and Landscape Appraisers[5] measure a 10 to 30 percent property premium for landscaping that included trees. Manmade water features such as pools, ponds, and fountains may contribute to a higher level of physical activity, quality of life, improved property value, and aesthetics, but may lead to conflicts between recreational users or lead to higher costs due to the need to manage these resources.[6]

Schools or other institutional facilities may have either a positive or a negative perception due to a variety of factors. Buildings in this category include schools, school playgrounds, and libraries. The positive aspects include physical activity, travel convenience, property values, and possibly being located in proximity to nearby amenities or activities, while noise and traffic are the main negatives associated with these uses.[7] Bus or other transit stops that may be located near schools or other institutional land uses may lead to physical activity as well as cost savings due to not using a car, along with possible benefits to property values. The downside of bus or other transit stops is that there is likely to be some noise and traffic, as well as the routes may not be convenient or expedient in the suburbs.[8] Therefore, the quality (*e.g.*, route frequency, on-time service, connectivity to desired destinations), not just the simple presence or availability of service, appears important to assess the perceived values of transit services.

Amenities that may promote physical activity and safety from a walkable perspective include sidewalks, crosswalks, and traffic calming measures. Sidewalks have been shown to be linked with several perceived or actual benefits such as improved safety perception and increased walking. However, they require ongoing maintenance to ensure pedestrian safety and usability.[9] Crosswalks are continuations of sidewalks to allow for safe and convenient pedestrian crossings at street intersections and other mid-block locations. While general safety and connectivity benefits associated with crosswalks have been reported, high rates of collisions still occur at crossings and painted stripes alone may not bring sufficient safety benefits unless other measures, such as a stop sign and traffic calming devices, also are installed.[10] Traffic calming measures range from speed bumps to medians and curb extensions, and are shown to improve safety if installed and located properly. However, these can be consumed by costs in the form of infrastructure improvements, liability claims, problems for emergency and service vehicles, and general frustration by drivers.[11]

These walkability and safety related amenities are among the most commonly implemented environmental

EXHIBIT 1—PHYSICAL ACTIVITY PROFILE OF RESPONDENTS

	Full Data		Urban		Suburban		Rural	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Total	493	100	87	17.65	198	40.16	131	26.57
Walker or Non-walker								
Non-walker	52	11.48	3	3.45	23	12.17	20	16
Walker	401	88.52	84	96.55	166	87.83	105	84
High-walker or Low-walker								
Low-walker	347	76.6	65	74.71	152	80.42	89	71.2
High-walker	106	23.4	22	25.29	37	19.58	36	28.8

"Low-walker" is defined as walking less than 150 minutes per week.

"High-walker" is defined as walking at least 150 minutes or more per wee

interventions funded by the US Federal Safe Routes to School (SRTS) program. The US congress included the SRTS program in the 2005 transportation bill, which included engineering (infrastructure improvements), education, encouragement and enforcement strategies to improve safety around schools and encourage school-aged children to use active (*e.g.*, walking and bicycling) modes of transportation for school commuting.[12] Assessment studies showed that SRTS programs have contributed to reducing child pedestrian injuries and to increasing rates of walking and bicycling to school. Benefits expected from SRTS programs are only beginning to be documented but early evidence is quite promising in bringing health and safety related benefits to a large number of school-aged children. We expect that these walkability features known to support active transportation among children will likely hold positive values to the general public, especially among parents of school-aged children. Studies do show that these neighborhood amenities are considered desirable by most residents and home buyers, as they actually or are perceived to improve safety, accessibility and/or walkability. Even serving as perceived benefits, they are still shown to bring positive economic values.

METHODOLOGY AND DATA

This study was conducted via an online-based survey using Qualtrics. Because this survey focused on parents with an elementary school child, the participant recruitment was made primarily through the school districts. Specific methods for the recruitment included posting of our Web site on the school district Web site, sending emails to those parents who provided emails in the open-record database, They were recruited from one urban school district (Austin), two suburban school districts (Bryan and College Station) and 10 rural independent school districts (*e.g.*, Huntsville, Palestine, and Plainview) largely located in central and east Texas. The survey instrument was developed utilizing items from the existing validated or tested instruments. Some items were modified when additional specificity or tailoring was necessary, and new items were added when no previously developed items were available. The survey instrument underwent several rounds of pilot testing. Despite instructions stating that the survey would take 20 to 30 minutes to complete, the average survey response time was about one hour. As compensation, survey respondents were offered a $10 gift card. Of the 430 responses, 416 responses (96.7 percent) were valid. The other 14 responses that were excluded due to respondents indicating that they no longer had a child attending elementary school.

Two versions of WTP questions were used as the main study variables. One version was asked to those who already had the amenities in their current neighborhood, and the question was worded to report their WTP to keep the existing amenities; and the other version was asked to those who did not have the amenities in their neighborhood and therefore worded to ask their WTP to have the amenities. These two versions of WTP questions were asked for each of the 15 neighborhood amenities selected for this study. A neighborhood in this study was defined as the area within a 20-minute

EXHIBIT 2–SOCIODEMOGRAPHIC PROFILE OF RESPONDENTS

	N		N
Gender		Employment status	
Female	316	Full time	257
Male	103	Part time	51
Location		Unemployed	11
Urban	87	Retired	4
Suburban	198	Full-time homemaker	67
Rural	131	Full-time student	9
Not given	77	Part-time student	4
Age in years		Other	11
Under 25	4	No answer	79
26-35	96	Income	
36-45	221	Under $20,000	14
46-55	87	$20,000-$29,999	23
56-65	12	$30,000-$39,999	20
Over 65	3	$40,000-$49,999	23
No answer	70	$50,000-$59,999	31
Race		$60,000-$69,999	24
White	333	$70,000-$79,999	29
African-American	21	$80,000-$89,999	34
Hispanic	48	$90,000-$99,999	15
Asian	12	$100,000-$109,999	37
Native American	1	$110,000-$119,999	22
Hawaiian/Pacific Islander	1	$120,000-$129,999	23
Other	6	$130,000-$139,999	7
No answer	71	$140,000-$149,999	8
Highest level of education completed		$150,000 and over	53
Less than high school	1	No answer	47
High school/GED	17		
Some college	68		
Two-year degree	32		
Four-year degree	168		
Masters degree	90		
Doctoral degree	21		
Professional degree	20		
No answer	76		

walking distance from their home, which is commonly used in similar studies. The possible responses ranged from a minimum of zero dollars or no bid to a premium bid of $500. Respondents could choose a number by either typing in the dollar amount in the box or by moving a slider bar between the two price points. The number of valid responses for WTP to keep versus WTP to have amenities had significant variation, but the

means tests between the two were not significantly different across sociodemographic and household variables. Therefore, the WTP to keep and WTP to have variables for the two groups were combined for the multivariate logistic regression models.

In the surveys, parents were asked to provide information about their socio-demographic backgrounds, physical activity behaviors, perceptions of neighborhood environment, frequency to use the selected amenities (WTU), and WTP to keep or have the selected amenities. The level of walking was measured by the total weekly minutes of walking that was categorized in two groups: (1) a low walker group signifying less than 150 minutes of walking per week and (2) a high walker group signifying greater than or equal to 150 minutes of walking per week. These criteria are derived from Physical Activity Guidelines developed by the Centers for Disease Control and Prevention (CDC), which considers 150 minutes of moderate-intensity aerobic activity per week as necessary for important health benefits.[13] The WTP variables are closed-ended questions asking for one-time hypothetical payments ranging from $0 to $500 for each of 15 typical neighborhood amenities. Multivariate logistic regression models were employed to measure significant variables related to the WTP and WTU for these amenities.

Survey Respondents' Physical Activity Levels

Exhibit 1 provides respondents' physical activity levels based on responses to the number of times they walk per week and how many minutes they typically spend walking in a single period of time.

Over 88 percent of all respondents were walkers (walking at least once a week), yet their level of walking fell short of being in the high-walker category, based on the 76.6 percent of people in the low-walker group. The low-walker group was relatively similar across urban, suburban, and rural groups, ranging from a high of 80.4 percent in the suburbs to a low of 71.2 percent in rural areas. Rural areas had the largest percentage of people in the high-walker group.

EXHIBIT 3—HOUSING CHARACTERISTICS OF RESPONDENTS

	N
Type of housing	
Single-family home	351
Apartment	27
Condominium/townhouse/duplex	25
Mobile home or trailer	16
No answer	74
Do you currently have a mortgage?	
Current mortgage in repayment	275
Mortgage paid off	40
Rent	96
Occupy without payment or rent	6
No answer	76
Number of bedrooms	
1	1
2	49
3	174
4	169
5	24
6 or more	2
No answer	74
Number of bathrooms	
1	36
2	222
3	117
4	34
5	6
6 or more	3
No answer	75
Number of operable motor vehicles	
0	5
1	70
2	250
3	72
4	14
5 or more	2
No answer	80

Socioeconomic Background of Survey Respondents

The respondents had a fairly diverse background, as outlined in the descriptive Exhibits 2 through 4. Over 75 percent of respondents were female, and the largest segment of these respondents lived in suburban areas. In terms of age segmentation, the 36 to 45-year old segment had the largest share, which reflects the average age of parents with elementary school age children. The race of overall respondents was predominantly non-Hispanic white, followed by respondents that did not answer this question, then Hispanic. In terms of the highest level of

EXHIBIT 4—HOUSEHOLD CHARACTERISTICS OF RESPONDENTS

	N		N
Marital status		Number of adults living in household	
Single/Never married	23	1	54
Married	346	2	334
Separated/divorced/widowed	39	3	25
Living with partner	13	4	2
No answer	72	5 or more	3
Years at current residence		No answer	75
Less than one year	56	Number of children in elementary school	
1	25	0	20
2	39	1	244
3	45	2	116
4	35	3	28
5	23	4	8
6	38	5 or more	1
7	22	No answer	76
8	20	Health of respondent	
9	18	Excellent	126
10 or more years	98	Very good	171
No answer	74	Good	97
Number of people living in household		Fair	16
2	22	Poor	2
3	63	Don't know	1
4	192	No answer	80
5 or more	140		
No answer	76		
Known medical conditions of respondent that limit physical activity		Known medical conditions of any children that limit phyiscal activity	
No	378	No	389
Yes	36	Yes	21
No answer	79	No answer	83

education completed, the largest segment of the population had at least a four-year degree and the second largest segment had a Master's degree. These numbers might be slightly skewed due to the existence of Texas A&M University as a major employer in Bryan and College Station. A majority of respondents were employed in full-time positions, with 79 respondents not answering this question and another 67 respondents reporting that they were full-time homemakers. Regarding household income, the largest segment of respondents earned over $150,000, with the second largest segment falling in the $100,000 to $109,999 range. The full sociodemographic profile of the respondents is in Exhibit 2.

The survey also had a section of questions related to housing characteristics (Exhibit 3). The largest segment of people lived in single-family residential homes. Another 27 lived in apartments, 25 lived in a condominium, townhouse, or duplex, and 16 respondents lived in a mobile home. Sixty-six percent of respondents reported currently repaying a mortgage, while slightly less than 10 percent had paid

EXHIBIT 5—BIDDING RESULTS FOR NEIGHBORHOOD AMENITIES

	Did Not Answer	Premium Bid (=$500)	Valid Bids (>0)	Percent Bidding	Average of Total Bids	Top Half	Top Quarter	No Bid (=0)	Total Bids
Parks/natural recreation areas	44	29	416	92.7%	$ 136.03	$ 221.09	$ 328.56	33	449
Trails/greenways	84	26	367	89.7%	$ 139.52	$ 236.14	$ 346.14	42	409
Playgrounds	68	11	397	93.4%	$ 121.97	$ 198.95	$ 285.84	28	425
Sport fields/courts	142	8	293	83.5%	$ 114.57	$ 195.38	$ 289.94	58	351
Water features	149	15	297	86.3%	$ 136.44	$ 232.42	$ 335.29	47	344
Public plazas/squares	244	7	164	65.9%	$ 109.41	$ 190.66	$ 286.51	85	249
Public schools	104	66	343	88.2%	$ 235.58	$ 373.77	$ 482.94	46	389
Bus or other public transit services	241	8	165	65.5%	$ 118.38	$ 205.94	$ 311.71	87	252
Nice view of buildings or other scenery	217	17	202	73.2%	$ 147.23	$ 249.84	$ 359.14	74	276
Bike lanes	189	11	233	76.6%	$ 131.43	$ 227.59	$ 324.97	71	304
Sidewalks	98	17	357	90.4%	$ 132.97	$ 229.90	$ 334.81	37	395
Street trees	152	19	294	86.2%	$ 134.02	$ 236.98	$ 354.36	47	341
Street lighting	88	21	374	92.3%	$ 132.50	$ 216.11	$ 320.74	31	405
Crosswalks	161	12	282	84.9%	$ 119.85	$ 210.99	$ 324.65	50	332
Traffic calming devices	180	7	253	80.8%	$ 112.45	$ 191.69	$ 286.10	60	313

their mortgage off and owned their home free and clear. The typical home had slightly more than three bedrooms and at least two full bathrooms. The average number of operable motor vehicles was two.

The next section of the survey asked a series of questions related to household characteristics ranging from family structure to health questions (Exhibit 4). Over 80 percent of respondents were married, with 9 percent reporting that they were separated, divorced, or widowed. In terms of duration at their current residence, 23 percent of respondents reported living there for 10 or more years, while 13 percent had been living in their current residence for less than a year. The number of people living in the household was most likely four people (46 percent of respondents), but another 34 percent reported having five or more people living under the same roof. On average, 80 percent of these homes had at least two adults, with another 13 percent having only one adult. Fifty-nine percent of respondents reported having one child in elementary school, while 28 percent reported having two children in elementary school. There were 20 respondents who responded that they had no children in elementary school, possibly indicating that the child had graduated from elementary school during the course of the survey, since it was administered in the spring and the summer. These respondents were not included in the models. In terms of health, 31 percent answered that they were in excellent shape, and 91 percent reported no known medical conditions limiting their physical activity and 95 percent stated that the children living in their home also did not have any physical limitations.

MODEL RESULTS

The responses were categorized based on how many respondents chose premium bids (the maximum amount of $500), the number of valid bids (where valid bids are greater than zero), the percentage of respondents bidding on that amenity, average total amount of bids, the top half average amount of bids, the top quarter average amount of bids, the number of people who bid zero dollars (meaning they would not pay for the amenity), and the total number of bids (Exhibit 5). The two amenities with the largest number of people who did not answer were for the public plazas/squares and bus or other public transit services. Given the number of people in suburban and rural areas, driving their

EXHIBIT 6—PROBIT RESULTS: PARKS OR RECREATION AREAS

	Parks or Natural Recreation Areas		Trails or Greenways		Playgrounds		Sports Fields or Courts		Water Features	
	β	Wald	β	Wald	β	Wald	β	Wald	β	Wald
Suburban	**0.675**	**4.814**	**0.514**	**4.119**	0.012	0.079	0.262	1.874	**–0.570**	**–3.738**
Rural	**0.829**	**5.670**	**0.880**	**6.812**	**0.964**	**6.309**	0.110	0.663	–0.186	–1.211
Age of Respondent	**–0.020**	**–2.625**	*–0.018*	*–2.535*	**–0.062**	**–7.313**	**–0.041**	**–5.010**	0.000	–0.054
Male	0.159	1.469	**0.454**	**4.638**	0.017	0.132	**0.585**	**4.779**	*–0.286*	*–2.043*
White	**–0.487**	**–3.697**	–0.236	–1.802	**–0.608**	**–4.394**	–0.044	–0.263	**–0.480**	**–3.141**
Born in the U.S.	**2.273**	**8.195**	**2.862**	**9.809**	**0.728**	**2.657**	**4.175**	**10.936**	*0.687*	*2.193*
English Speaker	0.778	1.857	0.345	0.859	0.328	0.787	**–2.181**	**–3.728**	–0.296	–0.774
Married	**0.991**	**5.512**	**1.553**	**8.217**	**0.819**	**4.506**	**1.216**	**5.863**	–0.235	–1.259
Education	–0.008	–0.201	**–0.176**	**–4.990**	**0.171**	**3.267**	0.073	1.463	**0.355**	**7.155**
Number of People in Home	–0.065	–0.773	*0.161*	*2.293*	0.069	0.714	**–0.597**	**–6.129**	**0.297**	**3.012**
Number of Adults in Home	*–0.314*	*–2.398*	**–0.819**	**–5.801**	0.136	1.201	**0.457**	**3.112**	**0.481**	**4.091**
Number of Elementary School Children in Home	**–0.348**	**–4.674**	**–0.577**	**–8.253**	–0.048	–0.613	–0.011	–0.137	–0.100	–1.363
Home Owner	–0.055	–0.382	–0.025	–0.190	–0.114	–0.723	**–0.902**	**–6.071**	0.302	1.844
Number of Bedrooms	**0.494**	**6.074**	–0.141	–1.745	0.163	1.709	**0.379**	**3.471**	**0.608**	**6.071**
Number of Bathrooms	**–0.388**	**–5.228**	*–0.151*	*–2.089*	**–0.370**	**–4.573**	0.098	1.391	**–0.763**	**–8.676**
Employed	0.065	0.527	**0.449**	**3.670**	–0.209	–1.611	**–0.576**	**–4.552**	**0.377**	**2.624**
Income	*0.030*	*2.214*	*0.027*	*2.308*	*0.030*	*2.053*	0.007	0.429	**–0.136**	**–7.544**
Vehicle	*–0.200*	*–2.209*	–0.043	–0.534	**–0.331**	**–3.613**	0.035	0.383	**–0.634**	**–6.090**
Health	**0.555**	**8.195**	**0.268**	**4.148**	**0.321**	**4.106**	**0.431**	**5.249**	**0.335**	**3.862**
Adult with Disability	**–1.964**	**–8.445**	**–1.186**	**–4.868**	**–1.338**	**–5.451**	**–1.201**	**–4.626**	*0.491*	*2.178*
Child with Disability	*0.482*	*2.411*	0.228	1.018	**–1.276**	**–4.211**	**0.828**	**3.784**	**–1.871**	**–5.702**
Intercept	**–6.979**	**–8.878**	**–3.219**	**–4.653**	**–5.492**	**–5.477**	**–5.944**	**–5.887**	**–9.184**	**–9.391**

Bold = p<.01
Italics = p<.05

own vehicle is a lot more prevalent than bus or related public transit services. In terms of public plazas/squares, while some urban and suburban areas have this amenity, they are not as well-known or as prevalent as other amenities such as parks. Parks or other natural areas had the largest number of valid bids, followed by playgrounds, trails and greenways, street lighting, and sidewalks.

In terms of the premium bid, public schools had the largest number with 66 bids (19.2 percent of total valid bids), followed by parks or natural recreation areas as a distant second with 29 premium bids (7.0 percent). The large number of premium bids for public schools also was reflected in having the highest average total bids, top half average bids, and top quarter average bids. The amenity that had the highest percentage of respondents bidding on it, though, was playgrounds, followed closely by parks or natural recreation areas, street lighting, and sidewalks. These amenities received bids from at least 90 percent of respondents. The lowest average total bid was for public plazas or squares, followed by traffic calming devices, sport fields or courts, and bus or other public transit services.

EXHIBIT 7—PROBIT RESULTS: PUBLIC PLAZAS

	Public Plazas or Squares		Public Schools		Bus or Other Public Transit		Views		Bike Lanes	
	β	Wald	β	Wald	β	Wald	β	Wald	β	Wald
Suburban	–0.219	–1.020	0.035	0.237	0.471	*2.063*	–0.196	–1.415	–0.292	–1.562
Rural	*0.452*	*2.124*	**0.440**	**3.039**	**0.623**	**2.601**	*–0.376*	*–2.321*	**0.919**	**5.089**
Age of Respondent	0.014	1.451	0.013	1.755	**–0.059**	**–5.079**	0.006	0.656	**–0.032**	**–2.957**
Male	0.169	1.250	**0.873**	**7.063**	**0.720**	**4.030**	*–0.259*	*–1.999*	–0.205	–1.396
White	0.284	1.591	**0.766**	**4.879**	0.031	0.148	*0.399*	*1.982*	–0.154	–0.986
Born in the U.S.	**3.185**	**8.005**	**–1.280**	**–5.502**	*0.838*	*2.070*	**2.879**	**6.767**	**2.098**	**5.822**
English Speaker	**–3.419**	**–7.834**	0.386	1.366	0.254	0.593	**–3.017**	**–6.442**	**–1.593**	**–3.183**
Married	**–0.748**	**–3.177**	**–0.715**	**–4.552**	**0.726**	**2.761**	–0.264	–1.302	*0.496*	*2.151*
Education	*0.133*	*2.354*	–0.047	–0.957	**0.410**	**6.196**	**0.491**	**9.831**	**0.225**	**3.468**
Number of People in Home	–0.222	–1.920	**0.626**	**6.383**	**0.673**	**4.447**	**0.439**	**4.642**	**0.412**	**3.770**
Number of Adults in Home	*0.326*	*2.285*	0.177	1.469	–0.024	–0.139	**0.509**	**3.658**	**–0.763**	**–4.623**
Number of Elementary School Children in Home	**0.544**	**4.989**	**–0.242**	**–3.046**	**–1.130**	**–8.171**	**–0.297**	**–3.369**	*0.176*	*1.964*
Home Owner	*0.605*	*2.532*	–0.285	–1.785	–0.257	–1.083	*–0.341*	*–2.022*	0.330	1.494
Number of Bedrooms	0.101	0.783	–0.093	–1.022	–0.194	–1.384	**0.544**	**4.629**	**0.514**	**4.339**
Number of Bathrooms	**–0.276**	**–2.570**	**–0.461**	**–5.441**	–0.091	–0.799	**–0.347**	**–4.210**	**–0.590**	**–5.749**
Employed	**0.592**	**3.008**	0.127	1.009	**–0.498**	**–2.939**	0.174	1.222	**–0.419**	**–2.578**
Income	**–0.094**	**–4.359**	**–0.059**	**–3.624**	**–0.061**	**–2.798**	**–0.061**	**–3.341**	–0.021	–1.075
Vehicle	**0.452**	**3.982**	–0.158	–1.723	–0.124	–0.896	**–0.778**	**–6.741**	–0.058	–0.441
Health	–0.100	–1.013	–0.087	–1.145	**–0.474**	**–4.537**	**0.578**	**7.723**	**0.550**	**5.499**
Adult with Disability	**–1.977**	**–5.393**	*0.504*	*2.503*	*0.676*	*2.089*	**–0.772**	**–2.807**	–0.367	–1.351
Child with Disability	0.527	1.756	**–2.048**	**–5.229**	**–2.447**	**–5.621**	**–2.899**	**–7.499**	0.399	1.387
Intercept	**–5.853**	**–5.184**	**–3.403**	**–3.771**	**–7.279**	**–6.051**	**–12.573**	**–11.766**	**–7.907**	**–6.520**

Bold = p<.01
Italics = p<.05

Probit Models

Fifteen probit models were run to determine which variables, if any, were significant in relation to the given amenity. For these models, the Chi-Square Pearson Goodness-of-Fit tests were significant at the 0.01 level for all 15 models. For model validity, Cook's distance was less than one, indicating that there were no abundant cases that might impact the models. Other tests, including low leverage statistics, a lack of standardized residuals above two, and low DF betas reinforced the models' validity. The results of the models in Exhibits 6, 7, and 8 should be interpreted as follows: If the coefficient is positive and significant, it means that respondents with that characteristic are more likely to demonstrate a willingness to pay for that specific amenity. If the coefficient is negative and significant, it means that respondents with that characteristic are more likely to pay less for the given amenity. Given the number of models to run for willingness to pay for certain amenities, the model results will be discussed in sections of five models at a time.

For parks or natural recreation areas, people who were more willing to pay were, on average, from suburban or rural communities, born in the United States, married, and healthy. (*See* Exhibit 6.) There also is a greater likelihood that their home has more rooms. Negative

EXHIBIT 8—PROBIT RESULTS: SIDEWALKS

	Sidewalks		Street Trees		Street Lighting		Crosswalks		Traffic Calming Devices	
	β	Wald	β	Wald	β	Wald	β	Wald	β	Wald
Suburban	–0.031	–0.197	*–0.379*	*–2.471*	0.064	0.446	*–0.319*	*–2.246*	0.135	0.875
Rural	**1.245**	**8.557**	**0.522**	**3.481**	0.199	1.365	0.232	1.625	**0.463**	**2.770**
Age of Respondent	**0.024**	**2.956**	**–0.044**	**–5.254**	–0.011	–1.195	**–0.037**	**–3.999**	0.015	1.645
Male	**–0.393**	**–3.082**	**–1.201**	**–8.469**	0.026	0.204	**0.659**	**5.264**	**0.868**	**6.028**
White	*–0.376*	*–2.752*	**–0.858**	**–7.363**	**1.608**	**9.497**	**0.935**	**5.893**	**0.547**	**2.996**
Born in the U.S.	**0.942**	**2.914**	**0.988**	**3.231**	**–1.644**	**–6.707**	**–2.140**	**–8.152**	–0.027	–0.069
English Speaker	**–1.977**	**–5.580**	**–1.471**	**–4.462**	*0.733*	*2.295*	**1.799**	**5.332**	–0.432	–1.021
Married	**–0.757**	**–4.812**	0.146	0.880	–0.173	–0.955	–0.055	–0.301	*0.372*	*2.115*
Education	**0.127**	**2.757**	0.084	1.857	**0.240**	**4.769**	**0.285**	**5.389**	**0.246**	**4.467**
Number of People in Home	*0.184*	*2.120*	**0.402**	**4.971**	0.066	0.684	0.081	0.747	**–0.339**	**–2.891**
Number of Adults in Home	0.197	1.839	–0.195	–1.739	–0.198	–1.387	**–0.741**	**–5.040**	*–0.361*	*–2.525*
Number of Elementary School Children in Home	**0.198**	**2.798**	**–0.224**	**–3.036**	**0.351**	**4.624**	**0.223**	**2.766**	–0.158	–1.672
Home Owner	**–0.437**	**–3.130**	**0.542**	**4.184**	**–0.672**	**–4.805**	**–0.555**	**–3.505**	**–0.972**	**–5.746**
Number of Bedrooms	0.050	0.558	*0.221*	*2.477*	**0.498**	**5.675**	0.124	1.174	**0.331**	**3.042**
Number of Bathrooms	–0.136	–1.520	**–0.389**	**–4.491**	*–0.207*	*–2.520*	0.060	0.649	**–0.278**	**–3.260**
Employed	**0.313**	**2.642**	–0.065	–0.547	**0.470**	**3.685**	**–0.671**	**–5.403**	**–1.229**	**–9.848**
Income	0.004	0.240	**–0.049**	**–2.931**	**–0.072**	**–4.390**	**–0.060**	**–3.233**	0.022	1.393
Vehicle	–0.032	–0.342	–0.058	–0.600	0.066	0.639	**0.656**	**6.463**	**0.267**	**3.071**
Health	0.102	1.344	**0.557**	**7.128**	*–0.193*	*–2.385*	*0.196*	*2.352*	0.144	1.697
Adult with Disability	**0.589**	**3.378**	–0.141	–0.689	**0.595**	**2.842**	0.312	1.412	0.031	0.125
Child with Disability	–0.258	–1.160	**–2.696**	**–7.623**	**–2.467**	**–8.281**	**–2.789**	**–8.221**	**–2.722**	**–7.633**
Intercept	**–6.253**	**–7.241**	**–3.121**	**–3.695**	**–7.772**	**–8.102**	**–6.762**	**–6.856**	**–6.004**	**–5.410**

Bold = p<.01
Italics = p<.05

coefficients that would make a person less likely to pay for parks were being younger (age of respondent), white, having fewer elementary school children in the home, having fewer bathrooms, or being an adult with a disability that limited their physical activities. For people more willing to pay for trails or greenways, suburban or rural residents, males, and those born in the United States, married, employed, and healthy showed a greater willingness to pay. The level of education, number of adults in the home, number of elementary school children in the home, and an adult with a disability were all variables that were significant and associated with a lower probability of paying for the amenity.

Playgrounds, as an amenity, most likely meant that rural, born in the United States, married, educated, and healthy respondents would be willing to pay more for that amenity, while respondents who were younger, white, had fewer bathrooms and fewer vehicles, or were an adult or had a child with a disability were less likely to pay for playgrounds. Compared to playgrounds, sports fields or courts had many of the same significant variables, with the exception that having a child with a disability is significant and positive in this

model, perhaps having to do with the accessibility and openness of fields. A majority of the variables for water features that were significant and positive all revolved around characteristics suggestive of higher-income neighborhoods, such as higher levels of education completed, larger number of rooms, employed in a full-time job, and higher health status.

The next set of models indented correlates of WTP for public plazas, public schools, buses or other public transit, views, and bike lanes. (*See* Exhibit 7.) Public plazas had one of the lowest responses regarding a respondent's WTP. This fact is worth mentioning because any significant variables, whether positive or negative, should be interpreted with caution due to the smaller sample size. Born in the United States, and having more children in elementary school, as well as full-time employment and the number of operable vehicles were all positive, while speaking English in the home, being married, having fewer bathrooms, lower income, or being an adult with a disability indicated a lower willingness to pay for amenities.

For sidewalks, the greatest willingness to pay was by respondents located in rural areas. (*See* Exhibit 8.) Given the significant lack of sidewalks in many rural areas throughout the United States, this result is not surprising. If a person did not speak English as his or her primary language, there was a greater unwillingness to pay for that amenity. If a person was not married or was not a homeowner, then there was also a lesser likelihood to pay for sidewalks. For homes that had a child with a disability, these respondents were unwilling to pay more for everything ranging from street trees and street lighting to crosswalks and traffic calming devices. This response may indicate that, while these amenities may be used by people living in the neighborhood, it is not as important to families with a child who has a disability that prevents physical activity.

CONCLUSIONS

Across all amenities, there was a greater willingness to pay for several amenities if the respondent was born in the United States, white, married, male, and in a rural area. For six of the models, born in the United States had the highest likelihood of paying for sports fields or courts, public plazas or squares, views, trails or greenways, parks or natural recreation areas, and bike lanes. Many of the amenities with the lowest likelihood coefficients included either an adult with a disability or a child with a disability. A major contributing factor is the fact that many of these amenities may not necessarily be handicap accessible or, if the disability is significant, many of these amenities may not be accessible at all.

Neighborhood amenities that are safe, convenient and attractive can help increase physical activity and social welfare. The results provide solid evidence to develop economically feasible strategies for improving streetscapes and promoting walking that can be tailored based largely on the existing demographic in that neighborhood. The outcomes of this research can be used to support the development of planning policies and interventions to create safe and attractive environments to facilitate healthy outdoor activities for parents and their children.

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Valuation of Real Estate Market Values As an Indicator

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It was noted in 2011 by the General Accounting Office that the departments of the Central Government have limited insight into the market value of the real estate that they hold. A concrete point of criticism is that various valuation principles are used, so that a unified vision is lacking.[1] Diverse authors[2] assume that the *Waardering Onroerende Zaken* (Valuation of Real Property; WOZ) value can be indicative of the market value. If this research confirms this assumption, the recommendations of the General Accounting Office, among others, can be met relatively simply and at quite low costs for a large part of the buildings. In the reverse, the research prevents the improvident use of WOZ values. Knowing that there are multiple initiatives for utilizing the WOZ value makes this very relevant socially. In this context, thought must be given to use for the purpose of the housing valuation system.

That the quality of WOZ valuations is not always a given may be concluded from research by Bekkers.[3] The estimated value of non-homes shows in some municipalities striking value jumps per year, sometimes of "tens of percentage points."[4] Despite the relevance of the subject, there currently, however, is a lack of unambiguous evidence-based research in the literature. The available research also is not completely representative for the portfolio of the Central Government Real Estate Agency (RVB). The existing research is primarily focused on homes and commercial real estate. It can be noted that there is a connection between the currency of the real estate and the quality of the WOZ valuation. De Vries and others[5] come to the conclusion on the grounds of 227,500 Overijssel private homes, for example, that the average WOZ value and the average market prices "are reasonably related to each other." For more expensive homes, this relationship is "not yet reasonable." Hooijmaijers[6] and De Roo[7] confirm the relevance of currency by stating that the WOZ values of promising offices at a good location are a good reflection of the investment value. The WOZ value for less-promising offices is structurally too high. The aforementioned research of Tjeerdsma comes to the conclusion for social real estate that a higher value is assigned to the objects in the transaction than is established in the associated WOZ values. The exception to his research is real estate for the purpose of utilities, culture, and special living functions. The most recent research in particular gives direction to the expected outcomes from this research, with the understanding that a municipal real estate portfolio has a different composition than that of the Central Government. Based on Tjeerdsma, one has to wonder to what extent it is valid and reliable to utilize the WOZ value as a market value indicator for the purpose of the Central Government's real estate portfolio.

DEFINITIONS

The definition of *market value* was adopted in 2011 by the Property Assessment Board from the market value standard of the *International Valuation Standards* (IVS) and translated from the *Red Book* of the RICS[8]: "The estimated amount on the valuation date for which an object would be transferred between a willing

buyer and a willing seller after proper marketing in a commercial transaction, whereby the parties would have acted with full knowledge, prudently and not under duress." The description given here of the definition for *market value* also applies as the main theme for the WOZ valuation.[9] The definition of WOZ value is not further defined in the WOZ Act. The main rule is that the market value (WOZ WEV) is determinative, unless the corrected replacement value (GVW) leads to a higher value. Homes and national monuments always must be valuated at market value and no corrected replacement value method may be used.

The relationship between the two elements described above forms the core of this research and will be considered as follows: If there is a high degree of accuracy in the estimate of the WOZ value, this variable can serve as a more optimal estimate of the market value. The cohesion can be modeled as follows:

Cohesion of realized transaction price & WOZ value = (corrected for the value development) transaction price / WOZ value (1).

On the grounds of the applicable insights from the theory, it may be expected that in a majority of cases, the WOZ value of real property corresponds with the real market value and/or transaction price. The cohesion is then equal to 1, after any correction of the realized transaction price for the difference between the price determination date and the transaction date, and as long as all personal and commercial rights are held by one party and the WOZ factors have no effect.

In line with this, it is noted that the only exception to this statement arises in the event that there are insufficient comparable market references available. In this case, the GVW method would have to be applied, according to the General Valuation Guide and the Valuation Instruction. In contrast with the other valuation methods (model-based comparison, rent value capitalization and corrected replacement value), it is not the value but the "worth concept" that is central here.

The relative non-currency of the underlying real estate would then lead to greater deviation between the WOZ and the market value. Before beginning to test these assumptions, the methodology will first be explained.

DATA AND METHODOLOGY

This research focuses primarily on the WOZ values of non-exempted built objects in the real estate portfolio of the Central Government and the market value thereof. The data file consists of realized, transaction figures according to WOZ (market value) with the associated WOZ values in the year of the transaction. These are the transaction figures from the real estate sold by the Central Government Real Estate Agency in the period of January 1, 2010 through December 31, 2015. Earlier data are unfortunately not complete enough. The RVB is, by its own statement, responsible for the management and maintenance of the largest and most diverse real estate portfolio in the Netherlands. Given the outcomes from existing research, the most typical real estate classes were chosen, to wit, the offices, court buildings, monumental buildings, homes, defense complexes, prisons, and other related real estate in the Central Government's real estate portfolio.[10] The data include locations throughout the Netherlands.

Due to the requirements that are set for the alienation of excess Central Government real estate,[11] it is plausible to assume that the realized transaction prices from the data set are a realistic reflection of the defined market value as described in the IVS. For all transactions, it can be excluded that the WOZ value has any influence on the created and ultimately realized transaction price in any way. Pure investment transactions in which multiple objects are sold in one transaction are considered as non-conforming to WOZ and held out of the data set.

In order to make the transaction prices more comparable with the established WOZ values, a number of corrections are made. When doubt has arisen about the market conformity in the exceptional cases where there is a (partial) use by third parties, these transactions are removed from the database in accordance with the valuation guide *Huurwaardekapitalisatie*.[12] The transactions that ultimately are included in the dataset therefore connect well with the factors that apply in the context of the WOZ Act, so that a realistic comparison is possible.

The WOZ value for which a fixed price determination date applies is corrected, by means of indexing based on the pricing index for existing homes (PBK) of the CBS and the Cadastre, for the influence of the value development in the housing market during the period between the price determination date and the transaction date. For the non-homes, use is made for this of the national sales price development for offices and commercial spaces Midas, the market information database of the Dutch Association of Realtors. In contrast to the PBK, there is no valid pricing index for commercial real estate. The non-indexed

transaction figures are therefore involved in the analysis in the research for both the homes and the non-homes.

To keep the research pure, the transaction prices are compared with the established WOZ values that are not influenced by an objection. After all, it is not useful to use a WOZ value as a market value indicator when an objection first has to be filed against it before it becomes applicable. That compromises the currency. In the research, the choice is made to test the reliability of the WOZ values at two different moments: (1) on the date that an object/complex is declared excess, and (2) on the recording date, the date that the object is actually transferred by the notary. The results will be presented as much as possible for both moments.[13]

Given that valuation always happens under conditions of uncertainty, the permissible average absolute margin of deviation must be determined. Noting the lower degree of difficulty for the value determination of homes and the market's own margin of deviation, the choice is made in the research for a permissible absolute margin of deviation of 12.5 percent. If the (corrected) transaction price seen absolutely for the homes differs by more than 12.5 percent from the established WOZ value, then this will be considered as an outlier. For non-homes, given the higher degree of difficulty, this is set to 20 percent.

First, ratios are used to make the relationship between WOZ values and transaction prices clear. For the purpose of a valid and reliable way of distinguishing between coincidence and causality, the cohesion between the two statistics is tested with the help of the correlation coefficient. In the ideal case, the market value (= transaction price) and the WOZ value will be equal to each other. The correlation coefficient (r) is then equal to 1. By means of the paired t-test, it will be investigated whether there is a significant difference between the variables. The t-value is a test statistic in units of standard error, which shows the reliability of the estimate of one individual coefficient and the expectation that this coefficient is not equal to 0. The t-value determines to what extent the relevant independent variable significantly adds something to the explanation of the dependent variable. For the benefit of the final regression analysis, dummy variables are created for a number of nominal variables.

DESCRIPTIVE STATISTICS

The database ultimately includes 115 market-conforming transactions. The dataset is divided into eight groups. The categories of homes and "monumental building sand complexes" are relatively over-represented, with 31 percent and 30 percent respectively. Analysis of the valuation method chosen by the municipality on the recording date shows that for 28 objects/complexes from the dataset, use is made of the corrected replacement value (GVW).

On the basis of a basic comparison between the current WOZ value in the year of designation as excess and the corrected transaction price split out into the total dataset, as well as into non-homes and homes, it must be noted that the sum of the established WOZ values in all cases lies higher than the sum of the realized transaction figures. According to the expectation, the average of the (corrected) transaction prices on the recording date (n=31) and the average WOZ values differ the least from each other for homes.

In the research, as previously described, the following comparison stands for the cohesion between the transaction price (equal to the market value) and the WOZ value is central: Cohesion of WOZ value and realized transaction price = (corrected for the value development) transaction price/WOZ value. The outcomes from this comparison are shown in Exhibit 1.

The average ratio for the total dataset (homes and non-homes) on the recording date (n=115) is 0.93. This lies well within the established range. The skew of the distribution of all ratios, however, makes it premature to assume that the WOZ value is a realistic reflection of the market value. Of all the ratios, 65 percent are under 1 and 35 percent over 1; there are no ratios equal to 1. If the test statistic is smaller than 1, then the transaction price is lower than the WOZ value. If it is larger than 1, the transaction price is higher than the WOZ value. In five cases, the transaction prices realized on the recording date are more than twice as high as the WOZ values. The largest number of ratios is located in the range between 0.40 and 1.60.

The ratios on the excess designation date show a range of 0.58–0.82. It can be derived from this that the sum of the established WOZ values in all cases lies higher than the sum of the transaction prices. Looking at the averages of the ratios that lie in the range of 0.85–1.07, it could be concluded that there is a relatively robust cohesion. However, there also is a relatively large spread here of the ratios between 0.00 and 5.45, so that this conclusion may not be drawn without reservations. The smallest spread in the ratios is seen on the date of excess designation, without the transaction figures being corrected for the difference between the transaction date and the price determination date.

EXHIBIT 1—RATIOS ON DATE OF DESIGNATION AS EXCESS AND THE RECORDING DATE FOR THE WHOLE DATASET (HOMES AND NON-HOMES)

Ratios on the date of designation as excess	
Ratio (sum of transaction value / sum of WOZ value)	0.58
Ratio of transaction value / WOZ value	
Average	0.85
Min	0.00
Max	3.91

Ratios on recording date	
Ratio (sum of transaction value / sum of WOZ value)	0.64
Ratio of transaction value / WOZ value	
Average	0.93
Min	0.00
Max	4.11

Ratios on date of designation as excess (corrected transaction price)	
Ratio (sum of corrected transaction value / sum of WOZ value)	0.82
Ratio of transaction value / WOZ value	
Average	1.07
Min	0.00
Max	5.45

Ratios on recording date (corrected transaction price)	
Ratio (sum of corrected transaction value / sum of WOZ value)	0.71
Ratio of transaction value / WOZ value	
Average	1.01
Min	0.00
Max	5.06

Exhibit 2 shows the number of (corrected) transaction figures that do or do not fall within the established ranges on the recording date (n=115) and on the date of designation as excess (n=108) for the total dataset. In addition, on the basis of the valuation method chosen by the municipalities, current (n=87) and non-current (n=28) objects are split out. In the case of the homes in the dataset, we consider the (corrected) transaction prices that fall in a range of 0.875–1.125 (+/– 12.5 percent) of the WOZ values as normal, and for the non-homes, if the (corrected) transaction prices lie in a range of 0.80–1.20. Of the total dataset (homes and non-homes), just 33 percent of the transaction figures fall in the established range on the recording date. In all other cases, these percentages for the total dataset are lower. What can further be derived from the analyses is that it is not the object group of homes but the object groups of other, office, monumental building/complex and court buildings that fall relatively more often within the established range. On the date of excess designation with corrected transaction figures, 21 percent of the transactions in the total dataset fall within the ranges, and 79 percent lie outside the established ranges.

It appears from Exhibit 2 that on the basis of the valuation by means of the GVW, about 25 percent of the objects in the dataset are considered by the municipalities as non-current. The statement is confirmed that objects considered as current in all cases more often fall within the range than objects considered as non-current. This also applies for the non-corrected transaction figures, which more often fall within the range than the transaction figures that are corrected with the help of pricing indexes for the time lapse between the price determination date and the transaction date.

In Exhibit 3, a split is made by object group on the recording date (n=115). The transaction prices in this analysis are not corrected for the time between the price determination date and the transaction date. It can be derived from Exhibit 3 that proportionately, it is not the object group of homes but the object groups of other, office, monumental building/complex and court buildings that score better. That is to say, these object groups more often fall within the established ranges than the homes. Even when the transaction figures are indexed to the price determination date, the outcomes remain nearly the same.

The outcomes in Exhibit 4 show that with the analyses with the paired t-test at both testing moments, there is a significant difference (average difference) between the (corrected) transaction prices and the WOZ values. The outcomes in Exhibit 4 show that if the extreme scores (the realized (corrected) transaction price differs more than 100 percent from the WOZ value) with a ratio ((corrected) transaction price/WOZ value) > 2.00 are removed from the dataset, there is in all cases a significant difference between the (corrected) transaction prices and the WOZ values on the recording date and the date of designation as excess. The

EXHIBIT 2—(CORRECTED) TRANSACTION PRICES IN THE ESTABLISHED RANGES RELATIVE TO WOZ VALUES YES/NO

	Entire dataset		Current objects		Non-curr. objects	
Transaction price within range on recording date	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	38	33%	31	36%	7	25%
No	77	67%	56	64%	21	75%
Total number of objects	115	100%	87	100%	28	100%
Corrected transaction price within range on recording date	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	34	30%	29	33%	5	18%
No	81	70%	58	67%	23	82%
Total number of objects	115	100%	87	100%	28	100%
Transaction price within range on excess designation date	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	32	30%	29	36%	3	11%
No	76	70%	52	64%	24	89%
Total number of objects	108	100%	81	100%	27	100%
Corrected transaction price within range on excess designation date	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	23	21%	20	25%	3	11%
No	85	79%	61	75%	24	89%
Total number of objects	108	100%	81	100%	27	100%

chance of coincidentally finding differences (average difference) between the (corrected) transaction prices and the WOZ values is in all cases less than 5 percent. For the total dataset on the recording date for non-corrected transaction figures, these are 5 extreme scores with a ratio > 2.00. On the date of excess designation, there are also 5 scores with a ratio > 2.00. In both cases, these are 4 non-homes and 1 home that are removed from the total dataset (homes and non-homes). When the paired t-test is done for the total dataset without removal of the extreme scores, there is no significant difference except for with homes.

Finally, the total dataset is tested by means of regression analysis. This is to determine what the influence is of the directional region (North & East, West, South), the valuation method (comparison method (VM), rent value capitalization (HWK), corrected replacement value (GVW)) and the object group (home, office, other) on the absolute differences between the transaction prices and the WOZ values ((corrected) transaction price/WOZ value (- 1)).

The questions that are answered by means of the t-value are whether there is cohesion of the individual characteristics, the directional region, the valuation method and/or the object group with the (absolute) differences between the (corrected) transaction prices and the WOZ values ((corrected) transaction price/WOZ value (- 1)). The independent variable, the absolute difference ((corrected) transaction price/WOZ value (- 1)), has a ratio measurement level. The independent variables, the directional region, the valuation method and the object group, have a nominal measurement level. For these variables, dummy variables are created. For the analysis, the objects are divided into groups: homes, offices, and other. The extremes in the dataset are not included in the analysis. All ratios ((corrected) transaction price/WOZ value) are used that lie in a range of

EXHIBIT 3—NUMBER OF TRANSACTION PRICES IN THE ESTABLISHED RANGES RELATIVE TO THE WOZ VALUES SPLIT OUT BY OBJECT GROUP

Object group	Number	Number of transaction prices within the range on the recording date	Number of transaction prices in the range as a percentage of the total dataset on the recording date	Number of transaction prices not within the range on the recording date	Number of transaction prices not in the range as a percentage of the total on the recording date
Home	31	9	29.03%	22	70.97%
Commercial space, storage, distribution	14	3	21.43%	11	78.57%
Defence	7	2	28.57%	5	71.43%
Court building	3	1	33.33%	2	66.67%
Prison	6	0	0.00%	6	100.00%
Office	21	10	47.62%	11	52.38%
Monumental building/ complex	30	11	36.67%	19	63.33%
Other	3	2	66.67%	1	33.33%
Total	115	38		77	

EXHIBIT 4–SUMMARY OF OUTCOMES FOR PAIRED T-TESTS FOR (CORRECTED) TRANSACTION PRICES AND WOZ VALUES (FOR RATIOS IN THE RANGE 0 – 2)

Variables (ratio between 0 and 2)	t-value entire dataset	n	sig. (2-tailed)	t-value non-homes	n	sig. (2-tailed)	t-value homes	n	sig. (2-tailed)
transaction price – current WOZ value in the year of the recording date	–2.8077	110	0.0059	–2.8064	80	0.0063	–4.8219	30	0.0000
corrected transaction price / current WOZ value in the year of the recording date - current WOZ value in the year of the recording date	–2.6416	109	0.0095	–2.6385	79	0.0100	–4.2681	30	0.0002
transaction price - current WOZ value in the year of the excess designation	–3.2762	103	0.0014	–3.2941	75	0.0015	–5.6262	28	0.0000
corrected transaction price / current WOZ value in the year of the excess designation - current WOZ value in the year of the excess designation	–2.8344	100	0.0056	–2.8393	72	0.0059	–4.6869	28	0.0001

0–2. The outcomes of the regression analyses are shown in Exhibit 5.

From the comparison between the valuation method,VM, HWK with the GVW (omitted category), it can be derived that the (absolute) differences between the (corrected) transaction prices on the recording date and the date of excess declaration and the WOZ values are proportionately smaller when the VM or the HWK method is used. In all cases, these differ significantly from 0, with a reliability of 95 percent. The chance that this is coincidence is negligible in all cases, given the extremely low p-values. The t-values are in all cases larger than 1.96.

From the comparison of the object groups office and other with the object group homes (omitted category),

EXHIBIT 5—SUMMARY OF OUTCOMES OF REGRESSION ANALYSES FOR THE INFLUENCE OF THE CHARACTERISTICS OF DIRECTIONAL REGION, VALUATION METHOD AND OBJECT GROUP ON THE ABSOLUTE DIFFERENCE BETWEEN THE TRANSACTION PRICES AND THE WOZ VALUES (FOR RATIOS IN THE RANGE 0–2)

(Variables) Whole dataset, ratios between 0 and 2, absolute difference of transaction price – current WOZ value in the year of the recording date (n = 110)	South	West	VM	HWK	Office	Other
coef.	0.2266322	0.1223669	–0.2946334	–0.2517595	0.0737479	0.1369003
t-value	3.45	2.09	–4.38	–4.16	0.94	2.22
sig. (2-tailed)	0.001	0.039	0.000	0.000	0.348	0.029
(Variables) Whole dataset, ratios between 0 and 2, absolute difference of corrected transaction price / current WOZ value in the year of the recording date - current WOZ value in the year of the recording date (n = 109)	South	West	VM	HWK	Office	Other
coef.	0.2534257	0.1568537	–0.3090154	–0.0202527	0.1153687	0.1838705
t-value	4.02	2.77	–4.62	–3.35	1.53	3.09
sig. (2-tailed)	0.000	0.007	0.000	0.001	0.128	0.003
(Variables) Whole dataset, ratios between 0 and 2, absolute difference of transaction price - current WOZ value in the year of the excess declaration (n = 103)	South	West	VM	HWK	Office	Other
coef.	0.1569995	0.0306006	–0.3001893	–0.2720834	0.1562462	0.0962994
t-value	2.22	0.50	–4.47	–4.50	1.96	1.52
sig. (2-tailed)	0.029	0.615	0.000	0.000	0.053	0.131
(Variables) Whole dataset, ratios between 0 and 2, absolute difference of corrected transaction price/current WOZ value in the year of the excess declaration - current WOZ value in the year of the excess declaration (n = 100)	South	West	VM	HWK	Office	Other
coef.	0.1731589	0.1082905	–0.2927537	–0.1439637	0.1843114	0.194944
t-value	2.53	1.84	–4.31	–2.33	2.48	3.27
sig. (2-tailed)	0.013	0.069	0.000	0.022	0.015	0.001

it can be derived that for both the object group of offices and the object group of other, the (absolute) differences between the (corrected) transaction prices on the recording date and the date of excess declaration and the WOZ values are proportionately larger than for the object group homes. For the object group offices, these differences from the object group homes are not significant in the majority of the cases, only on the date of excess declaration when using corrected transaction prices are these significant for the object group of offices. In all other cases, the chance of coincidence is too great. For the object group of other, by contrast, the difference from the object group of homes is significant in the majority of the cases. Only on the date of excess declaration and when non-corrected transaction prices are used is the difference not significant, given that the t-value here is 1.52.

CONCLUSION

Based on the empirical analyses from this research, it must be concluded that the WOZ value is not a valid and reliable market value indicator for the real estate portfolios managed by the Central Government. Strikingly enough, this also applies for the object group of homes, despite the relative

abundance of reference values. It appears that the model-based valuation includes too few object characteristic, such as the relevant zoning of an object.

In addition, it is empirically demonstrated that WOZ values that are created with the help of the GVW method in general differ more from the real market value. That seems plausible, given the more limited amount of available market information. It also is apparent from this research, however, that the method is used in a limited number of cases where this is not permitted. A WOZ object that is considered as a national monument must be valuated at market value. In all other cases, that is to say the buildings/complexes for which no corrected replacement value method is used on the grounds of the WOZ Act and where the WOZ value and the value based on the WOZ Act and the market value definition from the IVS should be the same. The statistical analyses show little cohesion between the WOZ values and the transaction prices. This is confirmed by the correlation analyses.

In addition, it is striking that the transaction figures that are not corrected for the time between the price determination date and the transfer date, both at the time of the excess declaration and at the time of recording show more cohesion with the WOZ values than the corrected transaction figures. This means that the Central Government's objects for sale are probably less sensitive in the shorter term to market fluctuations. Whatever the reason, it must be concluded that the indexing of transaction figures must be done with extreme care, particularly for objects such as those of the Central Government Real Estate Agency.

The picture matches in a certain sense existing research results. The conclusions from the research of Tjeerdsma that the market assigns more value to the objects than is established in the WOZ values fully context with the outcomes of this research. An essential difference is that in contrast with social real estate at the municipal level, the market rather assigns *less* value to the (social) real estate of the Central Government than is established in the WOZ value.

The observations of De Roo: that (a) WOZ valuators do not or do not fully work from market transactions,[14] and therefore (b) offices in less promising locations are usually valuated higher than the realized transaction price (market price) justifies can be supported with this research. It is noted that when an objection is signed against the established WOZ value of an object, the WOZ after objection usually is established in line with the realized transaction price. This conclusion also applies for objects for which the corrected replacement value is used. This connects with the observation of Scholte Lubberink,[15] that supporting the WOZ values with market transactions from outside the municipal boundaries always gives more reliable results than calculating WOZ values on the basis of standardized figures from the valuation guide for rent value capitalization.

DISCUSSION

Despite the WOZ Act and the associated regulations and jurisprudence, there is still too much room for differences in interpretation. The pivot point between using the market value and the corrected replacement value remains a grey area. In particular at the time of designation as excess, it appears relevant to assess whether the corrected replacement value is the most valid valuation method. The economic write-off established by the owner upon designation as excess usually justifies a high functional write-off.

In some cases, there seems to be a lack of ability or a lack of will with municipalities. Despite the availability of reference files, deviating WOZ values are still regularly established. Why is little or no use made for non-homes of the direct comparison method or at whether the GVW method is used inappropriately?

In addition, it stood out when compiling the dataset that municipalities did not send a number of WOZ determinations until well into the tax year, or even after the tax year had passed. For a current market value indicator, this is not optimal.

The last recommendation lies in the relatively low implementation costs, which make it impossible to meet the IVS standard. The Property Assessment Board and the VNG might be able to contribute to changing this, so that the quality of the implementation of the WOZ Act can be further improved.

NOTES

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Impact of 2017 Tax Act on Real Estate—Key Issues

By Dr. Mark Lee Levine and Dr. Libbi Levine Segev

AU: Please supply author bio.

The Tax Cuts and Jobs Act of 2017 (2017 Act) was passed by Congress in late December 2017 and signed by President Trump on December 22, 2017. Thus, there is a new Act, HR 1, that provides for many changes to the federal income tax law, most of which apply starting in 2018. Generally, unless otherwise indicated, most of the rules noted below sunset or end after 2025. See below for some of the exceptions to this general rule.

The 2017 Act contains important tax changes that impact real estate. Some of the more important provisions of this new act are *summarized*, below.

Given the haste in which the 2017 Act was processed, reviewed, discussed, amended, and voted on in both the House and the Senate, coupled with the reconciliation that was necessary as between the House and the Senate prior to final voting on the same by Congress, there are many issues that will require further refinement to understand the idiosyncrasies within the new 2017 Act. Nevertheless, there are many changes in this act that are important to taxpayers in general and to real estate practitioners and investors on the specific tax issues related to real estate.

An examination of some of these issues follows. For more detail, see the Internal Revenue Code (IRC) and the other authorities cited.[1]

TAX RATES

One of the most discussed issues when the 2017 proposed Tax changes were being considered were the rates that would be applicable to individuals and entities. The 2017 Act, as finalized, allows for a number of brackets (rates).[2]

Under the new rules for individuals, there are seven brackets. For those filing a single return, making under $9,525, the rate on taxable income is 10 percent. However, the big change for individuals as to rates/brackets is the reduced rate for the top level of 37 percent for those having taxable income over $500,000. This is not a huge savings for those in the top bracket; but, there are some savings.

For those filing joint returns, the 10 percent rate applies for a taxable income amount of under $19,050. The highest rate, the 37 percent rate noted above, applies for those with taxable income over $600,000.

Tax rates applicable to corporations were an important topic in the discussion surrounding the 2017 Act. The argument by the Trump Administration and others was that the United States is not competitive with other nations, given the very high corporate tax rates. Congress addressed this issue in the 2017 Act by reducing the highest corporate rate to 21 percent starting in 2018!

STANDARD DEDUCTION

To eliminate the need for most taxpayers to have to keep track of deductible expenses that were allowable for itemized deductions under the prior law, the new 2017 Act increased the standard deduction.[3] The impact of this type of change eases the burden on taxpayers. The new standard deduction starting in 2018 for individuals is $12,000; and the deduction for a married couple, filing a joint return, is

$24,000. This standard deduction is indexed[4] to increase for the coming years.

EXEMPTION

Another approach to simplifying the tax law is to simply take away deductions! This approach is exactly what Congress and the President undertook as to exemptions. That is, although the exemption for 2017 was $4,150 per person, that exemption was suspended under the 2017 Act.[5] Thus, there is no exemption for 2018. The argument in part is that this exemption can and should be repealed (suspended), since the standard deduction was increased to a level to account, in part, for the loss of the exemption.

INTEREST DEDUCTION—MORTGAGES, ETC.

One of the more important deductions that the tax law has allowed for many years under IRC § 163 is the deductions for interest paid on the notes/mortgages to acquire the taxpayers' principal residence and/or a secondary residence.

There has been a good deal of discussion for many years as to whether such a deduction should or should not exist.[6] One argument in favor of the deduction is that it supports home-ownership, a social goal that has been thought to be a positive position in US society. A counter to this position is the argument that renters should not be penalized because they do not own their residences.

Although the deduction for such personal (not business) interest has been allowed for many years,[7] Congress chose to reduce the level at which such deductions could be allowed. Congress limited the deduction to the interest on mortgages of $1,000,000 or less.

Following the passage of the 2017 Act, Congress further limited the base to calculate the interest deduction by reducing the mortgage base of the debt that is employed to acquire the acquisition debt to a maximum of $750,000.[8] Effectively, what Congress did is allow the continued deduction (if itemizing) for interest, but it imposed a ceiling on such deduction by limiting the debt on which the interest deduction is calculated. This ratcheting down of the qualified debt is exactly what many in Congress, tax practitioners, Realtors, and others argued would happen if Congress placed a limit on the amount of the mortgage that could be obtained when computing the interest deduction. Thus, in place of an immediate repeal of the interest deduction, this reduction in the debt allowed for the interest calculation has the effect of reducing the interest deduction. Thus, this approach was a compromise. The 2017 Act did not repeal the IRC § 163 interest deduction for the home, but it did reduce the amount of such deduction for many taxpayers who will seek new loans in 2018[9] for the purchase of a residence. There are provisions in the 2017 Act to allow taxpayers to refinance an existing loan that exceeds the $750,000 amount, but which are less than 1 million.[10]

Congress also eliminated the $100,000 home equity loan rule that allowed for a taxpayer to claim interest deductions on a base of up to $100,000.[11] Effectively, what Congress did with these interest deductions on the home loan is to tighten the requirements and reduce the effective base to allow for the interest deduction.

Although Business interest is not subject to the above rules limiting the deduction of interest, the 2017 Act limited some deductions of interest connected with businesses. Under the 2017 Act, Net interest as a deduction[12] is limited to 30 percent of the earnings as calculated before deducting for interest, depreciation, taxes and amortization, among other items. The good news is that smaller businesses, defined as ones under 25 million, are not subject to this limitation.

If one is subject to this limit, the deduction that was denied can be carried forward, indefinitely. Real estate and farm businesses can choose to not be subject to this interest limitation rule.

These rules have different effective dates and transitional rules. Thus, a review of the specific rule is needed.

PASS-THROUGH ENTITIES WITH GAINS

Where there is an LLC, partnership, or certain other types of pass-through entities, the owners of such businesses must pick up the income on their returns. However, the 2017 Act allows for another deduction to such owners, if qualified. In essence the owners might qualify to claim a 20 percent deduction from AGI for qualified business income. There are limits on how much can be deducted, many of the limits being tied to wages.

EXPENSING OF CAPITAL EXPENDITURES AND USE OF COST RECOVERY

IRC § 179

This rule has existed for many years. It has allowed a qualified taxpayer, with qualified property, to currently deduct the cost of certain property. This rule, immediately prior to the 2017

Act, allowed taxpayers to deduct up to $500,000 of acquired qualified property as opposed to being required to apply cost recovery to the property over a given number of years.

This rule was enhanced by the 2017 Act. IRC § 179 under the 2017 Act allows for taxpayers to deduct, currently, for qualified property, up to $1 million of property that was acquired and placed in service under the 2017 Act.

The phasing out of such property deductions was increased to $2.5 million. Thus, the $1 million is reduced to the extent the property placed in service was over $2.5 million. If the $2.5 million amount is not exceeded, there is no reduction. Thus for example, a taxpayer might place in service $800,000 worth of qualified property and deduct the whole amount under IRC § 179. Most of the property coming within IRC § 179 is non-residential trade or business personal property, not real estate. (There are exceptions where qualified retail, residential, and leasehold improvements may fall within IRC § 179. Further, some other areas for fire protection and air conditioning and roof work may fall within this Section.)

There are other limitations as to IRC § 179, for example, use of autos for business.[13]

IRC § 168—Other Expensing

Under an additional rule, beyond IRC § 179, there is another possible, immediate write-off allowed for taxpayers.[14] Although taxpayers in business generally have recovered, for tax purposes, their investments via depreciation or cost recovery, the 2017 Act allows for more expedited recovery of such expenditures, from a tax standpoint.

Under the 2017 Act, some types of capital expenditures for property can be subject to an immediate 100 percent deduction. This is for qualified new and used property acquired by the taxpayer for the taxpayer's business use. This generally has an effective date for such property placed in service after September 27, 2017.

This Bonus write-off moves this approach far beyond the rule that existed prior to the 2017 Act. (Under the prior rule, the deduction, the bonus depreciation was generally 50 percent of the basis of the property. But, this new rule, for qualified property and taxpayers, allows for a 100 percent deduction. This bonus percentage is reduced in future years.)

Qualified Improvement Property and Depreciation

Qualified Improvement Property (QIP) under the 2017 Act generally includes property acquired after December 31, 2017 and is the grouping of property that is retail improvements, restaurant improvements, and leasehold improvements. This type of property generally can be depreciated over 15 years, straight line, as opposed to the normal 39 year life for commercial real property.

REHABILITATION CREDIT

The IRC, prior to the 2017 Act, allowed for a credit when qualified rehabilitation work was undertaken on either older structures (prior to 1936) or a certified historic property.

Under the 2017 Act, the credit for the older structures, allowing a possible 10 percent credit, was repealed. This generally applies for the credit for years after 2017; however, Congress did allow for transition on this point, allowing the credit for those that could meet the transitional rules to show that the project was underway in 2017.[15] This favorable rule was generated after the efforts of many commercial Realtors that worked with Congress.

The certified historic credit of 20 percent continues under the 2017 Act, so long as the taxpayer meets the requirements of the IRC.[16] Taxpayers claim the credit over a five year period.

IRC § 1031: REAL AND PERSONAL PROPERTY EXCHANGES

IRC § 1031 has existed for many years.[17] Members of Congress have raised the specter of a possible repeal of IRC § 1031 for many years. There have been positions asserted that this law favors the postponement of taxes—with little justification for such tax benefit. Although this issue supporting repeal has been successfully opposed by many groups, such as the National Association of Realtors, the CCIM and SIOR organizations, etc., it appears that there was strong support in Congress in 2017 for a repeal of Section 1031. However, ultimately, the Members of Congress concluded that Section 1031 would not be repealed **as for real estate**. However, the 2017 Act did repeal the rule for all property, other than real estate. Thus, one cannot, with some transitional rules in place, defer the gain on the exchange, for example, of tangible personal property used in the trade or business for other such qualified tangible personal property. Under the 2017 Act, such non-real estate is disqualified under Section 1031 from the tax deferral benefits.

Certainly, real estate people should be concerned with the possibility that Congress may choose, in coming years, to

also eliminate Section 1031 exchanges as to real property. However, for now, Section 1031 continues to apply to real estate that meets the requirements of Section 1031.[18]

CARRIED INTEREST

In some instances, taxpayers have received an interest in a given project that they directed. In such cases, the taxpayer often claimed that any gain from the disposition of the interest was subject to being taxed as long-term capital gain.

The 2017 Act addressed this issue by holding that if the interest might otherwise be qualified for long term capital gains, such interest would not be taxed as long term capital gain unless the interest was held for a minimum of three years.[19]

ALTERNATIVE MINIMUM TAX

Ever since the passage of the Alternative Minimum Tax (AMT), there have been many arguments as to why such a tax should not exist. The arguments include the position that the AMT is not needed as we have a regular income tax; it is unfair to create an additional burden on taxpayers that already complied with the regular tax rules; and the intent when first passing the AMT was to impact, if at all, only those taxpayers in the "higher" income levels. However, the AMT impacted a much larger group of taxpayers than members of Congress anticipated. Thus, the approach that was talked about, prior to the passage of the 2017 Act, was to simply repeal AMT. It appeared that there was strong support for such repeal. However, when the Conference Committee finalized the position for the 2017 Act, AMT was not repealed. Rather, the 2017Act retained AMT, but increased the exemptions, thus attempting to address the prior complaints that many in the "middle class" needed relief from AMT.

What the 2017 Act does is increase the exemption to $109,400 for those taxpayers filing a joint return, and increased the exemption for the single taxpayer/filer to $70,300. Thus, this means that most taxpayers will not have to be concerned with AMT, especially since the exemption is now not subject to being lost or phased-out, unless the taxpayer has a very high taxable amount under AMT.

It appeared, from this approach to AMT, that although Congress could have simplified this area of the tax law by repealing AMT, Congress chose to keep the law and insulate most taxpayers from the AMT by allowing for higher exemptions. (Such an approach also allowed members of Congress to argue that the AMT position can still tax the "higher" earning taxpayers, *i.e.*, the "rich people.")

Although the individual AMT was not repealed, Congress did repeal AMT for corporations.[20] This is effective in 2018. Consistent with the tax rate ceiling of 21 percent, noted above for corporations, such change, it is argued, will make US corporations more competitive and more likely to want to undertake more business within the United States.

NET OPERATING LOSSES

The deduction of net operating losses (NOL) generally has been allowed for businesses for many years. The 2017 Act continues to allow businesses that had a NOL to use it for years when there is a gain by the entity. Prior NOL rules allowed the business to carryback the loss (filing amended returns) or carrying the loss forward. Under the 2017 Act, these losses generally only will be carried forward. There is a perpetual carryforward and the amount of the NOL to be used each year is limited to 80 percent of the taxable income for the year in question.

PASSTHROUGH OF LOSSES

Starting in 2018, if there are pass-through losses from a business, there is a limit of how much of the pass-through loss can be used in the given year. The losses that cannot be deducted currently generally are carried forward as a NOL. (These rules also must be coordinated with the passive loss limitations rules under IRC § 469.[21] A discussion of the passive loss rules is outside the scope of this article.)

CHARITABLE DEDUCTION

There was talk that maybe Congress should repeal the IRC § 170 deduction, which allows taxpayers to deduct qualified contributions to qualified charitable recipients. Of course, this deduction applies only if the taxpayer itemizes deductions and does not claim the standard deduction. (There were some prior proposals to allow the use of the standard deduction AND to also claim a charitable deduction; however, such proposals were not part of the 2017 Act that was passed.) What members of Congress chose to do in the charitable area was to allow the continued use of a charitable itemized deduction, assuming it was otherwise qualified under Section 170. Further, Congress also changed the rules in this area to allow for an even greater deductible charitable contribution.[22] That is, the limit for the year as to a qualified deduction to charity as an itemized deduction generally was 50 percent of the adjusted gross income

(AGI) of the taxpayer. Under the 2017 Act, Congress raised this limit by allowing such deductions, annually, to up to 60 percent of AGI.[23]

DEDUCTION FOR STATE AND LOCAL TAXES

If the taxpayer itemizes deductions, the taxpayer had been allowed to claim a deduction for the state and local income taxes paid.[24] Under the 2017 Act, the Conference Committee resolved various conflicts on this issue by allowing taxpayers who itemize to continue to deduct for income taxes (or sales taxes) paid on the state and local levels, subject to a few additional limitations:

1. The deduction is limited to a maximum of $10,000;
2. No deduction is allowed for prepaid taxes in this area; and
3. The limit applies to income tax deductions (or sales taxes) as well as property taxes.[25]

CASUALTY LOSSES

IRC § 165 allowed for certain types of losses generated from casualties and theft losses to be deductible, even if they were personal in nature and not connected with a business.[26] The personal losses under Section 165 have been limited for many years.[27] Those limits included a requirement to itemize deductions, provide a minimum level of losses,[28] and meet other requirements.

Under the 2017 Act, for individuals, most casualty and theft losses are no longer deductible.[29] In most instances this change does not adversely impact most taxpayers as they now have a larger standard deduction and the losses and thefts, even prior to the 2017 Act, were often not deductible, given the many requirements that taxpayers were forced to meet to comply with IRC § 165 (c)(3).[30]

These changes were directed to limit non-business casualty and theft losses. The losses and thefts incurred in business and investments were not impacted by this 2017 Act change.

MEDICAL EXPENSES

Medical expenses[31] have been allowed as an individual, itemized deduction, if the taxpayer could meet certain threshold amounts. That is, in general, the taxpayer who itemized expenses could deduct the costs for medical expenses. Prior to the 2017 Act, the taxpayer could not deduct even the qualified medical expenses, except for the amount that exceeded a percentage of the AGI of the taxpayer. That percentage changed over the last few years, moving from 7.5 percent to 10 percent. That is, for example, the taxpayer could only deduct the expenses in a given year where the medical expense exceeded 10 percent of AGI. Thus, for example, if the taxpayer had AGI of $100,000, and incurred qualified medical expenses of $15,000, only $5,000 could possibly be deducted. The $100,000 × 10 percent or $10,000 could not be deducted. Thus, of the $15,000 incurred, only $5,000 would remain as a deductible amount, given the 10 percent rule.

Because the standard deduction, mentioned above, was increased to $12,000 per person, the argument was that there was no reason to allow many of the itemized deductions that were allowed prior to this substantial increase in the standard deduction. The medical expense deduction was one deduction that was thought to be expendable, given the change noted. However, the Conference Committee chose to leave this medical expense deduction in the law—at least for now—and the deduction was changed to allow for qualified medical expenses to be deducted for the amount in excess of 7.5 percent of AGI.

This 7.5 percent rule applies for both 2017 and 2018 returns.[32] This change can prove to be helpful for those that itemize their deductions and that incur a large amount of medical expenses.

ESTATE TAX

Of course, taxpayers that accumulate a fair amount of wealth would like to be able, in most cases, to pass this along without incurring more taxes. This "death tax" issue was hotly debated over the last many months. There was talk about repealing the federal estate tax and the federal gift tax.

Under the 2017 Act, Congress chose not to repeal the estate tax. Rather, to address the issue that many individuals, such as farmers, that built an estate consisting of farm land, etc., should be somewhat insulated from the estate tax, the 2017 Act increased the exemption available to the estates of decedents. However, such increase in the exemption amount did not eliminate all estate tax concerns, especially for larger estates.

The 2017 Act increased the estate and gift tax exemption to an amount of $11.2 million. This amount is indexed for inflation, allowing for the position that such estates will grow and thus the exemption also should be increased. This rule applies for years beginning in 2018. This change means that most individuals will not have

an issue with estate tax and/or gift tax, since most estates will not exceed $11.2 million. (There are further protections to avoid any estate tax, such as deductions that apply for gifts to a spouse,[33] etc.[34])

OTHER ISSUES

There are many other issues in the tax area that were contained in the 2017 Act and that are important to real estate practitioners.[35] This brief article was designed to highlight most of the 2017 Act changes that might be most important to real estate practitioners in the coming months. However, a thorough reading of the 2017 Act will generate many other topics that could be important to practitioners. Such reading also will allow an examination in more detail as to the key elements that apply within the rules discussed above.

Congress considered many more law changes than those that were reflected in the 2017 Act. An examination of the proposals that were **not** passed also is worthwhile. It helps avoid confusion as to what the law is, how it was changed under the 2017 Act, and what might be coming in new legislative proposals!

NOTES

1. *See* Internal Revenue Code of 1986, as amended, especially under the 2017 Act, HR 1. The IRC herein referenced is referring to this 1986 Act as amended. *See also*, Levine, Mark Lee and Segev, Libbi Levine, Real Estate Transactions, Tax Planning, Thomas Reuters West (2018).
2. *See* IRC § 1(i).
3. *See* IRC § 63(c).
4. *See* IRC § 1(f).
5. *See* IRC § 151(d).
6. *See* Levine and Segev, *supra* n.1, Chapter 13 on the Interest deduction.
7. *Id*.
8. *See* IRC § 163(h)(3).
9. The 2017 Act allows the deduction for qualified interest on the principal residence for a loan amount of up to $1 million, so long as the loan was already in place before December 15, 2017. Thus, these loans are grandfathered.
10. *See* the 2017 Act as well as the modified IRC § 163 provision on this issue.
11. *Id*.
12. *See* IRC § 163(j).
13. *See* IRC § 280(F).
14. *See* IRC § 168.
15. *See* IRC § 47(c).
16. *See* IRC § 47. *See also* Levine and Segev, *supra* n.1, Chapter 23.
17. This law can be traced to 1921, with a substantial change in 1924. For a discussion of this history of now IRC § 1031, *see* Levine, Mark Lee, Handbook of Real Estate Exchanges, PP & E, Inc. (2017); *see* also on Amazon.com in hardcopy and electronic format.
18. Real property experts should recall that Congress changed the law some years ago to eliminate the use of Section1031 when exchanging real estate for real estate, when the replacement property is located outside the United States. That is, although real estate can qualify within Section 1031, generally speaking, such real estate will not qualify if the replacement property is outside the United States!
19. *See* IRC § 1061. If the holding does not exceed the three years, the gain is short term capital gain.
20. *See* IRC § 55.
21. *See* IRC § 469. *See also* Levine and Segev, *supra* n.1, Chapter 7.
22. *See* IRC § 170(b)(1).
23. The 2017 Act provided some other limits, such as denying the 80 percent charitable deduction that had been allowed, prior to the 2017 Act, when a contribution was made in connection with seating for certain college athletic events.
24. *See* IRC § 164(b)(6).
25. Thus, the total of the income taxes (or sales taxes, if elected) and the property taxes, cannot exceed the $10,000 amount. For taxpayers in some states, such as California, NY, Connecticut, etc., with high property taxes and/or high income taxes, this limitation generates lost deductions and thus produces a higher taxable amount on the Federal income tax return.
26. *See* IRC § 165. *See also* Levine and Segev, *supra* n.1, Chapter 10. This Section distinguishes losses that are personal in nature as opposed to business or investment losses. The losses that are personal in nature are the type of losses that the 2017 Act addressed—and limited, as noted above.
27. *Id*.
28. *See* IRC § 165 (c)(3), where most losses needed to exceed $100, the total losses for the year were not deductible unless they exceed 10 percent of the AGI of the taxpayer, etc. With the 2017 Act changes, these limitations are not necessary, since most of these personal losses, aside from Presidential Disaster declarations, are no longer deductible by the individual.
29. *See* IRC § 165(h).
30. *Id*.
31. *See* IRC § 213. *See also* Levine and Segev, *supra* n.1, Chapter 13.
32. *See* IRC § 213(f).
33. *See* IRC § 2056; *see also* Levine and Segev, *supra* n.1, Chapter 43.
34. *Id*.
35. *See*, *e.g.*, IRC § 67(c), where the miscellaneous itemized deduction rule was suspended under the 2017 Act.

Signaling the Structural Break in the US Housing Market: An Approach for Early Warning System

By

AU: Please supply author name and bio.

In the recent past, the housing market has experienced prolonged episodes of noteworthy upsurge as a result of persistent increase and then followed by a significant decrease in both housing demand and price. This decline in the housing market was substantially worse and possibly more severe than many other declines in the history of the housing market. The upwelling in subprime mortgage lending resulted in a significant increase in homeownership and caused sharp appreciation in housing price. At the same time, the required ability for homeownership such as, disposable income had not increased in tandem during the second half of the market swell prior to the crisis. Consequently, this sequential association of housing price and disposable income reversed due to the finite nature of economic capacity. One possible argument that may be explored further is that disposable income is finite and therefore, unable to sustain the co-movement with the housing price indefinitely. Since the peak of the housing market in late 2006, the home price index has declined considerably and created a domino effect of widespread mortgage defaults. In addition, the spillover effect of this housing crisis spread into other financial/economic sectors and has remained due to their domino effect characteristics.[1]

Many researchers have explored the post analysis of the housing market crisis. Aßmann[2] observed that a joint occurrence of a housing crisis mixed with a banking crisis is particularly more costly for an economy. Sun[3] found that the share prices of Real Estate Investment Trusts (REITs) with higher debt-to-asset ratios and shorter maturity debt fell more during the housing market crisis. This exceptionally high, but albeit, unsupported home price the nation was enjoying for years prior to the recent rapid decline created a housing "boom" and "bust" cycle[4] that is usually referred to as a housing bubble.[5] Researchers[6] defined housing bubble as a "large mean-reverting fluctuation in prices" and quantified the bubble by calculating the bubble index applying geometric mean on the boom and bust legs over a specified time interval. Case and Shiller[7] provided some explanation of the term "bubble" to a situation in which perception of future price rise causes current housing prices to elevate. In turn, the prospect of large price increase may have consequences on housing demand if the investors feel that there is little risk associated with the home purchase and thus creates an inflated housing price environment. Many researchers considered the housing price movement of 2006 as a housing bubble.[8] However, the usual price increase of homes may not be an indication of a housing bubble as long as underlying economic factors support the price increase. Therefore, we explore this concept of structural relationship of economic factors with housing price.

Researchers observed that various types of economic/financial factors played important

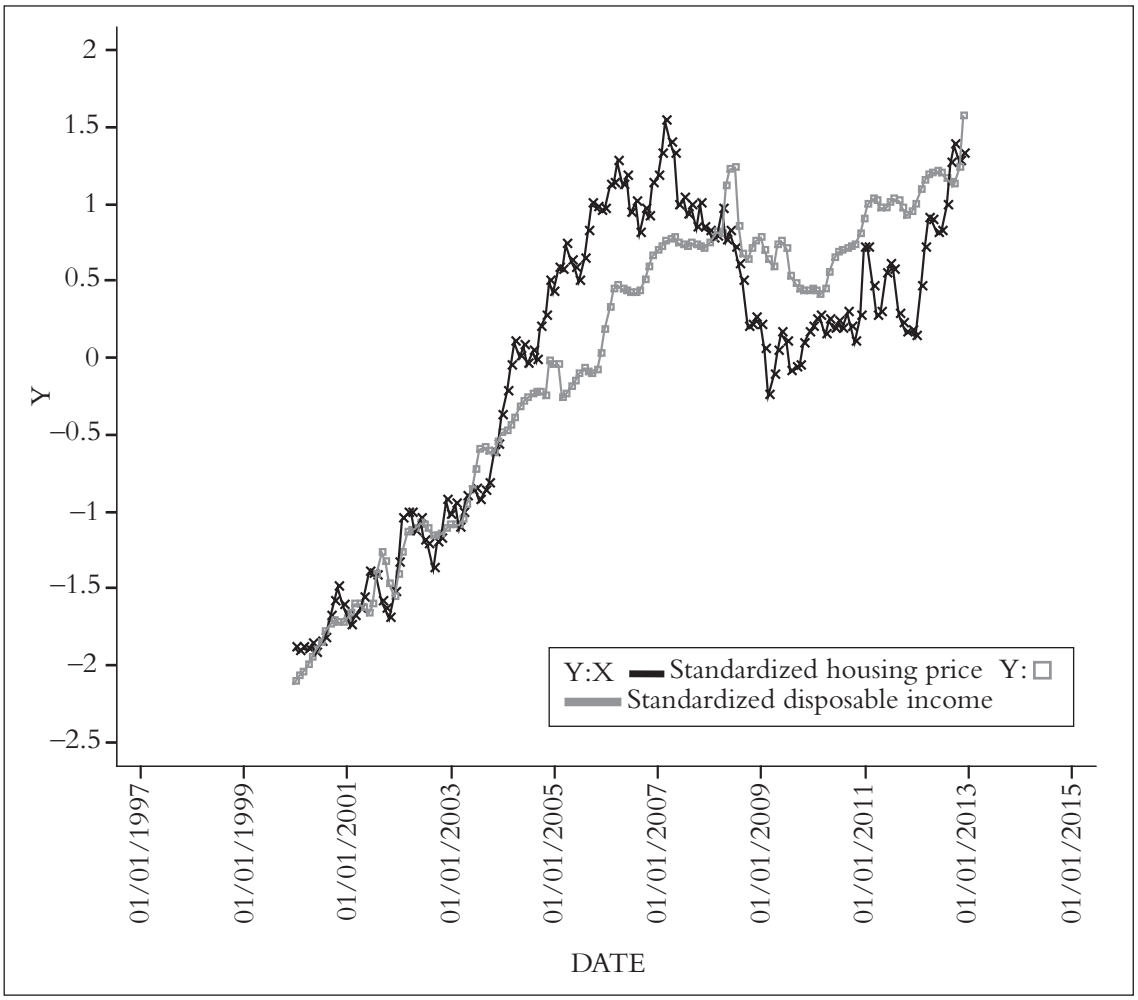
roles in affecting the housing market crisis. As for example, Miles[9] provides an excellent research study on the housing bubble by examining the role of Federal policy and found that long-term interest rates have a larger impact on the housing price as compared with the federal funds rate. Mian and Sufi[10] among others have observed that loan channel plays an important role in the housing crisis. On the other hand, Berkovec[11] observed that loan contracts have more significant influence on the housing crisis. Himmelberg[12] in their study primarily focused on the ability of macroeconomic fundamentals to explain housing price patterns for 46 metropolitan areas for the time period of 1995–2004. In their research they have found that the cost of owning a house increased proportionately to the cost of renting a house during that specific time period. However, they have not found much evidence against housing price increase being due to economic fundamentals. Claessens and Jannsen[13] analyzed the consequences of the housing crisis on the economy and documented that the housing crisis had significant negative economic impact that lead to long-lasting and deep recessions. Specifically, when the housing market is perceived as a speculative investment and creates a boom-bust cycle.[14] Similarly, Lloyd[15] viewed speculation in the housing market as an investment reason. Along the same line, Dreger and Kholodilin[16] stressed the need for a better understanding of the housing market and to detect the speculation scenario as early as possible for providing proper remedial measures. One way to understand the change in the housing market structure is to test for structural deviation.

There is a large amount of literature on structural change, but there are only a few studies that deal with the housing market itself. Damianov & Escobari[17] observed a shift in the market equilibrium by using cointegration analysis. Wheaton and Nechayev[18] observed that an increase in housing price is proportionate to income over time for the period 1975-1998 on quarterly data. However in their study, no such co-movement exists for the time period 1998-2005. Ngene[19] observed that there is a regional difference in structural breaks and their timing (break point) in the housing market. Researchers also attributed regional differences in housing markets are due to wealth disparity.[20] Choi & Zivot[21] and Ngene implemented Bai and Perron[22] structural break technique for their studies, which provides an estimation process for unknown break point. The Chow[23] test for structural break can be equivalent to the Bai and Perron test when considering linear regression with a known break point.

The classic Chow test is a very simple but powerful structural change test using any basic statistical software and does not require specialized techniques. Many researchers apply a structural break test to identify an unknown break point[24] from the historical data, others assume the break point is known.[25] The exogenous factor(s) that cause these shocks usually are unknown and therefore these break points are detected long after the event occurs. However, identifying the exogenous factor that may detect the change in response factor would facilitate detecting the break point much earlier than the usual procedure of a random detection method. In that regard, we propose a concept of creating a ratio that could be applied to spot change in the structural relationship. Specifically, we suggest a ratio of affordability index (a function of disposable income) with relation to housing price for signaling structural change in the housing market. This AI-HP (Affordability Index to Housing Price) ratio is capable of identifying the exact cross-over point in our data for detecting the beginning of a structural change at the time of occurrence. Therefore, it has the capability of signaling change in the market dynamics at the start of break.

The primary contribution of this article is the concept of "AI-HP" ratio of affordability index to housing price that shows the cross-over point about two years in advance of market peak and acts as a vehicle for signaling the starting point of structural change. In addition, we have found that disposable income was a key indicator for monitoring drift in the market structure and was instrumental in the test for structural change. In the process, we show that there was a structural break in the relationship of disposable income and housing price long before the market crash. We also, demonstrate how the AI-HP ratio can be advantageous to uncover the beginning of a drift in the market structure. This observation will aid in identifying and determining the break-point in advance of a housing market collapse. Therefore, our research provides an understanding of market mechanism with respect to economic factors and indicates predictability of a possible market crisis. The pre-crisis analysis of the housing market has important implications for market participants and regulators interested in identifying risk factors, their behavior, and timing by understanding the dynamics. This will enable investors and policy makers to take appropriate measures in advance. (*See* Exhibit 1.)

EXHIBIT 1—PLOT OF STANDARDIZED HOUSING PRICE AND DISPOSABLE INCOME



DATA AND RESEARCH METHODOLOGY

This research involves monthly time series data beginning January 2000 and ending March 2006. We limited our date to this time period for identifying and determining if there was a structural break in the US housing market before it crashed towards the end of 2006. Even though the data is available beyond March 2006 (as all of our graphs used data till 2013), keep in mind our objective is to identify market distress in advance of the market collapse in 2006 and therefore we have used data prior to the market crash only. We collected data from the US Census Bureau, the Bureau of Labor Statistics, and the Federal Reserve Board. We have selected the median housing price as a measure of the housing market. Median housing price is the most widely used factor in understanding the dynamics of the housing market.[26] Disposable income is defined as the amount of money that households have available for spending and saving after income taxes. Disposable income may be used as one of the proxies for housing demand. Therefore, a co-movement should be expected between disposable income and housing price. Thus, any deviation from this co-movement can be postulated as a result of structural break in the housing market. In addition, any structural change in the housing price or disposable income on themselves over time may also be a ground for structural break. The housing affordability index also may be used to gauge the changes in the housing factors relationships. The affordability index measures the capability of a median income purchaser of a median priced home. The higher the affordability index the better is the ability to purchase a home. Hilber and Vermeulen[27] explored the home affordability crisis in the United Kingdom with regards to planning and regulatory constraints.

When a regression model is used to represent an economic relationship over time, such as, housing price and income, the question often arises as to whether the relationship remains stable. Keeping that in mind, we performed a statistical test that is an equality test on relationships to test the hypothesis. One of the focuses in our research is to detect and identify the differential relationship of housing price with factors, such as, disposable income and affordability index to detect a structural break in the market system. We construct the AI-HP ratio to detect the break-point and perform the Chow test to analyze the differential effect due to changes in housing market behavior. (*See* Exhibit 2.)

CONCEPT OF STRUCTURAL BREAK IN HOUSING MARKET

In an economic relationship, the Chow test often is used for determining whether the independent variables or time trend have different impacts on the dependent variable at different time segments. In our study, we observe the differential effect of disposable income on the housing price in two different time segments. The housing market decline that started towards the end of 2006 was devastating for the economy and investors. A careful analysis of the housing price data in comparison to macroeconomic factors specifically disposable income indicated that the change in this relationship already had started at the beginning of 2004 (*see* Exhibit 1).

However, the affordability index depicts a much clearer picture of this divergent scenario (*see* Exhibit 2). This prompted us to construct the "AI-HP", (affordability index to housing price) ratio using standardized data to bring them into the same scale for comparison purposes. This newly created AI-HP factor is instrumental in showing the exact timing of the cross-over point for directional change. (*See* Exhibit 3.) Thus, this AI-HP factor can be a very

EXHIBIT 2—PLOT OF STANDARDIZE HOUSING PRICE AND AFFORDABILITY INDEX

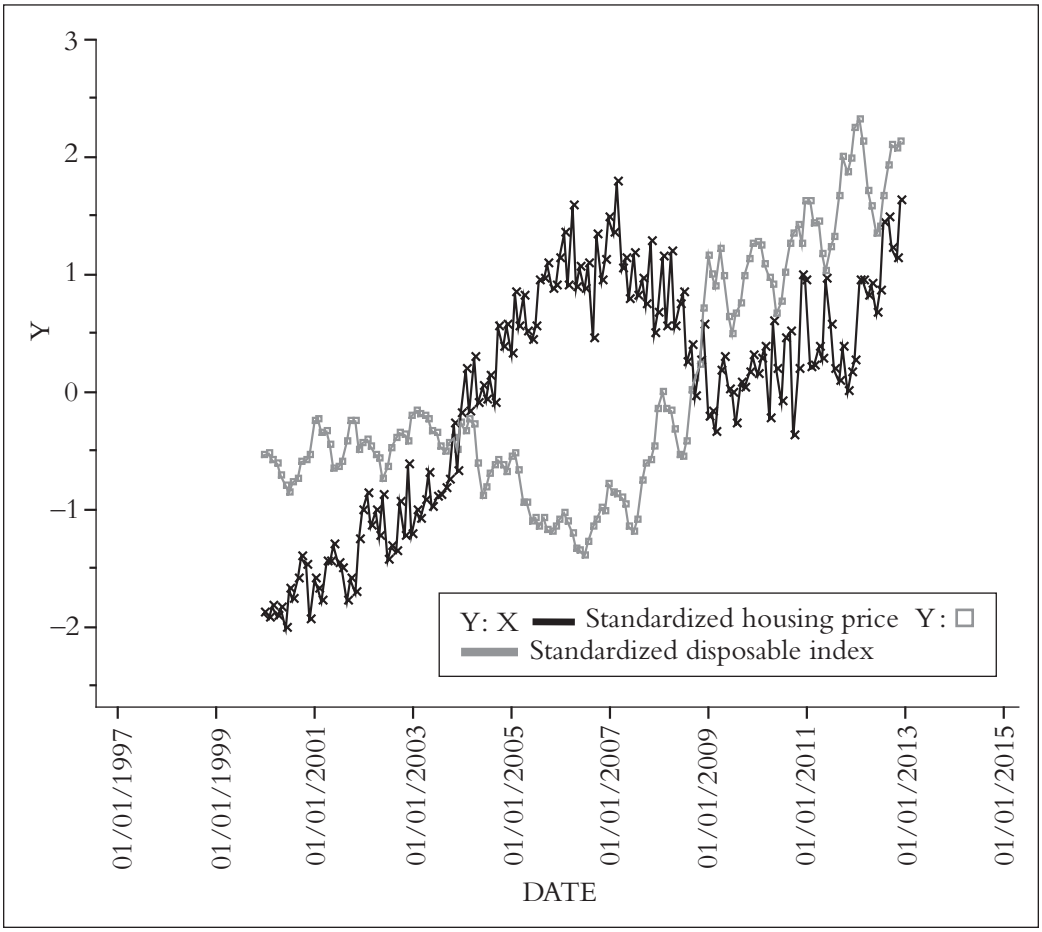
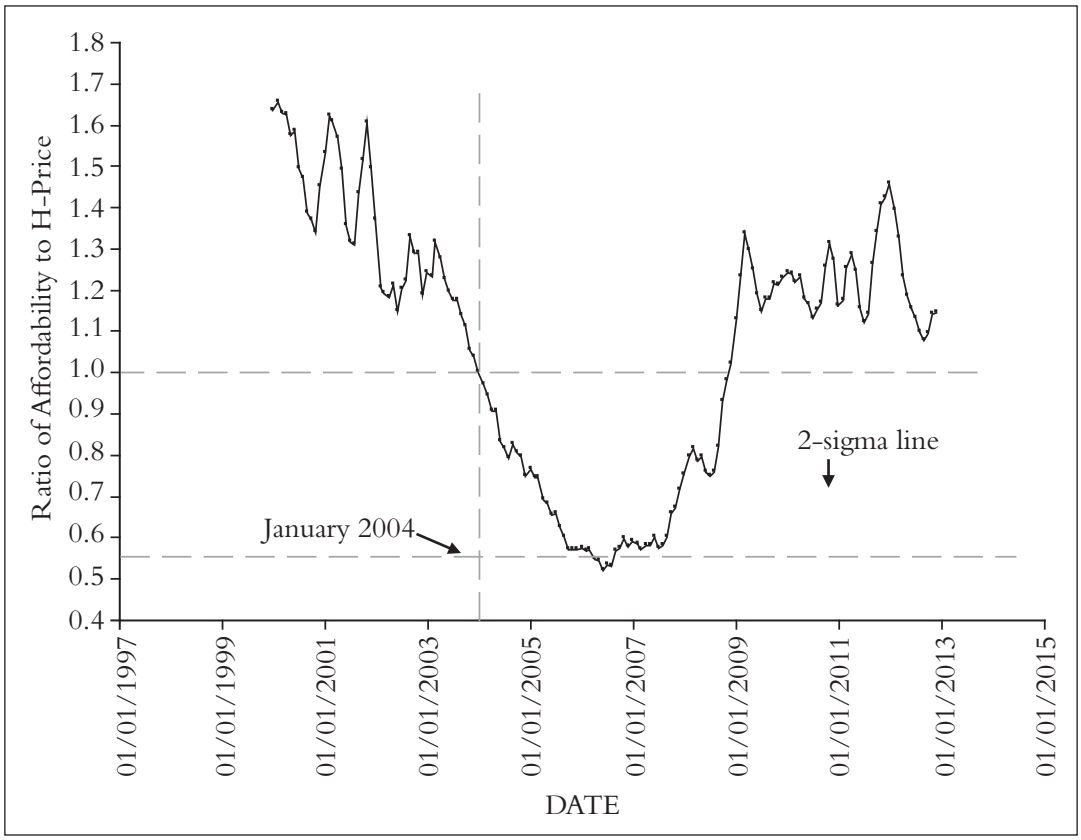


EXHIBIT 3—PLOT OF AI-HP RATIO OF AFFORDABILITY INDEX TO HOUSING PRICE



powerful tool when suspecting structural change occurring in the housing market to identify the beginning of the market change. Alternatively, one could estimate linear models of standardized housing price and disposable income with time trend in the neighborhood of the cross-over point using about 12 months of data before and after for identifying the separation point. This method may be more valuable and effective when the cross-over point is unclear with jagged behavior in their directions. The process can be described as follows:

Let's assume that the linear models are of the following form:

$$HP_t = a_1 + b_1 TT_t \qquad \text{and} \qquad AI_t = a_2 + b_2 TT_t$$

The cross-over point would imply that the ratio AI-HP is equal to one and therefore the cross-over time point is calculated as,

$$TT = \frac{(a_2 - a_1)}{(b_1 - b_2)}$$

Thus, the ratio of the differences between intercepts and slopes defines the cross-over point. The purpose of the above described processes is to spot the break-point for identifying different segments that will facilitate the Chow test for structural change in the housing market. To establish the change in the relationship of housing price and disposable income we divided the data utilizing the AI-HP ratio into two segments: (1) Jan 2000–Jan 2004 and (2) Feb 2004–Mar 2006. It is important to note that Mar 2006 was not the highest peak of the housing price (it was second to the last) and thus providing opportunity to the investors for liquefying their assets a few months in advance of the crisis.

For the purpose of illustrating the Chow test, let us denote housing price as HP, disposable income as DI, affordability index as AI, time trend (1,2, .., n) as TT. The specification of the relationships for our analysis can be of the following form:

$$HP_{t1} = \alpha_1 + \beta_1 DI_{t1} + \varepsilon_{t1} \qquad t1 = jan2000,....jan2004 \quad (1)$$

$$HP_{t2} = \alpha_2 + \beta_2 DI_{t2} + \varepsilon_{t2} \qquad t2 = feb2004,....mar2006 \quad (2)$$

This can be represented in matrix-vector notations as

$$\begin{bmatrix} HP_1 \\ HP_2 \end{bmatrix} = \begin{bmatrix} DI_1 & 0 \\ 0 & DI_2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \quad (3)$$

The combined model for both time periods is,

$$HP_t = \alpha + \beta DI_t + \varepsilon_t \qquad t = jan2000,....mar2006 \quad (4)$$

Therefore, the Chow test can be expressed as:

$$F = \frac{\left[\frac{\left\{\hat{\varepsilon}'\hat{\varepsilon} - \left(\hat{\varepsilon}_1'\hat{\varepsilon}_1 + \hat{\varepsilon}_2'\hat{\varepsilon}_2\right)\right\}}{k}\right]}{\left[\frac{\left(\hat{\varepsilon}_1'\hat{\varepsilon}_1 + \hat{\varepsilon}_2'\hat{\varepsilon}_2\right)}{(N_1 + N_2 - 2k)}\right]} = \frac{\left[\frac{\{S_C - (S_1 + S_2)\}}{k}\right]}{\left[\frac{(S_1 + S_2)}{(N_1 + N_2 - 2k)}\right]} \quad (5)$$

The null hypothesis of the Chow test asserts that both intercepts and slopes are equal. Where, S_C is the sum of squared residuals from the combined time period, S_1 is the sum of squares from the time period Jan 2000–Jan 2004, and S_2 is the sum of squares from the time period Feb 2004–Mar 2006. N_1 and N_2 are the number of observations in each group and k is the total number of parameters. This test statistic is then followed by the F distribution with k and $N_1 + N_2 - 2k$ degrees of freedom. (*See* Exhibit 4.)

EMPIRICAL RESULTS

During the years before the financial crisis, the housing prices were extremely volatile. The median housing price ranged from $160,100 to $250,800 an increase of 56.65 percent in less than six years (*see* Exhibit 4C). In comparison, disposable income ranged from $31,111 to $35,451 with an increase of only 13.95 percent. This disparity indicates that there was a difference in growth rate between these two factors and therefore there was a drift in the association. Consequently, our first step is to identify the cross-over point where the drift has started and divide the data into two segments for structural break analysis. After employing AI-HP ratio, we have identified the cross-over point that occurred in January of 2004 (*see* Exhibit 3). The plot of affordability index in Exhibit 2 also provides the same divergent picture. It is noteworthy to mention that, it is not necessary to identify and divide the data exactly at the cross-over point for our analysis. The plan is to find a reasonable cross-over point well in advance of the market crisis.

EXHIBIT 4A—SUMMARY STATISTICS (PERIOD-1: JAN 2000–JAN 2004)

Variables	N	Minimum	Maximum	Mean	Std Dev
Disposable Income	49	31111	33861.0	32453.80	764.57
Housing Price	49	160100	209500.0	179514.29	12092.32
Affordability Index	49	117	137.1	128.35	5.14

EXHIBIT 4B—SUMMARY STATISTICS (PERIOD-2: FEB 2004–MAR 2006)

Variables	N	Minimum	Maximum	Mean	Std Dev
Disposable Income	26	33880	35451	34466.69	447.96
Housing Price	26	209600	250800	228819.23	11557.47
Affordability Index	26	107	135	118.13	8.66

EXHIBIT 4C—SUMMARY STATISTICS (COMBINED PERIOD: JAN 2000–MAR 2006)

Variables	N	Minimum	Maximum	Mean	Std Dev
Disposable Income	75	31111	35451.0	33151.60	1173.48
Housing Price	75	160100	250800.0	196606.67	26419.78
Affordability Index	75	107	137.1	124.81	8.15

An interesting observation is the relationship of housing price with the affordability index around the cross-over time period is much different from what one would expect in a normal scenario. Therefore, the AI-HP ratio may act as an extremely useful tool to signal unusual housing market movements and work as an early warning system. As observed in Exhibit 4A and Exhibit 4B, the median housing price increased faster between period-1 and period-2 as compared to disposable income. For example, the median housing price increased 27.46 percent on average compared to only a 6.20 percent increase in disposable income between period-1 and period-2. It also is interesting to note that the average affordability index declined (7.96 percent) during the same time period. As shown in Exhibit 5A, the magnitudes of the relationships were different for different time periods. For instance, correlation between housing price and disposable income were 0.88 during period-1 as compared to 0.65 during period-2. Another way to observe the structural change in relationship is to compare correlations of housing price and disposable income with time trend. As shown in Exhibit 5, correlation differences between period-1 and period-2 of disposable income with time trend were 0.96 and 0.74, a considerable decrease as compared to 0.89 and 0.88 for housing price. This result becomes more prominent when the affordability index is taken into consideration. Thus, indicating significant change in the relationship between housing price and income in advance of housing market crisis.

Therefore, we explore to identify the break-point and also test for the structural break during the pre-crisis period. There are a number of possible investigations that may be explored. One of the possibilities is that disposable income, which is one of the key ingredients from the demand side, was not increasing at the same rate as the housing price and thus limiting the affordability of purchasers. In fact, the affordability index is negatively related to the housing price in period 2. These results suggest that changes in disposable income and consequently the affordability index leads to changes in the housing market structure. Obviously, many other factors are associated with this market structure change as explored by other researchers. However, we view that the economic factors discussed above are the key indicators for determining structural break-point and a signal for a possible market crisis.

The analysis in this article focuses on the housing market dynamics, but our analysis goes beyond the simple growth effect of income on the housing price. In particular, we consider the potential identification of a key indicator for market distress that arises due to macroeconomic factors that were unable to sustain the market change indefinitely. Specifically, we consider the possibility that a shift in association before the downturn can lead to a market crisis and the tipping point to create a domino effect for amplification of a downward spiral. An analysis of these potential macroeconomic factors

EXHIBIT 5A—CORRELATION COEFFICIENTS (PERIOD 1 JAN 2000–JAN 2004)

	Disposable Income	Housing Price	Affordability Index	Time Trend
Disposable Income	1.00000	0.88260<.0001	0.408180.0036	0.96134<.0001
Housing Price	0.88260<.0001	1.00000	0.386840.0060	0.88562<.0001
Affordability Index	0.408180.0036	0.386840.0060	1.00000	0.52864<.0001
Time Trend	0.96134<.0001	0.88562<.0001	0.52864<.0001	1.00000

P-values are in second row.

EXHIBIT 5B—CORRELATION COEFFICIENTS (PERIOD 2: FEB 2004–MAR 2006)

	Disposable Income	Housing Price	Affordability Index	Time Trend
Disposable Income	1.00000	0.648320.0003	–0.594770.0014	0.73862<.0001
Housing Price	0.648320.0003	1.00000	–0.669830.0002	0.88303<.0001
Affordability Index	–0.594770.0014	–0.669830.0002	1.00000	–0.85556<.0001
Time Trend	0.73862<.0001	0.88303<.0001	–0.85556<.0001	1.00000

P-values are in second row.

associated with market distress is the central focus of our research. By observing the movement of disposable income as well as the affordability index, we were able to identify the pre-crisis separation point of the association. The slight changes in the association may not appear relevant for the amplification effect in pre-crisis market, however due to their bounded nature this macroeconomic relationship change amplified the effect on housing price change. To explore these issues, we examine the association of factors in two separate pre-crisis time periods; January 2000 to January 2004 (before crossover) and February 2004 to March 2006 (after crossover) as identified and detected by the AI-HP ratio. If successful in identifying a structural break, this will provide investors and policy makers plenty of time to take precautionary measure. Also, keep in mind that March 2006 is not the last (highest) housing market peak, even at this point market participants had several months left to make adjustments. (*See* Exhibit 6.)

Chow Test on Disposable Income over Time

To test the differential effect of disposable income in two different time periods we perform a Chow test shown below. First, we run a regression for the combined (Jan 2000–Mar 2006) period.

$$DI_t = 31152^{\star} + 52.62^{\star}\ TT_t$$

* Statistically significant at better than 1 percent level (*see* Exhibit 6C).

S_C = sum of squared residuals (combined) = 4576108.

Combined estimated regression model above is highly statistically significant with a positive slope. Therefore, if the time trend increases the disposable income also will be higher and the rate of increase is about $52.62 for each additional month.

We then run two different regression models separately for two periods to observe any significant differences in the association due to different time periods. If no difference exists, we can postulate that there is no structural break due to different time periods.

$$DI_{t1} = 31168^{\star} + 51.44^{\star}\ TT_{t1}$$

* Statistically significant at better than 1 percent level (*see* Exhibit 6A).

S_1 = sum of squared residuals (period 1) = 2127764.

$$DI_{t2} = 31763^{\star} + 43.26^{\star}\ TT_{t2}$$

* Statistically significant at better than 1 percent level (*see* Exhibit 6B).

S_2 = sum of squared residuals (period 2) = 2279846.

Although, both models are highly statistically significant with positive intercepts and slopes. Slope is higher in period 1 as compared to period 2. This result is consistent with the correlations reported in Exhibit 5A and 5B. This implies that disposable income at period 1 has a higher increase per month as opposed to rate of change of disposable income during period 2. This indicates that disposable income may have shifted its direction and thus creates a structural break in the housing market. To establish any change in differential effect, we calculate the test statistic to perform the Chow test.

$$F = \frac{\left[\frac{\{S_C - (S_1 + S_2)\}}{k}\right]}{\left[\frac{(S_1 + S_2)}{(N_1 + N_2 - 2k)}\right]}$$

$$= \frac{\left[\frac{\{4576108 - (2127764 + 2279846)\}}{2}\right]}{\left[\frac{(2127764 + 2279846)}{(49 + 26 - 4)}\right]}$$

$$= 1.36$$

The observed test statistic F=1.36 does not exceed the critical test statistic F=2.36 at 10 percent significance level with 2 and 71 degrees of freedom. Therefore, the null hypothesis of equality of regression parameters is not rejected. This implies that the two regression models from two different time periods are not different in their construct, suggesting that there is no structural break in disposable income due to different time periods. The test result leads us to conclude that disposable income is progressing normally over time and does not possess any unusual change from its past behavior. Perhaps, housing price developed its own environment from the influence of other market characteristics leading to an extra elevated

EXHIBIT 6A—REGRESSION RESULTS OF DISPOSABLE INCOME ON TIME TREND (PERIOD 1: JAN 2000– JAN 2004)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	25931110	25931110	572.79	<.0001
Error	47	2127764	45272		
Corrected Total	48	28058874			
R-Square	0.9242				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	31168	61.73433	504.87	<.0001
Time Trend	1	51.43959	2.14931	23.93	<.0001

EXHIBIT 6B—REGRESSION RESULTS OF DISPOSABLE INCOME ON TIME TREND (PERIOD 2: FEB 2004–MAR 2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	2736898	2736898	28.81	<.0001
Error	24	2279846	94994		
Corrected Total	25	5016744			
R-Square	0.5456				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	31763	507.3221	62.61	<.0001
Time Trend	1	43.25949	8.05933	5.37	<.0001

EXHIBIT 6C—REGRESSION RESULTS OF DISPOSABLE INCOME ON TIME TREND (COMBINED PERIOD: JAN 2000–MAR 2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	97325268	97325268	1552.57	<.0001
Error	73	4576108	62686		
Corrected Total	74	101901376			
R-Square	0.9551				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	31152	58.40415	533.39	<.0001
Time Trend	1	52.61991	1.33544	39.40	<.0001

risky position for the market to collapse. We explore this possibility next. (*See* Exhibit 7.)

Chow Test on Housing Price over Time

To test the differential effect of housing prices for two different time periods we perform the Chow test as below. First, we run a regression for the combined period.

$$HP_t = 152603^{\star} + 1158.00^{\star}\ TT_t$$

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 7C).

S_C = sum of squared residuals (combined) = 4517462067.

Combined estimated regression model above is highly statistically significant with a positive slope. Therefore, if the time trend increases then the housing price also increases and the rate of increase is $1158.00 dollars for each additional month.

Thus, we run both regression models separately for each time period to observe any differences in the association due to different time periods. If no difference exists, then we can postulate that there is no structural break.

$$HP_{t1} = 160777^{\star} + 749.49^{\star}\ TT_{t1}$$

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 7A).

S_1 = sum of squared residuals (period-1) = 1513757449.

$$HP_{t2} = 145424^{\star} + 1334.32^{\star}\ TT_{t2}$$

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 7B).

S_2 = sum of squared residuals (period -2) = 735512280.

Results of these regression models are reported in Exhibit 7A and Exhibit 7B. Both of these models are highly statistically significant with positive intercepts and slopes. Slope is much lower in period 1 compared to period 2 (749.49 vs. 1334.32), that is almost doubled prior to the market crash. This result is consistent with the averages reported in Exhibit 4. This result points to the fact that the housing price during period 2 has a greater rate of increase per month as compared to period 1. It also is interesting to note that this direction in housing price is opposite of the direction of disposable income that we discussed earlier. Therefore, these results imply that the housing price had shifted its direction opposite to the disposable income with an increasing velocity that created the structural break. To determine this differential effect of association, we calculated the test statistic below to perform the Chow test.

$$F = \frac{\left[\dfrac{\{S_C - (S_1 + S_2)\}}{k}\right]}{\left[\dfrac{(S_1 + S_2)}{(N_1 + N_2 - 2k)}\right]}$$

$$= \frac{\left[\dfrac{\{4517462067 - (1513757449 + 735512280)\}}{2}\right]}{\left[\dfrac{(1513757449 + 735512280)}{(49 + 26 - 4)}\right]}$$

$$= 35.80$$

The observed test statistic F=35.80 does exceed the critical test statistic F=4.90 at 1 percent significance level with 2 and 71 degrees of freedom. Therefore, the null hypothesis of equality of regression parameters is rejected. This implies that the two regression models are dissimilar in their construct, suggesting a structural break. The test result leads us to conclude that the housing price is not progressing normally and does exhibit unusual changes in its behavior. This indicates that the housing price developed its own environment that was unsustainable by the market and lead to the market collapse.

These tests provide us evidence to explore further the hypothesis of structural break with disposable income. Because disposable income does not exhibit such structural break with respect to its past, we therefore, conducted a Chow test for structural break on housing price with respect to disposable income. (*See* Exhibit 8.)

Chow Test on Housing Price with Respect to Disposable Income

We test the differential effect of housing price with respect to disposable income. First, the regression model for the entire period was estimated.

$$HP_t = -506578^{\star} + 21.21^{\star}\ DI_t$$

EXHIBIT 7A—REGRESSION RESULTS OF HOUSING PRICE ON TIME TREND (PERIOD 1: JAN 2000– JAN 2004)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	5505002551	5505002551	170.92	<.0001
Error	47	1513757449	32207605		
Corrected Total	48	7018760000			
R-Square	0.7843				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	160777	1646.61912	97.64	<.0001
Time Trend	1	749.48980	57.32792	13.07	<.0001

EXHIBIT 7B—REGRESSION RESULTS OF HOUSING PRICE ON TIME TREND (PERIOD 2: FEB 2004–MAR2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	2603868104	2603868104	84.97	<.0001
Error	24	735512280	30646345		
Corrected Total	25	3339380385			
R-Square	0.7797				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	145424	9112.25875	15.96	<.0001
Time Trend	1	1334.32479	144.75761	9.22	<.0001

EXHIBIT 7C—REGRESSION RESULTS OF HOUSING PRICE ON TIME TREND (COMBINED PERIOD: JAN 2000–MAR 2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	47134884600	47134884600	761.68	<.0001
Error	73	4517462067	61883042		
Corrected Total	74	51652346667			
R-Square	0.9125				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	152603	1835.02847	83.16	<.0001
Time Trend	1	1158.00000	41.95881	27.60	<.0001

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 8C).

S_C = sum of squared residuals (combined) = 5805493169.

Estimated regression model is highly statistically significant with a positive slope. Thus, the housing price increases at a rate of $21.21 dollars for each additional dollar increase in disposable income.

We then run both time periods regression models separately to observe any differences in the association between housing price and disposable income. If no difference exists, we can postulate that there is no structural break.

$$HP_{t1} = -273515^{\star} + 13.96^{\star}\, DI_{t1}$$

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 8A).

S_1 = sum of squared residuals (period-1) = 1551219813.

$$HP_{t2} = -347697^{\star} + 16.73^{\star}\, DI_{t2}$$

⋆ Statistically significant at better than 1 percent level (*see* Exhibit 8B).

S_2 = sum of squared residuals (period -2) = 1935773680.

Although, both models are highly statistically significant (*see* Exhibit 8A and Exhibit 8B), coefficient of determination is much lower for period 2 (42.03 percent) compared to period 1 (77.90 percent). This indicates that disposable income explains only 42 percent of housing price variations during period 2 and thus indicating a structural break in the co-movement. As expected, slope is lower during period 1 compared to period 2 (13.96 vs. 16.73). This suggests that the housing price during period 2 has a much higher rate of increase for each additional dollar increase in disposable income. In particular, for each additional dollar increase in disposable income the housing price increases by $16.73 in period 2 compared to $13.96 during period 1. If this difference is found to be statistically significant this may imply that the housing price is structurally breaking away from the disposable income. We calculate the following test statistic to detect the structural break,

$$F = \frac{\left[\frac{\{S_C - (S_1 + S_2)\}}{k}\right]}{\left[\frac{(S_1 + S_2)}{(N_1 + N_2 - 2k)}\right]}$$

$$= \frac{\left[\frac{\{5805493169 - (1551219813 + 1935773680)\}}{2}\right]}{\left[\frac{(1551219813 + 1935773680)}{(49 + 26 - 4)}\right]}$$

$$= 23.60$$

The observed test statistic F=23.60 does exceed the critical test statistic F=4.90 at 1 percent significance level with 2 and 71 degrees of freedom. Therefore, the null hypothesis of equality of regression parameters is rejected. The test result indicates that the housing price movement is not cohesive with respect to disposable income and does exhibit a departure in the association during the pre-distress period.

DISCUSSIONS AND CONCLUSIONS

It is clear that the macroeconomic factors played an important role in the housing market crisis. The development of the AI-HP ratio concept to signal the break-point for structural change as an early warning system is a major contribution of our research. Our analysis indicates that a significant part of the market distress was due to a structural break related to macroeconomic factors a key indicator for market crisis. Specifically, we find that the housing price accelerated at a much faster rate and doubled during the second time segment immediately before the crisis. In contrast, disposable income decelerated during the same time-period. This finding is consistent with our hypothesis and established to be the leading cause of the market distress. Thus, the relationship between housing price and disposable income acts as a measure for stability of the housing market and any significant deviation can operate as a signal for a pending structural break.

We observe these effects through correlations, as the strength of the correlation of disposable income becomes weaker in the second time period, suggesting changes in the structural dynamics of the housing market. Regression results of housing price on disposable income also confirms the fact that the rate of increase in housing price for an unit increase in disposable income has accelerated rapidly in the second time period compared to the first time period and is a likely indication of market distress. This may be interpreted as the

EXHIBIT 8A—REGRESSION RESULTS OF HOUSING PRICE ON DISPOSABLE INCOME (PERIOD 1: JAN 2000–JAN 2004)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	5467540187	5467540187	165.66	<.0001
Error	47	1551219813	33004677		
Corrected Total	48	7018760000			
R-Square	0.7790				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	–273515	35208	–7.77	<.0001
Disposable Income	1	13.95921	1.08456	12.87	<.0001

EXHIBIT 8B—REGRESSION RESULTS OF HOUSING PRICE ON DISPOSABLE INCOME (PERIOD 2: FEB 2004– MAR 2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	1403606705	1403606705	17.40	0.0003
Error	24	1935773680	80657237		
Corrected Total	25	3339380385			
R-Square	0.4203				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	–347697	138212	–2.52	0.0190
Disposable Income	1	16.72676	4.00969	4.17	0.0003

EXHIBIT 8C—REGRESSION RESULTS OF HOUSING PRICE ON DISPOSABLE INCOME (COMBINED PERIOD: JAN 2000–MAR 2006)

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	45846853498	45846853498	576.49	<.0001
Error	73	5805493169	79527304		
Corrected Total	74	51652346667			
R-Square	0.8876				

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	–506578	29305	–17.29	<.0001
Disposable Income	1	21.21118	0.88342	24.01	<.0001

upward movement of the housing price exceeded its capacity with respect to the macroeconomic limitation as measured by disposable income created the divergent environment in pre-crisis period and resulted in housing market crisis.

Although, we were witnessing a precursor to an extreme event, to some extent market participants during this whole time period were unaware of this gradual change in the market dynamics, specifically during the second half. As we explore further with this line of research, we need to keep in mind that the investors and policy makers were perceived to be underestimating the potential effects of disposable income on the market dynamics. Even though, our analysis clearly has revealed that there was a statistically significant drift in the market factors' association and indicated a structural break well in advance. Therefore, findings of this study suggest that disposable income is an important component in housing market dynamics. In addition, our analysis indicates that disposable income in conjunction with affordability index may possess greater potential in signaling the structural break and providing market participants important information in advance of a looming market crisis. However, the generalization of these results will require further research of a similar kind in different time periods and also in different geographic locations. Therefore, future research on the implementation of the AI-HP ratio at different geographic locations could provide valuable insights.

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