Determinants of a foreclosure discount

Herman Donner

Journal of Housing and the Built Environment

ISSN 1566-4910

J Hous and the Built Environ
DOI 10.1007/s10901-020-09757-1

Springer

Journal of Housing and the Built Environment
https://doi.org/10.1007/s10901-020-09757-1

ARTICLE

Determinants of a foreclosure discount

Herman Donner[1]

Received: 11 October 2019 / Accepted: 2 June 2020

Abstract
This study adds to previous research analyzing the impact of foreclosure status on real estate sales price by using a Swedish dataset were an appraiser has estimated the market value of apartments before they were sold at foreclosure auction. Appraisal data can address the issue of selection bias and a potential overestimation of foreclosure related discount. A mean discount of 7.9% with a corresponding median value of 9.5% is shown when comparing appraisal estimates with prices achieved at foreclosure auction. A hedonic model is also applied, and the resulting discount is estimated at 23.9%. Measures of local market conditions are related to the foreclosure discount, with hedonic price models and models using appraisal data producing consistent results. It is found that the discount is higher in lower priced neighborhoods, in neighborhoods that are heterogeneous in terms of price and in less liquid neighborhoods (significant in the hedonic model). It is also found that apartments with a higher value relative to the neighborhood price level sell at larger discounts. The results are consistent with studies on search and matching theory and contrast from earlier studies that attribute a foreclosure discount to seller motivational factors.

Keywords Foreclosure · Hedonic Model · Search Theory

JEL Classification D80 · D82 · R30 · R31

1 Introduction

Numerous articles have aimed at estimating the impact that a forced sale has on real estate sale price (Campbell et al. 2011; Carroll et al. 1997; Chinloy et al. 2016; Clauretie and Daneshvary 2009; Forgey et al. 1994; Hardin and Wolverton 1996; Harding et al. 2012; Pennington-Cross 2006; Shilling et al. 1990; Springer 1996; Zhou et al. 2015), with most estimates indicating discounts in excess of 20% (Campbell et al. 2011; Forgey et al. 1994; Hardin and Wolverton 1996; Asabere and Huffman 1992; Shilling et al. 1990). A major empirical challenge does however arise due to foreclosure status being likely to proxy for unmeasured property characteristics that negatively influence property value. This issue

✉ Herman Donner
hdonner@stanford.edu

[1] Global Projects Center, Stanford University, Stanford, USA

Published online: 19 June 2020

of selection bias, therefore, has the potential to cause over-estimation of the impact that a foreclosure has on price when applying hedonic models.

Most studies that estimate the magnitude of the price impact of a foreclosure have paid attention to addressing the issue of selection-bias caused by foreclosed properties having characteristics associated with lower sales prices (Clauretie and Daneshvary 2009; Springer 1996). However, aside from property condition, foreclosed properties are likely to sell at lower prices for several reasons that are unrelated to property condition, with the most common explanation for lower prices being that sellers prefer a quick sale over achieving the highest possible sale price (Campbell et al. 2011; Forgey et al. 1994; Shilling et al. 1990). This is, however, most likely to be the case when lenders have taken ownership of the property before the sale and when the lender has substantial influence on the sale process. A sale through a foreclosure auction, were creditors have limited influence on the sale, requires an alternative explanation. Adding to this issue is that buyers have many reasons for not wanting to pay the full price when buying a foreclosed property, given the greater uncertainty associated with such a transaction. Although seller motivational factors are often mentioned, few studies offer a deeper analysis of why foreclosed properties achieve lower sale prices. By examination of the determinants of a foreclosure discount through measures of local market conditions, this study adds to the stream of literature that examine sales of foreclosed real estate.

A reliable estimate of the price impact of a forced sale is needed to examine the causes of a foreclosure discount. I also add to previous literature on this issue by using a Swedish dataset in which each foreclosed property has been visited and appraised by an independent and accredited real estate appraiser that estimates a market value defined as; *the most likely price to be achieved if the property were to be sold through an arms-length transaction on the open market*. Such an appraised value is representative of all the characteristics, both tangible and intangible, that influence property value—i.e. property condition is considered when determining the value.

If the appraisal estimate is unbiased, the appraised market value provides a counterfactual outcome, so that any remaining negative price impact of a foreclosure can be attributed to the sale mechanism. This study compares estimates of a foreclosure discount based on appraisal data with those obtained through hedonic regression models. That the former results in much lower estimated discounts illustrates the methodological challenge.

As real estate is a heterogeneous asset with markets characterized by incomplete information, the search process amongst buyers and sellers is characterized by friction; it is costly and time consuming for buyers to find information about available objects, their quality and value, while sellers face similar difficulties in setting their reservation price and deciding upon the type and level of marketing. As there is a trade-off between time and effort in relation to individual outcome, buyers who put in more effort into researching the market are also more likely to buy a property that meets their preferences well. Mayer (1995, 1998) relates this to real estate sold through auctions rather than negotiated sales, finding that auctions lead to lower sale prices as the matching of buyers and sellers becomes less efficient due to the time constraint of an auction sale. Following that line of theory, the price discount of an auction sale varies with market conditions, as the matching of buyers and sellers will take less time during boom periods when there are many market participants, thus, the price discount will be lower compared to bust periods when sales are expected to take longer time.

The data of this study offers a standardized and transparent sale mechanism through a government agency that handles all final debt enforcement. Most studies estimating a foreclosure discount have been based upon U.S. data and real estate owned (REO) property

that has been repossessed by the lender through foreclosure proceedings. Chinloy et al. (2016) point out that although typically referred to as interchangeable terms, a foreclosure sale and REO sale are considerably different in mechanism. The former refers to selling foreclosed properties to a third party through some sort of regulated sale mechanism, while the latter depends upon the routine of the lender in question.

To test the relationship between the impact that a foreclosure has on sales price and the search process on the real estate market, I take two approaches. First, using the discount estimated through appraisal data, and second, through hedonic models that explain real estate sales price. Measures of market condition that impact the search process are included in the models through measures of the number of transactions, local price change and dispersion of prices.

The remainder of this paper is structured as follows: Sect. 2 provides a literature review, Sect. 3 describes the data and institutional setting, and Sect. 4 covers the used method and results. Section 5 concludes.

2 Background and review of previous literature

Section 2.1 provides a brief review of the literature that estimates the impact on price caused by a foreclosure, and studies examining the determinants of a such an impact. This is followed by Sect. 2.2 that provides a review of studies touching upon the relationship between real estate sale prices and sale mechanisms.

2.1 Estimates and determinants of a foreclosure discount

That forced sales achieve lower sale prices is typically referred to as a *foreclosure discount,* although most studies have examined REO sales. Several early studies find that such sales cause a negative price impact of more than 20% (Forgey et al. 1994; Hardin and Wolverton 1996; Shilling et al. 1990). Exceptions are provided by Carroll et al. (1997) who estimate a considerably smaller discount in the range of 4–6% and Springer (1996) who finds no statistically significant difference in prices at all.

In addition to property and locational characteristics, previous studies have controlled for seller motivational factors that influence price, such as a transaction being a cash-sale (Clauretie and Daneshvary 2009; Forgey et al. 1994) and the time a property has spent on the market (Clauretie and Daneshvary 2009). Notably, Clauretie and Daneshvary (2009) estimate a considerably smaller discount of 7.5% after controlling for time on market, which is consistent with studies that find that time constrained sales result in lower prices due to less efficient matching of buyer and property. Several studies have attributed lower prices to seller incentives to achieve a quick sale to minimize costs of holding a property (Campbell et al. 2011; Forgey et al. 1994; Hardin and Wolverton 1996; Shilling et al. 1990; Springer 1996).

Campbell et al. (2011) relate a foreclosure discount to market liquidity and bid-ask spreads. As a forced sale reveals the "true" bid price, the price impact of a forced sale will vary with liquidity. A sale through a foreclosure auction is estimated to cause a discount of 27%, a sale due to sudden death of the owner a 5–7% discount, and a sale due to bankruptcy a 3% discount.

Harding et al. (2012) estimate that the price discount caused by a foreclosure provides buyers of REO-properties with a 1.4% higher annual return compared to buyers of similar

properties on the regular market during a seven-year holding period. This provides an upper-bound to excess return as such properties might have required excess repairs.

Zhou et al. (2015) find that a high concentration of REO sales increases the discount and recent house price appreciation decreases it. It is also found that properties in poor condition are sold at larger discounts. The dynamics of a foreclosure discount is analyzed further by Chinloy et al. (2016), who compare sales to third party buyers at foreclosure auctions to REO sales as well as sales on the general market. It is found that properties are sold at lower prices at foreclosure auctions as compared to REO transactions, which in turn occur at lower prices as compared to the general market.

Studies using U.S. data dominate this field of research, with a few studies of the European setting. A prior study of Stockholm, Sweden, provided by Donner et al. (2016) estimate a foreclosure discount on the prices for single-family houses and apartments. Discounts of 24.6% and 20.1% are estimated, respectively. Forced sales of apartments that are limited in time are sold at a 29.1% discount. Donner (2017) applies apply a repeat-sales approach on single-family houses in Sweden, finding that buyers of such properties earn excess annualized returns of 7.6–10.7% over a mean holding period of 4.3 years. It is also found that the turnover subsequent of a foreclosure auction is eight times higher than the non-forced market, as professional buyers take advantage of a discount. Another European study is provided by Mocking and Overvest (2017), that apply a repeat-sales approach to data from the Netherlands, and estimate a foreclosure related discount of 5%, and that a foreclosure lowers prices of nearby houses with 0.6%. Using an automated appraisal method stated to be more accurate than hedonic models, and less biased than human appraisals, Renigier-Biłozor et al. (2018) provide a study using Italian and Polish data, estimating discounts of 22% and 45%, respectively.[1]

The issue of defining a foreclosure discount has been addressed in a few studies. Campbell et al. (2011) state that if the process of a forced sale itself adversely impacts property value, the impact of a forced sale on sale price can be interpreted as a total effect on property value. When examining REO sales, a similar argument is made by Zhou et al. (2015) stating that a foreclosure discount should be defined as *the discount of a typical REO property off the sale price of its normal counterpart in normal condition.* By application of an automated valuation model on transactions spanning from 2000 to 2012 across 16 U.S. metropolitan areas, an average discount of 14.7% is estimated.

2.2 Studies on the impact of time and marketing on real estate sales prices

Many markets are characterized by incomplete information and dispersion of prices, so that buyers and sellers must make an effort to determine the most favorable price. As noted by Stigler (1961), such search is increasingly worthwhile when the dispersion of prices is greater and expenditure on the traded good is large. A search framework helps in explaining the relationship between selling time and sales price in other markets that exhibit certain characteristics. Notably, real estate is a very heterogeneous asset in which market participants trade with incomplete information, meaning that, in many respects, real estate is traded on a search market (Goetzmann and Peng 2006).

[1] The dataset used in Renigier-Biłozor et al. (2018) is small, totaling 113 properties in both Italy and Poland, of which 40 are foreclosed.

An early study of information on real estate markets is provided by Courant (1978). When examining racial prejudice amongst real estate sellers, Courant found that a market equilibrium in which some discriminated buyers overpay is sustainable given search costs. Yinger (1981) applied a search model to the transaction process of real estate where brokers search for buyers without being certain about the number of buyers that the search process will yield. The author notes that heterogeneous preferences amongst buyers and characteristics of properties make the matching of a particular buyer with a specific property uncertain and beyond the control of the broker. The matching process is therefore dependent on both listing price and a degree of randomness (Yinger 1981).

The linkage between liquidity and the process of search is studied by Lippman and McCall (1986) who proposed the expected selling time of an asset, given an optimal strategy, as a general definition and measure of liquidity. Subsequent studies, provided by Haurin (1988) and Yavas and Yang (1995), model the relationship between marketing time and price, with the underlying logic that the likelihood of finding a buyer with a high willingness to pay increases with time

Even as the findings of Lippman and McCall (1986) are general in nature, their measure of liquidity has gained a lot of traction within the field of real estate. A stream of literature has examined the impact of time-on-market (TOM) on real estate sales price (An et al. 2013; Anglin et al. 2003; Cheng et al. 2008, 2015; Forgey et al. 1996; Genesove and Mayer 1997; Ong and Koh 2000; Yavas and Yang 1995). Although results have varied, empirical studies have typically found a positive relationship (An et al. 2013), with the impact of marketing time having a diminishing marginal impact on price (Cheng et al., 2008).

Several studies have examined factors that impact the price-TOM relationship, finding that it varies with market conditions (An et al. 2013; Cheng et al. 2008; 2015). A number of studies examining the price-TOM relationship estimate that marketing time has a greater positive impact on price on markets with increasing property values (An et al. 2013; Cheng et al. 2015). During periods of declining property values, the benefit of search must offset declining property values for the price-TOM relationship to be positive. An et al. (2013) finds that the price-TOM relationship will vary depending on market conditions, although it is a generally positive relationship, except for markets with rapidly declining property values. Even as Cheng et al. (2015) find support for a positive relationship even in declining markets, so that the benefit of search still mitigates the impact of declining values, their findings do not necessarily contradict those by An et al.

A related stream of literature has examined the relationship between sale mechanism and price, typically by examining differences between negotiated sales and auctions (Allen and Swisher 2000; Mayer 1995, 1998; Ong 2006; Quan 2002). Consistent with matching theory, Mayer (1995) found that auction sales cause lower prices; as such a quick sale results in a poorer match between buyer and house as compared to a longer matching process. The theoretical framework predicts larger discounts in depressed and thinner markets, as fewer potential buyers leads to a worse matching. Following the logic of matching, auction discounts were modelled to be larger for heterogeneous and larger houses as the cost of mismatching is higher compared to smaller and homogenous houses—since the sale mechanism matters less when a larger number of buyers place a similar value on the same property (Mayer 1995, 1998).

Papers examining the incentives of real estate agents by Rutherford et al. (2005) and Levitt and Syverson (2008), illustrate that sale price is influenced by incentives and time, finding that real estate agents achieve higher prices when selling their own properties compared to client properties. The latter study is also consistent with a positive relationship between price and TOM as properties owned by real estate agents typically stay on the

market slightly longer and sell at higher prices. Another aspect of incentives that impact price is provided by Genesove and Mayer (1997, 2001), who examine how loss aversion amongst sellers will impact selling strategies. The authors find that property owners with high loan-to-value ratios tend to set higher listing prices, wait longer when selling, and achieve higher prices as compared to sellers with lower loan-to-value ratios.

An alternative framework of the relationship between marketing time and price that conflicts with the notion that a longer marketing time increases price is provided by the theory of clearance sales by Lazear (1986), implying that a seller that has failed at selling his product during a period will adjust the price during the subsequent period with the magnitude of adjustment given by the information gained during the prior period. The price will therefore be lowered during each period the product remains unsold. Consequently, the price-TOM relationship will be negative. Taylor (1999) finds results that are consistent with Lazear's theory when treating a longer TOM as a signal of the quality of a property, with a theoretical framework showing a negative relationship between TOM and price.

Studies relating to the characteristics of an asset and pricing during various market conditions are also relevant in this context. Wong et al. (2012) found that a higher fraction of land value increases liquidity of real estate. Consequently, properties that are easier for buyers to evaluate should be more liquid and be less impacted by a time constrained sale. Earlier research also supports that the cost of a mismatch between buyer and property is lower for homogenous properties (Mayer 1995), and that atypical properties take longer to sell (Haurin 1988) A parallel can also be drawn with studies of commercial assets, as Shleifer and Vishny (1992) find that assets with limited alternative use sell at larger discounts during industry wide recessions.

3 Data and institutional setting

Data of forced sales of cooperative apartments in the county of Stockholm, Sweden, sold from 2006 to 2013 were collected at the physical archive of the Enforcement Authority, which is the government agency that handles all sales of foreclosed property in Sweden. The data on foreclosed properties stems from two sources; appraisal documents and auction protocols. As these are archived separately, it was a very time-consuming process to compile the dataset.

Notably, the Swedish apartment market is somewhat different in an international comparison. Apartment owners themselves do not own the apartments as all owner-occupied apartments are in cooperative form. What is owned, and consequently sold through a foreclosure sale in this case, is the right to use an apartment that comes with owning a share of a housing cooperative. Because of this setting, structural issues of an apartment property are the responsibility of the housing cooperative and not of the individual apartment owner. This should therefore mitigate some of the risk and uncertainty for a buyer that a forced sale typically adds.

3.1 Foreclosures in Sweden

In Sweden, forced sales of apartments take two forms. It is either a consequence of unpaid debt which has caused creditors to apply for a foreclosure, or sales due to apartment owners' negligence of duties to the housing cooperative (typically unpaid monthly fees but could also be a consequence of having misbehaved as an apartment owner). In the latter

case, it is the housing cooperative that applies to the Enforcement Authority for a foreclosure sale. These two forms of sales each number at 344, thereby putting the total number of forced sale observations at 688. These two types of foreclosures are initiated at the same auctions under similar conditions, with the difference being that a sale initiated by the housing cooperative is limited to three attempted auctions while regular foreclosures have no such limitation. Although somewhat different, these two types are treated as equal in the empirical section of this paper. Motivation for this is provided by: the facts that (1) that the actual sale process in terms of marketing and auction is almost, if not entirely, identical and (2) the percentage difference between sale price and the appraised value exhibits no statistically significant difference between the two types. The sample should cover all, or almost all, forced sales of apartments during the period in the County of Stockholm.

3.2 The appraisal and foreclosure sales process

The foreclosure process is regulated by the 12th chapter of the Swedish Enforcement Code and all sales of foreclosed properties are handled by the Enforcement Authority. Noteworthy is that a property in foreclosure is owned by its initial owner up-until a foreclosure sale is finalized, i.e., a foreclosure does not transfer ownership of the property as is the case when a lender takes possession of a property. In this setting, lenders will have less influence over the process of selling a foreclosed apartment as such sales are regulated by the Swedish Enforcement Code and administered by the Enforcement Authority.

Prior to the foreclosure action, each foreclosed apartment is appraised by an appraiser hired by the Enforcement Authority. What is estimated is a market value as if the apartment were to be sold in a non-forced regular transaction, defined as: *the most likely price to be achieved if the property were to be sold through an arms-length transaction on the open market.* The appraisal document, with a description of the property and the estimated market value is made available through the Enforcement Agency's website and at the physical auction.

The appraiser is not an employee of the Enforcement Authority and is hired on a contractual basis (i.e. the same firm appraises all foreclosed properties for a time-period and geography). Appraisals for the time-period covered in this study were all conducted by the firm *Eminenta Värdia*. The firm has approximately 40 employees and was founded in the year 2000.[2] If unbiased, the appraisal should provide an estimated counterfactual outcome relative to prices achieved at foreclosure auction.

All forced sales are conducted through physical auctions at the Enforcement Authority's Stockholm office. An immediate down payment of 25% is required, with full payment typically required within a month of the sale. Non-forced sale apartments can often be bought with lower down payments in Sweden. A partial explanation for a discount on price could therefore be that buyers with little equity are unable to pay a 25% down payment.

It is the auctioneer who decides if a sale is to be made, based on two requirements. First, the protected amount needs to be met, which is the amount of the costs of the sale and all claims to the property with a higher priority than the claim having triggered the foreclosure. Second, that it is *unlikely that a considerably higher price could be achieved at a subsequent auction* (The Enforcement Code). When it is deemed that this second requirement has not been met, a foreclosed apartment can be put up for sale at a subsequent auction.

[2] Eminenta Värdia. Official Website (Visited on April 2, 2020). http://www.eminenta.se/om-oss.

The interpretation of this requirement is somewhat unclear, as foreclosed apartments are typically sold at prices below their estimated values, with prices that are more than 20% lower than the estimated value being common, as illustrated by Fig. 2a. That few properties sell at discounts above 30% could be a consequence of these regulations, as auctions that achieve very low prices are likely to result in a new auction rather than a sale. Unfortunately, the data does not include information regarding the number of auctions attempted for a property to be sold.

Studies on appraisal bias provide some reason to carefully evaluate the accuracy of the appraisals of foreclosed properties (Ben-David 2011; Yiu et al. 2006). Following the great recession of 2008, academics and policymakers gave the issue of appraisal bias increased attention (Ding and Nakamura 2016). In the U.S. setting, a stream of literature has analyzed potential bias in appraisals associated with the origination of residential mortgages and incentives for appraisers to set values at or above the contract amount as it is directly impacts to the loan-to-value ratio (An et al. 2012). Studies have shown that appraisers often have incentives to upwardly bias appraised values both when hired by a lender or a borrower—as it enables higher leverage or lower borrowing costs (Ben-David 2011). It is found that appraisers with prior knowledge of a transaction price are more likely to assess upwardly biased values (Eriksen et al. 2019). Adding to complexity to the issue is that the typical approach to identify appraisal bias is to compare the appraised value to econometrically derived values, which by themselves can be biased (Eriksen et al. 2019).

The Swedish setting, and the appraisal data used in this study are considerably different than in the U.S. and studies relating to incentives at the time of loan origination. Potential biases could stem from a few sources, notably, that the appraiser is paid by the Enforcement Authority and has an incentive to have their contract renewed. There is however no clear benefit associated with a high appraisal. In contrast, it is likely easier to sell a foreclosed apartment with a low assessed value given the legal requirements for a sale to go through (described above). Studies have found that it is in the process of selecting comparable properties that bias is most likely to influence the appraisal process (Eriksen et al. 2019). As appraisers that work with the Enforcement Authority might predominantly work with many foreclosed properties, this might influence the appraisal. In sum, a potential bias would most likely be downwards—consequently resulting in a downward biased estimate of a foreclosure discount.

3.3 Data construction

Before arriving at the final sample of foreclosed properties, observations with sale prices that deviate more than 50% from their appraised values are excluded, as there might be unobserved and atypical circumstances surrounding the sale.

Foreclosed apartments in neighborhoods with fewer than 10 non-forced transactions during the year in question are also dropped, as non-forced transactions are used to create variables that measure local market conditions such as average price and liquidity. If the number of transactions in a year is less than 10, these measures would not be robust. After these exclusions, 627 forced sales remain (91% of the original sample).

Each foreclosed apartment is assigned variables that provide measures of local market conditions. These variables are created from transaction data provided by the company *Valueguard,* which is a company that compiles real estate transactions for the purpose of creating indices. This data covers 180,466 sales of apartments through real estate agents for the period from 2006 to 2013.

Table 1 Summary statistics (mean values with standard deviations in parenthesis)

	Non-forced	Forced
Sale price (Swedish crowns)	2,118,798	1,255,483
	(1,350,029)	(1,492,976)
Appraised value (Swedish crowns)	N/A	1,348,907
		(1,652,347)
Discount (Swedish crowns)	N/A	− 93,424.24
		(357,265.6)
Discount (Percent)	N/A	− .0789708
		(.1567924)
Living area (sqm)	64.40645	64.7429
	(24.88668)	(28.38211)
No. of rooms	2.395077	2.307018
	(1.041929)	(1.087725)
Floor number	2.146648	2.082137
	(2.430174)	(2.077769)
Monthly fee (Swedish crowns)	3334.497	3623.724
	(1385.681)	(1587.715)
Balcony (1/0)	.1219399	.7559809
	(.3272173)	(.42984)
Elevator (1/0)	.5574291	.5964912
	(.4966923)	(.4909928)
Age (years)	50.33991	44.97767
	(32.83748)	(27.23703)
Neighborhood sqm price	34,779.26	24,868.21
	(16,485.71)	(16,282.73)
Neighborhood transactions	85.29778	72.47368
	(63.75787)	(56.77722)
Neighborhood price dispersion	.1813833	.2268224
	(.0672711)	(.106042)
Д Neighborhood sqm price	.0821297	.0889571
	(.105758)	(.124198)
% Appraisal deviation from neighborhood price	− .1789422	N/A
	(.3858739)	
No. of obs.	180,466	627

The data with non-forced transactions is aggregated at the neighborhood level through geographic information system (GIS) software, with the neighborhood measure being called *Base Areas,* which are used by Stockholm County for statistical purposes. The abovementioned 627 forced transactions are in 274 distinct *Base Areas* for which annual values of the average square meter price, the number of transactions, price dispersion, and yearly change in per square meter prices are estimated using the abovementioned transaction data.

Table 1 provides descriptive statistics of the samples of non-forced and forced apartment transactions. Noteworthy is that the apartment characteristics in terms of size and

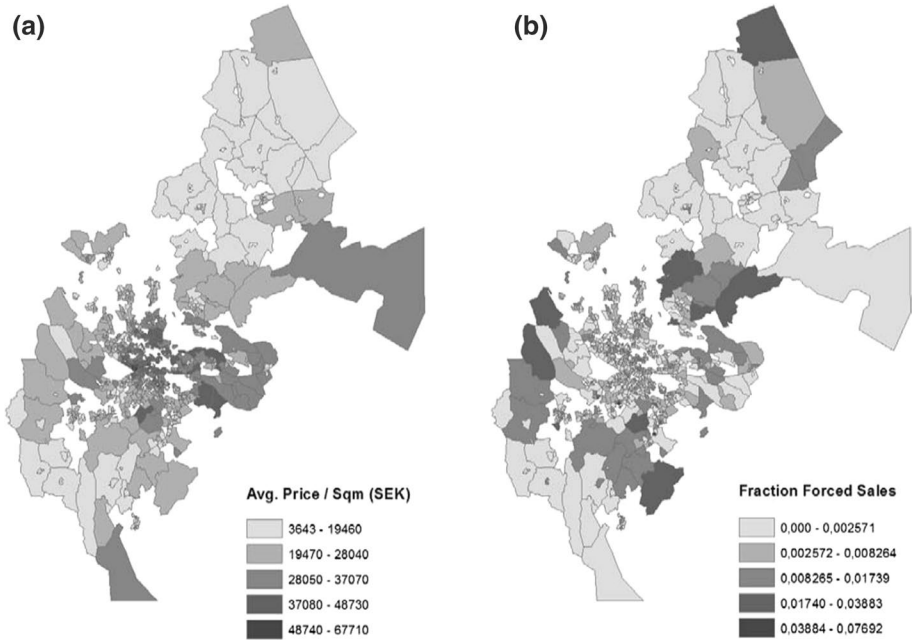

Fig. 1 **a** Stockholm county by neighborhood average square meter price (Swedish crowns) during 2006–2013. Neighborhoods with fewer than 50 transactions during the period are excluded. **b** Stockholm county by percentage of neighborhood forced sales in relation to total transactions during 2006–2013. Neighborhoods with fewer than 50 transactions during the period are excluded

number of rooms and floors do not deviate much. However, the average price of forced sales is considerably lower at about 1.255 million Swedish Crowns as compared to 2.112 million for non-forced apartments.[3] This difference does not, by itself, indicate a discount on price as exemplified by the average appraised value of apartments sold through a forced sale, which is 1.349 million. That apartments sold through forced sales have substantially lower appraised values despite similar characteristics illustrates the difficulty of estimating the price impact of a foreclosure through hedonic models. Given similarities in characteristics, the fact that apartments sold through forced sales have lower values must be attributed to location or omitted characteristics. The former is supported by the fact that a considerably higher proportion of forced-sale apartments have a balcony—which is consistent with neighborhoods further away from the expensive city center in Stockholm where balconies are comparably rarer.

The second part of Table 1 provides summary statistics of local market conditions. It shows that apartments that are sold through forced sales are in considerably cheaper neighborhoods, with an average square meter price of 24,868 SEK compared to 34,779 SEK for non-forced sales. Forced sales also occur in less liquid areas, with on average 72 transactions for the year of transaction, compared to 85 of non-forced sales. Forced sales also

[3] As of April, 16 2020, one Swedish Crown corresponds to approximately 0.1 US Dollar.

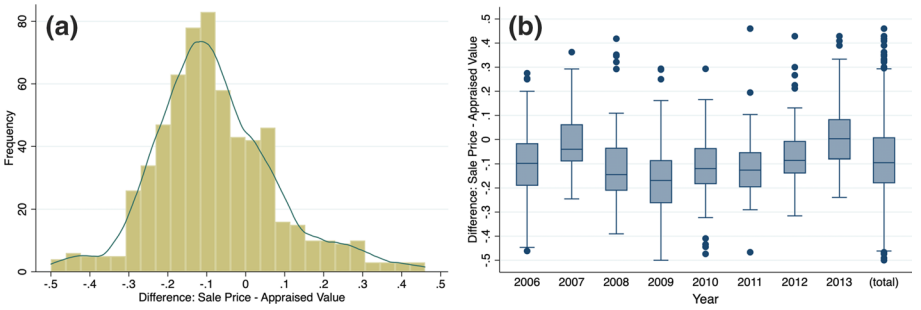

Fig. 2 **a** Distribution of differences between sale price and appraised value. **b** Boxplot of differences between sale price and appraised value by year

tend to happen in less homogenous neighborhoods with a larger dispersion of prices.[4] and in areas with a slightly higher annual price increase during the year of transaction (8.9% compared to 8.2% for non-forced sales). The data shows that forced sales tend to be on the lower-end of the local market, with an appraised market value that is on average 17.9% lower than the neighborhood average sales price.

Figures 1a and b illustrate that foreclosed apartments are clustered in lower priced neighborhoods, with Fig. 1a showing average square meter apartment prices in each *Base Areas* during the period of 2006–2013. Figure 1b shows the foreclosure rate[5] for the same neighborhoods during the period. The figures show that Stockholm can, in large, be described as a monocentric city with prices decreasing with distance from the city center and that forced sales typically occur in suburban, lower priced neighborhoods outside of the city center.

Figure 2a and b provide an illustration of the effect a forced sale has on price. Figure 2a shows the distribution of the deviation of sale prices from the appraised value. If a forced sale did not depreciate price, one would expect to see the same number of observations selling below the appraised value as below it. The graph shows that most apartments are sold at a discount, illustrated by the rightward skewness of the distribution. There is also considerable variation in prices, with a great number of apartments being sold above their appraised value.

As the data cover the fairly long period of 2006–2013, it is of interest to see if price impact has varied over time. Figure 2b, therefore, provides boxplot graphs by year as well as for the entire period. Some variation can be seen, most notable is that discounts on price increased in 2008 and 2009 when the Stockholm property market was depressed during the financial crisis. Discounts then decreased in subsequent years when the property market rebounded. This seems to support a correlation between local market conditions and the impact that a forced sale has on price.

The sale price of the abovementioned 627 apartments sold through a forced sale is 7.9% lower than the appraised value on an average. The corresponding median value is higher, at 9.5%. These values are considerably lower than research indicating discounts above

[4] Defined as the standard deviation of the average square meter price divided by the average square meter price.

[5] In this case the foreclosure rate is defined as the number of foreclosures as a percentage of all sales.

20% and are more in line with estimates below 10% of Springer (1996) and Clauretie and Daneshvary (2009).

The regression analysis described in the next section will provide a deeper analysis of the relationship between local market conditions and the impact on price caused by a forced sale.

4 Methodology and results

To test the relationship between the real estate market search process and a foreclosure discount, I run models that explain the difference between the appraised value and sales price, in addition to hedonic models that explain sales price.

In all models, measures of local market conditions are included; the neighborhood average square meter price, the number of transactions, price dispersion and change in price. Notably, both approaches produce results that are consistent with a search framework and that a significant fraction of a foreclosure discount is attributable less optimal matching between buyer and property.

4.1 Estimation using appraisal values

To test how local market conditions impacts the difference between the achieved discount (or premium) of a foreclosed apartment, a regression model that is defined as (1) is applied;

$$Pct\ Deviation\ from\ Value_i = X_i\beta + \varepsilon \tag{1}$$

Meaning that the percentage deviation between the appraised value and sale price for observation *i* is regressed on *X,* which is a matrix of local neighborhood market conditions as well as variable indicating the percentage deviation of the appraised value from the average neighborhood price. Because of the nature of the dependent variable, a positive (negative) coefficient of an independent variable indicates a higher (lower) sale price relative to an apartment's appraised value i.e., a smaller (higher) discount on price.

In models 1 and 2, the deviation between sale price and appraised value is a function of the following neighborhood market characteristics: the average price per square meter, the number of transactions during the year in question, the price dispersion,[6] and the percentage change in average square meter price (Table 2). To test if variation in the dependent variable over time confounds the results, model 2 includes time dummies. This does not change the overall result, except for the number of transactions being statistically significant at the 10% level in model 2 while not being so in model 1.

The expected effect is that higher priced neighborhoods should be associated with lower discounts, i.e., have a positive coefficient, as supported by previous research such as Campbell et al. (2011) and Zhou et al. (2015). Earlier studies have related this combination to seller costs of protection. It could, however, have to do with buyer perspective as well, as a lower percentage discount still corresponds to a large discount in cash.

[6] This is estimated as the standard deviation of the average square meter price divided by the average square meter price for the year of transaction.

Table 2 Regression results: dependent variable is the deviation of price from appraised value

	Model 1	Model 2	Model 3	Modell 4
Neighborhood sqm price	2.40e−06	1.87e−06	2.76e−06	2.28e−06
	(6.00)	(4.57)	(7.29)	(5.97)
Neighborhood transactions	.0001585	.0001939	.000108	.0001432
	(1.52)	(1.91)	(1.07)	(1.44)
Neighborhood price dispersion	−.2130965	−.2118841	−.2380177	−.2343828
	(−2.32)	(−2.58)	(−2.59)	(−2.86)
Д Neighborhood sqm price	.2889051	.1612363	.2768501	.1673158
	(3.91)	(1.93)	(3.85)	(2.00)
% Appraisal deviation from neighborhood price			−.0886953	−.0861192
			(−5.98)	(−5.98)
Intercept	−.1276087	−.0731343	−.142045	−.0999291
	(−4.86)	(−1.37)	(−5.52)	(−1.84)
Time fixed effects	No	Yes	No	Yes
R^2	0.1465	0.2905	0.1918	0.3298
No. obs.	627	627	627	627

Heteroscedasticity robust standard errors are estimated. T-values are shown in parenthesis below the coefficient estimates. Time fixed effects are binary variables indicating the quarter of the sale that are suppressed from the output to save space.

The number of transactions provides a measure of liquidity and should lead to lower discounts given that higher liquidity leads to a better match between buyer and property for a given period of marketing.

The same logic can be applied to the price dispersion of a neighborhood, as apartments in heterogeneous neighborhoods will have fewer prospective buyers compared to neighborhoods with many similar apartments. Moreover, motivating larger discounts is that a large span of prices will increase uncertainty regarding property value. Price dispersion therefore offers a measure of the complexity for buyers to arrive at their reservation bid price.

Apartments in markets experiencing increasing property values should be sold at lower discounts, consistent with the patterns of foreclosure discounts (Zhou et al. 2015) and auction sales (Mayer 1995, 1998). As bid-ask spreads are likely to be smaller when property prices are increasing, forced sales that reveal true bid-prices will take place at lower discounts during such periods. Price change can also be a measure of expectations as expectations of increasing prices are likely to increase reservation bid prices.

All of the above-mentioned variables show their expected signs, with smaller discounts for apartments in more expensive neighborhoods, more liquid neighborhoods, areas where prices are increasing and where prices are less heterogenous. All but liquidity is significant at the 1% level, which could be a consequence of liquidity being related to price dispersion (Yiu et al. 2009).

In addition to measures of local market characteristics, the deviation between the appraised value of the apartment and the neighborhood average property price is included in models 3 and 4. As this allows for separation of the neighborhood price level and value of the individual property, this shows the effect of property price in relation to the neighborhood average price. This variable is found to be negative and statistically significant, meaning that apartments with higher values relative to their neighborhood sell at larger discounts. This is the expected result and can be explained by the fact that such apartments

are likely to have a narrower appeal and a smaller pool of prospective buyers. Such apartments are therefore less liquid compared to apartments with a value closer to the neighborhood average price level. This finding is consistent with studies finding that atypical assets are more severely impacted by liquidation sales (Haurin 1988; Shleifer and Vishny 1992). Apartments with high values relative to the neighborhood price level will have a lower fraction of land value (in relation to total value), and will therefore be less liquid (Wong et al. 2012).

Besides these measures, models that include binary variables that indicate the quarter of sale are also applied to control for variation of general economic conditions that might endogenously influence a discount or premium of forced sales over time and therefore confound the results. Reassuringly, all variables show their expected sign regardless of including time fixed-effects.

The first model explains 14.7% of the variation of the impact on price caused by a forced sale, with all variables being statistically significant except for liquidity (measured as the number of transactions the year in question). When adding time fixed-effects in model 2, the explanatory power increases to 29.1% with liquidity becoming significant at a 10% level. Models 3 and 4 have explanatory powers of 19.2% and 33.0%, respectively.

4.2 Hedonic estimation of the determinants of a foreclosure discount

After having examined the determinants of a foreclosure discount estimated through appraisal data, a comparison with a traditional approach of applying a hedonic model as defined by Rosen (1974) provides several insights. First, the models offer an understanding towards the determinants of price and foreclosure discount. Second, if appraisals provide an accurate estimated value, a comparison with the hedonic estimate allows for identification of a potential overestimation due to the endogenous nature of foreclosure status.

The model is defined as (2):

$$Sales\,price_i = e^{X_i\beta + Foreclosure_i\gamma + \varepsilon} \tag{2}$$

meaning that the natural logarithm of sales price i is regressed on X, a matrix of apartment characteristics and location.[7] Following most research on housing prices, the dependent variable is transformed to a natural logarithm. An additional binary variable that indicates if an apartment was sold through a foreclosure auction is also included. This model is applied on the abovementioned transaction data in the county of Stockholm during the period from 2006 to 2013. The output of this model is shown in Table 3.

Model 5 includes property characteristics, time and location fixed effects, and a binary variable indicating a foreclosure. The explanatory power is very high with an adjusted R^2 of .90 and all independent variables showing their expected signs. Moreover, those with insight in the Stockholm property market know that the most expensive apartments are either newly constructed or old, typically dating back to the turn of the last century. A second-degree polynomial therefore provides the best way to model the effect of age on price.

A foreclosure is found to have a significant and negative impact of 23.9% on price, when interpreted as suggested by Halvorsen and Palmqvist (1980).[8] Although consistent

[7] As a measure of location, Base Areas are used. There are 645 distinct such Base Areas in the dataset.

[8] This implies that all binary variables that shift from 0 to 1 have an impact on price given by $g = 100[Exp(\beta i) - 1]$, with g being the percentage change.

Table 3 Regression results: dependent variable is the natural logarithm of sales price

	Model 5	Model 6	Model 7
Foreclosure	−.2734847	−.2712857	−.1199591
	(−21.96)	(−22.45)	(−2.18)
Living area (sqm)	.0137732	0137414	.0137358
	(144.17)	(144.64)	(144.54)
No. of rooms	.0509371	.0500417	.050092
	(34.72)	(34.43)	(34.45)
Monthly fee	−.000088	−.0000856	−.0000855
	(−69.98)	(−68.48)	(−68.48)
Age	−.0014895	−.001459	−.0014586
	(−16.08)	(−15.91)	(−15.91)
Age^2	6.15e−06	6.10e−06	6.10e−06
	(8.74)	(8.79)	(8.80)
Balcony (1/0)	.0059878	.0056744	.0059659
	(4.50)	(4.31)	(4.53)
Elevator (1/0)	.0089647	.0085953	.0087072
	(7.07)	(6.85)	(6.95)
Neighborhood sqm price		1.15e−06	1.15e−06
		(4.36)	(4.38)
Neighborhood transactions		−.0002844	−.0002855
		(−13.07)	(−13.12)
Neighborhood price dispersion		−.6373342	−.6303007
		(−29.73)	(.0213729)
Д Neighborhood sqm price		.2989845	.2979687
		(31.30)	(831.23)
Foreclosure * neighborhood sqm price			4.43e−07
			(0.52)
Foreclosure * neighborhood transactions			.0003667
			(2.38)
Foreclosure * neighborhood price dispersion			−.9237004
			(−4.23)
Foreclosure * Д neighborhood sqm price			.1698964
			(1.38)
Intercept	13.9157	13.97399	13.98917
	(229.08)	(235.21)	(240.17)
Time fixed effects	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes
R^2	0.9042	0.9066	0.9067
No. obs.	181,089	180,461	180,461

There are 628 fewer observations in models 6 and 7 compared to model 5 due to missing values of change in neighborhood price due to a lack of transactions the preceding period

Heteroscedasticity robust standard errors are estimated. T-values are shown in parenthesis below the coefficient estimates. Binary variables corresponding to each floor number, binary variables indicating the quarter of the sale, and binary variables indicating the Base Areas are suppressed from the output to save space.

with earlier studies, such as Campbell et al. (2011), Forgey et al. (1994) and Shilling et al. (1990), the estimate is considerably higher than the estimates produced by comparing sale prices with appraised values, which indicates a mean discount of 7.9% with a corresponding median of 9.5%.

It is notable that the difference in estimates is very large, with the implicit impact on price produced by the hedonic model approximately 2.5 times the median difference between sales price and appraisal. Even if there is potential bias in the appraisal estimate, the large difference illustrates the challenge associated with hedonic modeling of a foreclosure discount. Both estimates could be viewed upon as a bottom and upper range, clearly supporting a discount.

Most earlier research attribute overestimation of a foreclosure discount to foreclosure status being endogenously related to property characteristics that negatively influence price, such as being in a worse condition or having a lower interior standard. If a foreclosure depreciates price to different degrees depending on market conditions as illustrated in the above section, omission of such measures might be an additional cause for overestimation.

To see if the estimated impact of a foreclosure changes when measures of local market conditions are controlled for, model 6 is estimated in which such measures of local market conditions are included. Besides variables included in model 5, a measure of neighborhood price per square meter, the number of transactions, price dispersion, and changes in price are included.

Noteworthy is that the inclusion of locational measures, in addition to local market conditions, does not cause perfect collinearity as the latter variables vary over time. As controls for location (Base Areas[9]) are necessary when estimating sales price, the model specification is motivated given that interpretation of the locational variables is not within the aim of this study.

The explanatory variables show their expected signs in model 6, although the negative impact of the neighborhood number of transactions which proxies for liquidity is found to negatively influence price, which is a likely consequence of greater supply depreciating price. Although significant, inclusion of these variables does not change the estimate of the price impact caused by a foreclosure.

To further examine the relationship between a foreclosure discount and local market characteristics, model 7 is applied in which interaction variables that indicate local market conditions and foreclosure status are included. The results of this model show that liquidity positively impacts price when an apartment is a foreclosure as indicated by the positive interaction variable that is significant at the 1% level. This is consistent with the theoretical framework and search theory. Similarly, the price dispersion within a neighborhood is found to negatively influence price of foreclosed apartments, consistent with the line of theory that price dispersion decreases the potential number of buyers, which in turn lowers price when a sale is limited in time. Not only are these two interaction variables the only ones that are statistically significant, they are also the ones that are most closely related to the search process on the real estate market.

[9] As previously mentioned, there are 645 Base Areas. As a robustness check, the hedonic models were also applied using parish as locational measure, these are larger and fewer, with the number of parishes at 70. Although producing a larger negative estimate of the price impact of a foreclosure, the results are otherwise consistent in the sense that all variables relating to local market conditions show the same signs and the estimated impact of a foreclosure decreases when adding interaction variables (from − .342 to − .233).

Although showing their expected signs, interaction variables for neighborhood price and changes in neighborhood price are not statistically significant. This is a likely consequence of these variables being included in their non-interacted form in the model, in addition to locational fixed effects.

The overall results of model 7 illustrate that it makes little sense to discuss a foreclosure discount as if it impacts all apartments equally and that the mechanisms that cause a discount need further examination. The results are consistent with those in the preceding section in which the estimated discount is regressed on local market measures, which adds robustness.

Also notable is that inclusion of the interaction variables significantly decreases the foreclosure coefficient, dropping from 23.9% in model 5 to −11.3% in model 7 (when interpreted as suggested by Halvorsen and Palmqvist 1980). The difference between these two estimates does not imply that the discount is as low as 11.3% as the interaction variables that have non-zero means. It does however support that local market conditions have a significant impact on how much a foreclosure impacts price. This is an important finding as it contradicts previous research that attributes a discount to seller motivational factors, in addition to also showing that a large part of the negative impact on price caused by a foreclosure is driven by the search process on the real estate market.

5 Conclusion

This study uses a Swedish dataset with individual appraisals of apartments sold through foreclosure auction. The appraisal estimates a market value defined as; *the most likely price to be achieved if the property were to be sold through an arms-length transaction on the open market.* Comparing the appraised values with prices achieved at foreclosure auction leads to an estimated impact on price attributable to a forced sale of −7.9% on average, with a corresponding median value of −9.5%. Assuming the appraisals are unbiased, the data provides a considerably lower estimate of a foreclosure related discount compared to estimates from hedonic price models. The data could address the challenge associated with selection bias and foreclosure status being endogenously related to characteristics that negatively influence property value. The hedonic models estimate a discount of 23.9%, which is more than double the median discount estimated with appraisal data. This difference illustrates the methodological challenge associated with estimating a foreclosure discount. Both estimates provide a range with a lower- and upper bound of a true foreclosure discount.

The study also relates a foreclosure discount to the search process on the real estate market. It is found that discounts are higher in lower priced neighborhoods (significant in the appraisal model), in less liquid markets (significant in the hedonic model) and neighborhoods that are heterogeneous in terms of price. This is explained by a less effective search process and greater difficulty in assessing value in both thin markets and in settings with a large dispersion of prices.

It is also found that apartments with a higher value relative to their neighborhood price level are sold at larger discounts. This is consistent with an expensive property in a cheap neighborhood having a narrower appeal and therefore being less liquid, consequently selling at larger discounts when the matching process is limited in time. These results are consistent with search theory and studies that have examined the impact of TOM on real estate prices and liquidation values.

The results provide insight into the dynamics of a negative impact on price caused by a forced sale and adds to previous research that have attributed a discount on price to seller motivational factors. The results have the potential to allow stakeholders to model a potential discount in greater detail for individual foreclosed properties and consequently provide an important tool in management of credit risk.

References

Akerlof, G. A. (1970). The market for" lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics, 84,* 488–500.

Allen, M., & Swisher, J. (2000). An analysis of the price formation process at a HUD auction. *Journal of Real Estate Research, 20*(3), 279–298. https://doi.org/10.5555/rees.20.3.jqwl617266516655.

An, Z., Cheng, P., Lin, Z., & Liu, Y. (2013). How do market conditions impact price-TOM relationship? Evidence from real estate owned (REO) sales. *Journal of Housing Economics, 22*(3), 250–263.

An, X., Deng, Y., Rosenblatt, E., & Yao, V. (2012). Model stability and the subprime mortgage crisis. *The Journal of Real Estate Finance and Economics, 45*(3), 545–568.

Anglin, P. M., Rutherford, R., & Springer, T. M. (2003). The trade-off between the selling price of residential properties and time-on-the-market: The impact of price setting. *The Journal of Real Estate Finance and Economics, 26*(1), 95–111.

Asabere, P., & Huffman, F. (1992). Price determinants of foreclosed urban land. *Urban Studies, 29*(5), 701–707.

Ben-David, I. (2011). Financial constraints and inflated home prices during the real estate boom. *American Economic Journal: Applied Economics, 3,* 55–67.

Campbell, J. Y., Giglio, S., & Pathak, P. (2011). Forced sales and house prices. *American Economic Review, 101*(5), 2108–2131.

Carroll, T. M., Clauretie, T. M., & Neill, H. R. (1997). Effect of foreclosure status on residential selling price: comment. *Journal of Real Estate Research, 13*(1), 95–102.

Cheng, P., Lin, Z., & Liu, Y. (2008). A model of time-on-market and real estate price under sequential search with recall. *Real Estate Economics, 36*(4), 813–843.

Cheng, P., Lin, Z., Liu, Y., & Seiler, M. J. (2015). The benefit of search in housing markets. *Journal of Real Estate Research, 37*(4), 597–621.

Chinloy, P., Hardin, W., III, & Wu, Z. (2016). Foreclosure, REO, and market sales in residential real estate. *The Journal of Real Estate Finance and Economics, 54,* 1–28.

Clauretie, T. M., & Daneshvary, N. (2009). Estimating the house foreclosure discount corrected for spatial price interdependence and endogeneity of marketing time. *Real Estate Economics, 37*(1), 43–67.

Courant, P. N. (1978). Racial prejudice in a search model of the urban housing market. *Journal of Urban Economics, 5*(3), 329–345.

Ding, L., & Nakamura, L. (2016). The impact of the home valuation code of conduct on appraisal and mortgage outcomes. *Real Estate Economics, 44*(3), 658–690.

Donner, H. (2017). Foreclosures, returns, and buyer intentions. *Journal of Real Estate Research, 39*(2), 189–213.

Donner, H., Song, H.-S., & Wilhelmsson, M. (2016). Forced sales and their impact on real estate prices. *Journal of Housing Economics, 34,* 60–68. https://doi.org/10.1016/j.jhe.2016.08.002.

Eriksen, M. D., Fout, H. B., Palim, M., & Rosenblatt, E. (2019). The influence of contract prices and relationships on appraisal bias. *Journal of Urban Economics, 111,* 132–143.

Forgey, F. A., Rutherford, R. C., & Springer, T. M. (1996). Search and liquidity in single-family housing. *Real Estate Economics, 24*(3), 273–292.

Forgey, F. A., Rutherford, R. C., & VanBuskirk, M. L. (1994). Effect of foreclosure status on residential selling price. *Journal of Real Estate Research, 9*(3), 313–318.

Genesove, D., & Mayer, C. J. (1997). Equity and time to sale in the real estate market. *The American Economic Review, 87,* 255–269.

Genesove, D., & Mayer, C. (2001). Loss aversion and seller behavior: Evidence from the housing market. *The Quarterly Journal of Economics, 116*(4), 1233–1260.

Goetzmann, W., & Peng, L. (2006). Estimating house price indexes in the presence of seller reservation prices. *The Review of Economics and Statistics, 88*(1), 100–112.

Halvorsen, R., & Palmquist, R. (1980). The interpretation of dummy variables in semilogarithmic equations. *American Economic Review 70*(3), 474–475.

Hardin, W. G., & Wolverton, M. L. (1996). The relationship between foreclosure status and apartment price. *Journal of Real Estate Research, 12*(1), 101–109.
Harding, J. P., Rosenblatt, E., & Yao, V. W. (2012). The foreclosure discount: Myth or reality? *Journal of Urban Economics, 71*(2), 204–218.
Haurin, D. (1988). The duration of marketing time of residential housing. *Real Estate Economics, 16*(4), 396–410.
Lazear, E. P. (1986). Retail pricing and clearance sales. *The American Economic Review, 76*(1), 14–32.
Levitt, S. D., & Syverson, C. (2008). Market distortions when agents are better informed: The value of information in real estate transactions. *The Review of Economics and Statistics, 90*(4), 599–611.
Lippman, S. A., & McCall, J. J. (1986). An operational measure of liquidity. *The American Economic Review, 76*(1), 43–55.
Mayer, C. J. (1995). A model of negotiated sales applied to real estate auctions. *Journal of Urban Economics, 38*(1), 1–22.
Mayer, C. J. (1998). Assessing the performance of real estate auctions. *Real Estate Economics, 26*(1), 41–66.
Mocking, R., & Overvest, B. (2017). Direct and spillover effects of forced sales on house prices: Evidence from the Netherlands. *Journal of Housing Economics, 38,* 50–61.
Ong, S. (2006). Price discovery in real estate auctions: The story of unsuccessful attempts. *Journal of Real Estate Research, 28,* 39–60.
Ong, S. E., & Koh, Y. C. (2000). Time on-market and price trade-offs in high-rise housing sub-markets. *Urban Studies, 37*(11), 2057–2071.
Pennington-Cross, A. (2006). The value of foreclosed property. *Journal of Real Estate Research, 28*(2), 193–214.
Quan, D. C. (2002). Market mechanism choice and real estate disposition: Search versus auction. Available at SSRN 314960.
Renigier-Biłozor, M., Walacik, M., Źróbek, S., & d'Amato, M. (2018). Forced sale discount on property market–How to assess it? *Land Use Policy, 78,* 104–115.
Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, *82*(1), 34-55.
Rutherford, R. C., Springer, T., & Yavas, A. (2005). Conflicts between principals and agents: Evidence from residential brokerage. *Journal of Financial Economics, 76*(3), 627–665.
Shilling, J. D., Benjamin, J. D., & Sirmans, C. (1990). Estimating net realizable value for distressed real estate. *Journal of Real Estate Research, 5*(1), 129–140.
Shleifer, A., & Vishny, R. W. (1992). Liquidation values and debt capacity: A market equilibrium approach. *The Journal of Finance, 47*(4), 1343–1366.
Springer, T. M. (1996). Single-family housing transactions: Seller motivations, price, and marketing time. *The Journal of Real Estate Finance and Economics, 13*(3), 237–254.
Stigler, G. J. (1961). The economics of information. *The Journal of Political Economy, 69,* 213–225.
Taylor, C. R. (1999). Time-on-the-market as a sign of quality. *The Review of Economic Studies, 66*(3), 555–578.
Wong, S. K., Yiu, C. Y., & Chau, K. W. (2012). Liquidity and information asymmetry in the real estate market. *The Journal of Real Estate Finance and Economics, 45*(1), 49–62. https://doi.org/10.1007/s11146-011-9326-z.
Yavas, A., & Yang, S. (1995). The strategic role of listing price in marketing real estate: theory and evidence. *Real Estate Economics, 23*(3), 347–368.
Yinger, J. (1981). A search model of real estate broker behavior. *The American Economic Review, 71*(4), 591–605.
Yiu, C. Y., Wong, S. K., & Chau, K. W. (2009). Transaction volume and price dispersion in the presale and spot real estate markets. *The Journal of Real Estate Finance and Economics, 38*(3), 241–253.
Yiu, C. Y., et al. (2006). Alternative theories of appraisal bias. *Journal of Real Estate Literature, 14*(3), 321–344.
Zhou, H., Yuan, Y., Lako, C., Sklarz, M., & McKinney, C. (2015). Foreclosure discount: Definition and dynamic patterns. *Real Estate Economics, 43,* 683–718.