Competition and Appraisal Inflation

Abstract

In mortgage debt contracts, real property serves as collateral and the terms of mortgage financing are largely conditional on the certification of collateral value by appraisers. However, overstatement of collateral value is common in the appraisal industry, causing troubles in the mortgage market as observed in the recent crisis. In this paper, we examine whether competition in the appraisal industry affects appraisal bias. We model appraiser behavior given a loan officer's preference for favorable appraisals (i.e. appraisal values at least as high as the transaction prices). As appraisers cater to loan officers to increase their probability of winning future business, our model predicts more inflated appraisals in more competitive markets. We confirm this prediction using a sample of purchase mortgages originated between 2003-2006 by a large subprime mortgage lender. Our results show that a one standard deviation increase in appraiser competition, measured at the MSA/year level, is associated with a 1.6–3.7 percentage point increase in the share of at-price appraisals. Furthermore, the effect is stronger in areas experiencing high house price growth.

Key Words: *Competition, Appraisal Bias, Mortgages*

JEL Classification: G2, G01, G10, G18, D1, R2

I. Introduction

The recent financial crisis highlighted the importance of the US mortgage market to the global financial system. The sheer size of the US mortgage market ($14.6 trillion as of 2009),[1] combined with its relative importance on the balance sheets of both individuals and financial institutions, enables problems in mortgage markets to destabilize the global financial system and the economy (Campbell (2012)). In mortgage debt contracts, real property serves as collateral and the terms of mortgage financing are largely conditional on the certification of property value. For example, in residential purchase transactions, lenders base pricing and loan limits on the lower of the agreed upon purchase price and the appraised value of the property.[2] Since true property values are not directly observable in the market due to asset heterogeneity and infrequent trading, expert appraisers with local market knowledge typically perform the appraisal and on that account play an essential role in the mortgage financing decision by providing independent, unbiased estimates of the value of real properties used as collateral.

However, the independence of appraisers and the accuracy of appraisals have been widely questioned. Following the first empirical evidence by Cho and Megbolugbe (1996), the literature overwhelmingly documents a persistent upward bias in appraisals (Chinloy et al. (1997), Lang and Nakamura (1993), Quan and Quigley (1991), Calem et al. (2015), Shi and Zhang (2015), Agarwal et al. (2014), Griffin and Maturana (2016), Tzioumis (2017), and Kruger and Maturana (2017)).[3] This problem was particularly prevalent during the real estate boom leading to the 2007 financial crisis. For example, Griffin and Maturana (2016) estimate that nearly half of the appraisals on non-agency securitized loans between 2002 and 2007 were overstated. Several studies further show that loans associated with inflated collateral valuations are significantly more likely to default, thus concluding that appraisal bias was an important contributor to the recent mortgage crisis (Agarwal et al. (2015), Griffin and Maturana (2016), Agarwal et al. (2014), and Kruger and Maturana (2017)).

In line with the prior literature, Figure 1 shows that a staggering 47% of appraisals in our

[1] Total mortgage debt outstanding as reported by the Board of Governors of the Federal Reserve System.

[2] The refinancing of mortgage loans is also dependent on the confirmation of the value of the real estate. In this paper, the discussion centers primarily on purchase mortgages since the empirical tests can only be conducted on those mortgages.

[3] This is separate from bias stemming from the use of past transaction data that causes appraisals to lag real estate market cycles.

sample are at purchase price, with 2% of properties appraised below price and the remaining 51% representing above price appraisals. It strains credulity to think that this recurring exact agreement between the market transactors and an independent valuation of such a heterogeneous, lightly-traded asset is coincidental. Furthermore, given the absence of appraisals below the transaction price, it seems far more likely that below-price appraisals are "shaded up" to match the transaction. This has been dubbed "appraisal inflation". As proposed in Cho and Megbolugbe (1996) and Agarwal et al. (2015), such behavior is likely the result of other parties (e.g., borrowers, mortgage lenders, brokers, and realtors) influencing the appraiser's valuation. A low appraisal might prevent the buyer from obtaining the necessary financing for the purchase, resulting in lost opportunities for all parties involved, a point we return to shortly. Thus, these interested parties have an incentive to influence the appraiser to report a high appraised value. In fact, this perceived lack of appraiser independence became a serious concern to policymakers after the crisis, prompting the introduction of the Home Valuation Code of Conduct (HVCC) in May 2009 and its inclusion in the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010.[4]

Building on this notion of interference by other parties in appraiser independence, in this paper we propose that competition among appraisers plays an important role in explaining appraisal inflation. A higher level of competition may induce more cooperative behavior on the part of the appraiser. Bitner (2008) notes that in the subprime market "[A]ppraisers were influenced by brokers to increase the value. Brokers didn't need to exert direct influence. Instead, they picked another appraiser until someone consistently delivered the results they needed." The ability of a broker to move on is a direct consequence of increased competition in the appraiser market. On the other hand, with no competition from other appraisers, the influence of other agents (e.g., lenders and brokers) on the appraiser's valuation may be minimal. The point is, market competition between appraisers needs to be considered in any explanation of appraisal bias or inflation.

We first present a theoretical model in which the appraiser faces costs and benefits from appraisal inflation. Assuming that loan officers[5] prefer appraisers who report estimated values at least as high as the transaction prices, appraisers have the option of "shading up" a low appraisal to increase

[4]Introduced by the government-sponsored enterprises, the HVCC requires, among other things, the use of Appraisal Management Companies (AMCs) as a buffer between lenders and appraisers.

[5]The loan officer can either be a mortgage broker or an employee of the lender. In the data used in our empirical analysis, 89% of the loans are arranged by mortgage brokers.

their chance of winning future business from loan officers. They will, however, suffer a loss in utility (e.g., self-esteem) for reporting untruthful appraisals. We assume that there is a minimum level of appraised value below which appraisers are unwilling to "shade" because their utility loss is too high (relative to the benefits of shading). The difference between the purchase price and the minimum appraised value below which the appraiser is unwilling to inflate the appraisal is termed the tolerance level.[6] Our model predicts that the mass of appraisers in the market (relative to the number of transactions) is positively related to the tolerance level. That is, the more appraisers competing with each other in the market, the higher the tolerance level. Any appraisal that is below transaction price is assumed to be cancelled because such an appraisal would impose a greater down-payment burden on the buyer (note that we do not directly model the buyer's response to a below-price appraisal). Thus the resulting theoretical distribution of *observed* appraisals would be just as in the data presented in Figure 1– (virtually) no below market appraisals, a spike at the transaction price (consisting entirely of shaded up valuations) and a broad distribution of above-price appraisals. The key prediction of the model is that the height of the spike – the share of observed appraisals that are at price – is directly correlated with competition in the appraiser market.

It is important to note that while the theory model does make predictions about the relationship between the probability of an individual loan receiving an at-price appraisal and the level of competition in the appraisal market, this is not a useful prediction empirically, since we cannot observe the universe of appraisals, in particular a large bulk of below-price valuations.[7] Thus we cannot observe the sample probabilities of interest. What we can do is test the theory model's aforementioned prediction on the proportion of at-price appraisals. This is the main goal of the empirical sections below.

We use a sample of purchase mortgages originated by New Century Financial Corporation, one of the largest subprime mortgage originators during the recent housing boom. Our study period covers from 2003 to 2006. We begin our empirical modeling in Section VII.A by confirming the inverse relationship between below-price appraisals and the likelihood of a completed transaction in our data. This finding is consistent with the assumption in our model that loan officers have strong

[6]We are only concerned with positive tolerance levels.

[7]This data reporting issue occurs because truthfully reported appraisals below the transaction price often do not make it to the lender for final approval. We provide more detail on this censoring issue in Section III.

incentives to not report low appraisals, resulting in the data reporting issue described above. Therefore, we proceed to investigate the relationship between the *market share of observed appraisals* that equal the transaction price and the level of appraiser competition at the MSA level. We use the share of at-price appraisals as our primary dependent variable because Calem et al. (2015) argue that an at-price appraisal i) is evidence of appraisal inflation, and ii) makes the appraisal less informative ("information loss"). Consistent with our theoretical prediction, we find that a one standard deviation increase in appraiser competition is associated with a 3.7 percentage point increase in the share of at-price appraisals in the MSA when we measure appraisal competition by the number of appraisers per transaction, and a 1.6 percentage point increase in the share of at-price appraisals when we use a Herfindahl-Hirschman Index as our measure of appraisal competition. The effect ranges between 1.8 and 2.1 percentage points when using other alternative measures of appraiser competition. Further tests show that appraiser competition has a higher impact in areas with greater recent house price growth. In addition, we also find that the magnitude of the effect increased monotonically from 2003 to 2005, but dropped considerably and became statistically insignificant in 2006. In short, our theoretical model and empirical results emphasize the importance of competition in driving appraisal bias.

This paper contributes to our understanding of appraisal inflation by offering a new angle to examine the problem. From a policy perspective, our findings have important implications as well. Recent regulations aim to prevent interested parties (e.g., brokers, lenders) from influencing the valuation process. However, these policies are unlikely to address the issue of appraiser competition documented in this paper. In the current lending environment, appraisers still compete to earn business from appraisal management companies (AMCs) and lenders, thus appraisal bias as a result of competition is likely to remain an issue. Additionally, there have been calls to reduce barriers to entry into the appraisal industry (see Sorohan (2016) and National Appraisal Congress (2015) for examples).[8] Our analysis suggests that reducing barriers to entry into the appraisal profession may have the unintended consequence of increasing appraisal inflation. Note that this decrease in appraisal quality is not simply the result of (potentially) lowering average appraiser quality, but rather the result of increasing appraiser competition.

[8] Available at `https://www.mba.org/mba-newslinks/2016/april/mba-newslink-friday-4-1-16/residential/mba-urges-elimination-of-barriers-to-appraiser-entry` and https://www.aaro.net/docs/RemovingBarrierstoEntryinValuations_NationalAppraisalCongress.pdf, respectively.

The remainder of this paper is organized as follows. Section II describes a review of the related literature. Section III explains the institutional background of the appraisal and mortgage lending process, including a discussion on the role and incentive of all interested parties. This section provides readers with essential information to motivate our theoretical model in Section IV. We describe our empirical methodology and data in Section V and VI. We then present the empirical estimation results in Section V, and extensions in Section VI. The final section concludes the paper.

II. Literature Review

The first paper to document the upward bias problem in appraisal is Cho and Megbolugbe (1996), who find that 30% of the appraisals in their sample were identical to and more than 60% were above the purchase prices. The authors argue that this highly asymmetric distribution is evidence of moral hazard on the part of appraisers, who report inflated appraisals due to pressures from the end-users (buyers, brokers, lenders). A subsequent article by Chinloy et al. (1997) estimates the bias to be 2%. More recently, Kruger and Maturana (2017) find that appraisals are on average 5% higher than the values estimated by automatic valuation models. Eriksen et al. (2016) again confirm the appraisal bias problem using a unique dataset of foreclosed properties that were appraised twice between 2012 and 2015, where one of the appraisers was unaware of the contract price. They find significant differences between the two appraisals: the appraiser who knew of the contract price used different comparable transactions and price adjustment methods to justify their appraised values, which equaled the contract price. Appraisal biases due to feedback and anchoring have also been found in commercial appraisals in Hansz and Diaz III (2001) as well as Clayton et al. (2001). These observations are at odds with earlier theoretical appraisal models in the literature, in which appraisers follow an optimal updating rule or backward-looking expectations (Lang and Nakamura (1993); Quan and Quigley (1991)).

Kruger and Maturana (2017) show that appraisal bias varies across loan officers, mortgage brokers, and appraisers, which they interpret as evidence of intentional inflation. In a recent paper, Calem et al. (2015) theorize that appraisers substitute the transaction price for the actual appraised value if the latter is below the former (information loss). On the other hand, when the appraisal is above the transaction price, there is no need for inflation and the appraiser truthfully reports his estimated value. While it helps facilitate transactions, appraisal inflation inevitably increases default risk through large loan amounts that are too high compared to the true collateral values, as found in LaCour-Little and Malpezzi (2003), Ben-David (2011), Calem et al. (2016), and Kruger and Maturana (2017). The model proposed in Calem et al. (2015) implies that appraisers have to balance the tradeoff between the increased default risk versus the cost of a failed transaction. Accordingly, when the perceived credit risk of a mortgage is lower, the incentive for appraisers to engage in substitution is strengthened. Consistent with this reasoning, Calem et al. (2015) find that rising house prices and decreased foreclosure rates reduce the probability of low appraisals. Using data on mortgage refinancing and their subsequent sale transactions, Agarwal et al. (2015) show that the extent of bias depends largely on the motivations of mortgage originators and borrowers to influence appraisers. For example, valuation inflation is much more pronounced among refinance mortgages originated by brokers because they do not bear the default risk, and among loans with high LTV ratios because financially constrained borrowers have stronger needs to obtain high appraised values for their properties.

However, Tzioumis (2017) offers an alternative observation that there is no association between appraisal inflation and subsequent work volume, implying no incentives for appraisers to engage in such behaviors. Tzioumis (2017) uses the appraised value relative to purchase price minus unity to measure inflation, but, since there are very few below-price appraisals in his sample, he is effectively measuring how far the appraisal is above the transaction price. However, as we discuss further below, only a below-price appraisal impacts the likelihood of a transaction. There is no difference between an at-price or above-price appraisal from a loan officer's perspective. Thus, there is no reason to expect that an appraiser that consistently appraises (well) above price will get any more business than an appraiser that consistently appraises at-price. A few papers examine whether the use of AMCs as an intermediary between appraisers and lenders helps increase the objectivity of the former (Agarwal et al. (2014); Calem et al. (2015); Ding and Nakamura (2016)). The 2009 Home Valuation Code of Conduct, which mandated the use of AMCs for government-sponsored enterprise loans, is found to have reduced the magnitude of appraisal bias by as much as 45% in Agarwal et al. (2014).

One important missing piece in the literature discussed above is the impact of competition on the behaviors of appraisers, which is the focus of this paper. A rich literature exists that studies the link between competition and reporting bias of financial agencies, especially in the case of credit ratings and analyst forecasts. For example, that rating agencies often engage in rating inflation is a well documented phenomenon. The issuer-pay business model naturally creates a classic conflict of interest problem: issuers will shop for favorable ratings among agencies, leading to widespread rating inflation (Bolton et al. (2012), Skreta and Veldkamp (2009)). Building on a similar assumption that lenders shop for favorable appraisals from appraisers, our theoretical model in Section IV shows that competition contributes to drive appraisal inflation.

A large strand of literature provides evidence that competition forces credit rating agencies to bias their opinions to cater to the interest of the end users (investors, security issuers, consumers, etc.) in order to win business.[9] Using the market share of Fitch as a measure of competition with Moodys and SP, Becker and Milbourn (2011) document a positive link between competition and corporate bond ratings during the period 1995-2006. A similar finding is found in Cohen and Manuszak (2013) for the ratings of commercial mortgage-backed securities (CMBS) by Fitch. However, in a recent paper, Bae et al. (2015) argue that Fitchs market share is subject to a potential endogeneity issue caused by industry-wide characteristics. After including industry fixed effects to address this issue, the authors do not find any significant relation between Fitchs market share and rating inflation. Another working paper by Flynn and Ghent (2015) utilizes the entry of Morningstar Credit Ratings LLC and Kroll Bond Ratings into the CMBS rating market as an exogenous increase in competition for the four incumbent agencies (Moodys, SP, Fitch, and Dominion Bond Rating Service). Their data on the ratings of CMBS from 2009 to 2014 show that the entrants issued higher ratings than the incumbents in order to win business. In response, the ratings by the incumbents also became more generous as the entrants increased their market share.

III. Institutional Background

The market value of collateral is critical to assessing default risk and expected loss given default on collateralized borrowing. Yet, bargaining and search frictions that characterize real estate markets make it difficult to ascertain market value. Thus, even an agreed upon transaction price is

[9]A competing view in the literature argues that agencies facing higher competition have to maintain their reputation by providing more credible reports. See, for example, Hong and Kacperczyk (2010) and Xia (2014). In addition, Doherty et al. (2012) and Bolton et al. (2007) also suggest that competition enhances information disclosure of financial service agencies.

likely a "noisy" estimate of market value. Because the transaction price is "noisy" and the borrower may be overpaying for the property, lenders typically require an appraisal as a second estimate of market value.[10] Convention in the mortgage industry is to use the lower of the two estimates as the market value for lending decisions (e.g., accept/reject, LTV calculation, pricing). In fact, using the lower value estimate is a requirement for loans originated by federally regulated banking institutions, as well as loans guaranteed by the federal government or government-sponsored entities (GSEs) ((Calem et al., 2015)). In practice, even for loans outside these channels, mortgage lenders use the lower of the transaction price and the appraised value as the market value of the collateral (Ding and Nakamura (2016) and Nakamura et al. (2010)).

Before delving into the incentives of parties involved in the transaction, it is perhaps useful to describe some of the steps involved in a "typical" transaction.[11] After the buyer and seller negotiate a mutually agreeable transaction price, the buyer submits a copy of the sales agreement to his mortgage loan officer.[12] Next, the loan officer orders an appraisal by submitting an appraisal order form along with the sales agreement to an appraiser of his choice. Typically, the loan officer chooses the appraiser from a favored list of appraisers. Availability, turn-around time, and the appraiser's proclivity to not deliver problematic appraisals (e.g., low appraisals), can all affect the likelihood that an appraiser is on the favored list. The appraiser is usually an independent contractor, not directly employed for a mortgage broker or lender. An important detail is that the favored appraiser may not actually complete the appraisal request. For example, if he has a large volume of outstanding requests, the appraiser may decline the request. Alternatively, if the current turn-around time is unsatisfactory to the loan officer, the loan officer may cancel the request and

[10] The originating mortgage lender may temporarily fund a loan before selling the loan off in the secondary mortgage market to another lender (i.e., the ultimate lender). Appraisals improve mortgage liquidity in the secondary market.

[11] This is meant to describe a "typical" transaction, however, significant variation in the process is possible. Also, the steps described here are more reflective of the process in the time period covered by our empirical analysis (2003 - 2006). The Home Valuation Code of Conduct (HVCC) was developed as a result of a settlement between the GSEs, the Federal Housing Finance Agency (FHFA), and the New York Attorney General in 2009 (Tzioumis (2017)). A primary goal of the HVCC was to prevent parties with a vested interest in a closed transaction (e.g., real estate agents, loan officers) from attempting to influence appraisals. To help achieve this goal, loan officers were prevented from ordering appraisals directly from appraisers and from having substantive contact with appraisers. Instead, appraisals were typically ordered through another middleman, an appraisal management company (AMC), who then contracts with an appraiser. Interestingly, creating this "wall" (the AMC) between the loan officer and the appraiser may not prevent loan officer influence over the appraisal process. For example, if a loan officer consistently gets "low" appraisals from an AMC, then the officer can select a different AMC. Essentially the problem moves from loan officer influence over appraisers to loan officer influence over AMCs. The HVCC also inspired appraisal related provisions in the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Tzioumis (2017)).

[12] Prior to searching for homes, the loan officer gives the buyer an indication of the terms of credit that the borrower qualifies for.

submit a new request to a different appraiser. Figures 2 and 3 are examples of an appraisal order form and a sales agreement that a loan officer submits to an appraiser, respectively. Note that because the appraiser receives a copy of the sales agreement, he is aware of the purchase price of the property. After a request is accepted, the appraiser completes an appraisal of the subject property. The appraiser charges a fixed fee for his services that is independent of the property value or the outcome of the appraisal (below, at, or above price).[13] If the appraisal is at or above the transaction price, it is forwarded along to the loan officer, who then submits it to the lender, and barring any other issues that arise in the process, the sales transaction proceeds.

A below transaction-price appraisal can lead to several different outcomes, all of which decrease the probability of a completed sales transaction. A below transaction price appraisal may cause the lender to reject the application outright. LaCour-Little and Green (1998) find that a below-price appraisal significantly increases the probability of rejection. Even if the application is not rejected, a below-price appraisal either increases the required downpayment (to keep CLTV constant) or the interest rate (due to higher CLTV), *ceteris paribus*. A larger required downpayment or a higher interest rate reduces the likelihood of a transaction, particularly if the borrower is financially constrained. Finally, in response to a below-price appraisal, the buyer can attempt to renegotiate a lower sales price with the seller. If the seller is not willing to accept a lower price, the sale may be canceled. In practice, a below-price appraisal significantly reduces the likelihood of a completed transaction. In support of this conjecture, Fout and Yao (2016) estimate that a low appraisal (relative to transaction price) raises the probability that the sale is delayed or canceled from 25 percent to 32 percent. We provide empirical evidence to confirm this claim in Section VII.

Understanding the incentives of the different parties involved in the mortgage process is critical to our paper. A large portion of loan officer compensation comes in the form of commission, based either on loan volume or origination fees generated. Either way, loan officer compensation relies heavily on completed transactions (Shi and Zhang (2015) and Chinloy et al. (1997)). Since a below-price appraisal reduces the likelihood of a transaction, loan officers want to avoid below-price appraisals. A loan officer may be able to reduce the likelihood of a below-price appraisal

[13] Buyers also typically order a home inspection after receiving a satisfactory appraisal. The home inspection does not provide an estimate of the market value of the home. Rather, a home inspection evaluates the condition of the home's major systems (e.g., roof, structure, HVAC, plumbing). A lender may require a home inspection in addition to the appraisal.

by selecting an appraiser that tends to appraise at or above transaction price, or by trying to directly influence the appraiser's valuation. Indeed, policymakers developed rules and procedures in response to the crisis to curb loan officer and lender influence over the appraisal process (Ding and Nakamura (2016)). In the case that a loan officer receives a below-price appraisal, and the borrower is financially constrained and the seller is unwilling to renegotiate the sales price, the loan officer, particularly if a broker, has little (if any) incentive to submit the below-price appraisal. In fact, if a below-price appraisal is received prior to the broker submitting the loan package to the lender, the broker may never submit the package to the lender.[14]

In contrast to the loan officer, the appraiser collects a fixed fee that does not depend on a successful transaction. Thus, the appraiser's pay is not directly impacted by a below-price appraisal, and in theory he should report an objective, unbiased opinion of value. However, because appraisers are independent contractors, they rely on repeat business from loan officers. Submitting below-price appraisals is likely to move the appraiser off the loan officer's favored list. Fearing loss of business, the appraiser may avoid submitting below-price appraisals by inflating the reported value. This argument is analogous to the catering theory in the credit rating industry, where rating agencies are under pressures to bias their reports in response to rating shopping by issuers (Bolton et al., 2012). Appraisal inflation, though, is not costless to the appraiser. For example, the appraiser is generally hired by a mortgage broker, and brokers typically work with multiple lenders. The appraiser is not likely to know which lender(s) will receive the appraisal report. As long as there is a non-zero probability that the appraisal will be sent to a lender that values accurate/truthful appraisals, then there is an expected cost of "shading up" an appraisal. Lenders often use automated valuation models or in-house appraisers to review the appraisal reports submitted on loans. An appraiser that consistently shows a proclivity to inflate values could be banned from working with a lender that values accurate appraisals in the future ("blacklisted").[15] This is closely related to the idea in Calem et al. (2015) that appraisers face the cost of increased default risk when inflating

[14]Conversations with loan officers that worked in the industry during the time of our study suggest that this practice was common. Intuitively, if the loan officer knows the below-price appraisal will kill the deal, there is no reason to send the appraisal (or the application) to the lender. This means that a large share of below-price appraisals are never reported to the lender, and thus will not show up in standard data sets like the one employed in this study. Ding and Nakamura (2016) discuss this selection issue, while Demiroglu and James (2016) provide evidence that this selection issue could incorrectly be interpreted as appraisal inflation. Our theoretical model and empirical strategy account for this selection issue.

[15]Ironically, in the boom period some lenders allegedly used these "blacklists" to avoid appraisers that were unwilling to inflate values. See Harney (2008) for a description of one example of this alleged blacklisting.

appraisals, even though they do not bear the credit risk directly. Alternatively, finding comparable properties to justify an inflated value may require additional search. Additionally, appraisers may face psychological or moral costs for reporting fabricated values.

Finally, we turn to the lender. Specifically, why would the lender be willing to accept inflated appraisals? The first potential explanation is that the lender is unaware of appraisal inflation. Given the sophistication of market participants and the fact that appraisal inflation in mortgage markets was first documented over two decades ago (Cho and Megbolugbe (1996)), we find this explanation to be unlikely. Second, the lender may simply not care about appraisal inflation. For example, this would be the case if the mortgage lender can sell off mortgage loans to naive investors in secondary markets. Third, the expected benefits of appraisal inflation may simply outweigh the expected costs. If the lender expects high house price growth, for example, then the revenue generated through origination based on an inflated appraisal may outweigh the increased risk. But if participants understand the risk, and allow inflated appraisals, why are inflated appraisals necessary? Why doesn't the appraiser report the truthful value when it is below price, and the lender can decide whether to use the appraised value or the transaction price as the market value? Here it is important to remember that for many loans (e.g., loans backed by the Federal Government or the GSEs), it is a *requirement* that the lower of the appraised value or the transaction price equated to market value. Similarly, lenders originating loans outside these channels often follow suit. As we stated above, it is convention in the mortgage market to use the lower of these two values as the market value (Ding and Nakamura (2016) and Nakamura et al. (2010)). Although it is outside the scope of this paper to determine why lenders allow appraisal inflation, we note that evidence suggests it has real economic consequences. Inflated real estate valuations have been identified as a contributor to the 2007 real estate market crash and ensuing severe economic downturn (Agarwal et al. (2014) and Ben-David (2011)).

IV. A Theory of Appraisal Inflation

A. Set Up

We propose a model of appraiser behavior, wherein the appraiser faces costs and benefits from truthful appraisal. An appraisal that is not truthful lowers the utility of the appraiser but ensures higher future income, because the appraiser gains a reputation for "reliability." Reliable appraisers have higher match probabilities (higher probability of being selected) as new transactions come on the market. For the reasons discussed earlier, loan officers first go to appraisers who have recently been reliable in the sense that they have delivered appraisals at least as high as the transaction price.[16] Given loan officer behavior, the appraiser has the option of "shading" a low appraisal up to the transaction price. This ensures better matching prospects but creates loss in (monetized) self-esteem. We assume there is a region of appraisal values where this will occur, but that there is some point, far enough below the transaction price, that the appraiser becomes unwilling to "shade up." With this, three types of appraisal reports occur: truthful appraisals that are above the transaction price, a large number of appraisals that are at exactly the transaction value, and a potentially small number of appraisals that are both truthful and (well) below the transaction price.

The formal description of the model follows. A housing market is characterized by a discrete number of (housing) transactions per day, T, and a discrete population of appraisers, N. Both sides go to the appraisal market in the hopes of being matched with a market participant from the other side. There are two types of appraisers, those in the "favored" group, in a sense to be described shortly, with count V, and those in the "unfavored" group, with count U, so that

$$N = U + V \tag{1}$$

When an appraiser is matched with a transaction, an appraisal takes place, for which the appraiser is paid, under all outcomes, an appraisal fee F. Given the distribution of appraisals during this time period, we assume that appraisers know the transaction price, P. The appraiser arrives at a "true" appraisal, irrespective of the transaction price, which we denote $P + e$, e representing the appraisal's deviation from the transaction price (P).[17] This appraisal deviation has a mean of zero and is characterized by cumulative distribution G. If the true appraisal is greater than the transaction price, i.e, $e > 0$ then the appraisal is truthfully reported, and the appraiser is considered

[16] Loan officers can refer to the employee of a lending institutions or mortgage brokers. Even though Dodd-Frank regulations create some distance between loan officers and appraisers by requiring loan officers to go through an appraisal management company (AMC), the incentive problem still remains. Our empirical test covers the pre-Dodd-Frank period.

[17] G is the distribution of appraisals around the transaction price, which could also be considered to be the market value of the property in an arm-length transaction. This distribution is not necessarily symmetrical around P.

part of the V group. If the true appraisal is less than P then the appraiser must make a decision whether to report the true appraisal or to instead increase the appraisal to the transaction price. We posit that there is a threshold value of e, which we denote a such that if $0 > e > a$ the appraisal deviation is deemed inconsequential and P is reported as the appraised value. In this case the appraiser is also considered to be in the V group, but suffers a loss of esteem which we quantify as h. However, if $e < a < 0$ then the appraisal deviation is too large to be deemed inconsequential, and the true appraisal is reported. The appraiser still collects the fee, and avoids the loss of h, but is now regarded as being part of the U group. In sum, the payoffs and attendant probabilities for appraisers are:

$$F \ with \ probability \ (1 - G(0)) + G(a)$$

and

$$F - h \ with \ probability \ G(0) - G(a)$$

The importance of the market's classification of appraisers lies in the process that matches appraisers to transactions. A loan officer (who shepherds the transaction through the appraisal process) enjoys a higher payoff if the appraised value of the property is at least P. If the appraisal is less than P, the buyer is normally required to make up the difference between the two. If the borrower is liquidity-constrained, or is influenced by the low appraisal, they may withdraw from the transaction, in which case the loan officer loses incurred expenses and whatever profit that would be gained by making the mortgage loan. Thus the loan officer has an incentive to pick an appraiser who is more likely to bring in an appraisal of at least P.[18] This means going to the market in search of a V appraiser.

We assume a "balls and urns" matching process of the type described in Petrongolo and Pissarides (2001). With V appraisers, and T transactions, the number of matches that takes place is

$$M_1 = V(1 - exp(-T/V))$$

[18]In our model we assume that appraisers and loan officers do not consider the consequence of future losses from default due to appraisal inflation.

so that the probability that a V appraiser gets matched in this first round is

$$M_1/V = (1 - exp(-\frac{T}{V})) = \beta_1 \tag{2}$$

and we use γ_1 to denote the fraction of the T transactions that are matched in this round. If such a match fails to occur, we assume that the loan officer goes to the U group (in a manner similar to employer behavior in on-the-job search models (Pissarides, 1994)). The matching rate for this set of appraisers is determined by the same functional form:

$$M_2/U = (1 - exp(\frac{-(1-\gamma_1)T}{U})) = \beta_2 \tag{3}$$

where, again, the fraction of matched transactions is γ_2. Loan officers who fail in both of the first two rounds will exit the market that period.

The number of matches has to be the same on both sides of the market, therefore:

$$\beta_1 V = \gamma_1 T \tag{4}$$

$$\beta_2 U = \gamma_2 (1-\gamma_1) T \tag{5}$$

The appraisers decision variable is a, the optimal amount of "shading", which is state-dependent. With $J(V)$ and $J(U)$ representing their lifetime utility from current states V and U, the current flow values of those utilities can be given by standard Bellman equations (Pissarides, 2000)

$$rJ(V) = \beta_1 Z(a) + \beta_1 G(a)(J(U) - J(V)) \tag{6}$$

$$rJ(U) = \beta_2 Z(a) + \beta_2 (1 - G(a))(J(V) - J(U)) \tag{7}$$

noting that r is the exogenous discount rate and $G(a)$ is the probability of drawing a true appraisal that puts the appraiser into the U group, β_1 is the probability of a V group member making a match in the first round, β_2 is the probability of a U group member making a match in the second round, and

$$Z(a) = F - h(G(0) - G(a))$$

is the expected payoff (for either type) given a match. The appraiser maximizes utility given their current state, by the choice of a, which can be different across states. The model is closed with the steady state assumption that state transitions from U to V and the reverse are equal:

$$\beta_1 G(a(V))V = \beta_2[1 - G(a(U))]U \tag{8}$$

B. Solution

There are eight equations: the constraint that the number of U and V appraisers add up to N (equation 1), the two matching equations 2 and 3, the two equations that equate the numbers of buyers and sellers in each round (equations 4 and 5), the two first-order conditions, A3 and A4 in the Appendix, derived from equations 6 and 7, and the steady state assumption (equation 8). There are also eight endogenous variables: the two appraiser (buyer) matching rates (β_1 and β_2), the two transaction (seller) matching rates (γ_1 and γ_2), the number of U and V appraisers, and the two tolerance levels $a(U)$ and $a(V)$. The model is non-recursive and nonlinear, so we resort to simulations to analyze the market intuition. The model does appear to have multiple equilibria, but they are similar in nature and generally yield the same intuition.

The overall intuition of the model is clear. As is standard in most models of this type, the key variable is the ratio of participants on each side of the market. This ratio, T/N, is commonly referred to as "market tightness." Note that an increase in the ratio is a decrease in market tightness from the point of view of the appraisers. Such an increase in the ratio raises the matching rate for both types of appraisers, so that the effect on the number of U and V appraisers will depend on the relative impact on β_1 vs. β_2. In response to these increases both tolerance levels $a(U)$ and $a(V)$ will fall, and the number of at price appraisals will be reduced accordingly. Equilibrium comes about when the U and V flows that arise given the tolerance levels matches the U and V flows in the steady state equation.

We numerically solve for the eight endogenous variables $(\beta_1, \beta_2, \gamma_1, \gamma_2, a(U), a(V), U, V)$ in terms of the six model parameters ($N, T, r, F, G,$ and h). Our parameterization is based on a daily appraisal market in medium sized city. We set N=200, and allow the number of (daily) appraisals, T, to range between 1 and 200. (Above 200 the simulations become uninteresting as all appraisers seem to be employed on a daily basis). We set the daily discount rate, r to be 0.05/365 and F to be a standard appraisal fee of \$500. The remaining parameters are a matter of some speculation. We need to first parameter the distribution of the appraisal around the transaction price, e. For tractability, we assume e is uniform around 0, with a spread of \$7500 in each direction. (It is tempting to base this spread on, say, the standard error of a hedonic regression, but these turn out to be much larger than we believe the range of appraisal estimates would be.) More uncertain is h, the monetary measure of the psychic loss from an inaccurate appraisal. We set this at \$5000, much more than the appraisal fee, but will allow this to vary in the simulations to follow.

Figures 4 and 5 present the results of the simulation results. The figures represent the responses of the endogenous variables to changes in market tightness, as represented by the number of transactions on the horizontal axis. Thus an increase along that axis represents a decrease in appraiser competition. Note first of all that at high levels of market tightness (low values of T) the tolerance levels, $a(V)$ and $a(V)$, are very large. Appraisers are very willing to bump up appraisals to transaction price for fear of lost future assignments when competition is greater. As expected, however, U appraisers shows a higher propensity to shade at high levels of market tightness in order to increase their chance of getting matched next period. For example, $a(U)$ is almost twice as large as $a(V)$ when T=50 (\$3,800 vs. \$2,000 in Figure 5). As T rises, the matching rates for both types go up (Figure 4). Note that the matching rate for V appraisers, β_1, rises faster than β_2, the matching rate for U appraisers. As these matching rates rise, the fear of lost appraisal opportunities declines, and Figure 5 shows that tolerance levels decline as a result. There is less fear of lost opportunities. Given that $a(U)$ is larger than $a(V)$, note that the number of U appraisers rises, and V appraisers falls. This is sensible, since as market tightness falls, the disadvantage from being in the U group diminishes accordingly, and at about T=80 and above, the number of U appraisers is actually greater than the number of V appraisers. Note that at this point $a(U)$ is less than $a(V)$, an outcome that is necessary for the steady state to continue to hold.

As noted in Section III, the majority of truthfully reported below-price appraisals ($e < a < 0$) are not likely to show up in standard mortgage data sets. Thus, in the data we effectively only observe "shaded" at-price appraisals ($0 > e > a$) and above-price appraisals ($e > 0$). Since our empirical work is particularly concerned with the percentage of *observed* appraisals that are at-price (at-price as a share of at- and above-price), we are here interested in the outcome of this variable in the simulation. Figure 6 shows the relevant outcomes – the derivation is shown in the

Appendix. Note in Figure 5, the number of V appraisers falls with the tolerance level $a(V)$, so that unambiguously the number of observed at-price appraisals falls as well. Of course, the number of U appraisers rises, and as their tolerance levels falls, the effect on the number of observed at-price appraisals is ambiguous. As shown in Figure 6, our example simulation, the number rises until about T=40, and then falls drastically above this number. But the number of U appraisers is small relative to the number of V types, so that the percentage of at-price appraisals, as shown in Figure 6, falls with the decrease in competition, as expected. Nevertheless the total number of at price appraisals falls more or less steadily as market tightness falls.

Note that the number of above price appraisals rises steadily with declines in market tightness (Figure 6). This is strictly a function of the increased number of matches overall. But as the number of at-price appraisals falls, the proportion of observed (at-price plus above-price) appraisals that are at-price must unambiguously fall as well. This is shown in the final graph of Figure 6, and is the subject of empirical testing below.

V. Empirical Methodology

Since the focus of this paper is on appraiser competition and its effect on valuation, we must first define our appraiser competition measure. We measure appraiser market competition annually at the MSA level. Thus, our competition metric ($Compet_{mt}$) measures competition in MSA m at time (year) t. We propose two main measures of appraiser competition. Following our model, we use the number of appraisers per transaction by dividing the number of distinct appraisers in a MSA/year by the total number of purchase transaction in the same MSA/year. This measure of competition is most closely related to the market tightness measure used in our theoretical model. Obviously, the higher this measure, the more competitive the appraiser market. Next, we use market concentration since empirical studies typically assume that market concentration is inversely related to competition (Berger et al. (2004)), with the Herfindahl-Hirschman Index (HHI) serving as the most widely used proxy for market competition (Bikker and Haaf (2002)). Following this practice, we calculate appraiser competition as follows:

$$Compet_{mt} = -(HHI_{mt}) = -(\sum_{k=1}^{n} S_{kmt}^2) \tag{9}$$

where HHI_{mt} measures market concentration in MSA m at time t, and S_{kmt} represents the market share of appraiser k in MSA m at time t. Both S_{kmt} and HHI_{mt} range between zero and one. A HHI of one implies a monopolistic market while a HHI near zero implies perfect competition. We take the negative of the HHI so that an increase in this measure can be interpreted as an increase in competition. The construction of our competition measures will be discussed further in Section VI.A.

However, none of these competition measures is perfect. Given the shortcomings of HHI as a measure of competition noted in the literature, we also use two other concentration measures as robustness checks.[19] Our first alternative concentration measure is the concentration ratio of the two largest appraisers in each market (CR2). This is calculated by summing the market shares (based on the number of transactions) of the top two appraisers in an MSA in a given year. Similarly, we calculate the concentration ratio of the top four appraisers (CR4) as our second alternative measure. Concentration ratios range from zero to one, with higher values indicating lower competition, and are commonly used in the literature as proxies for market competition (Bikker and Haaf (2002)). As with HHI, we multiply these concentration ratios by negative one so that higher values of these variables reflect greater market competition. Our final proxy for appraiser competition, which is related to the number of appraisers per transaction, is the number of transactions per capita, calculated by dividing the number of appraisers in an MSA/year by the population of the MSA in the same year.

To test our model's main prediction, the positive effect of appraiser competition on the share of *observed* appraisals that equal transaction price, we estimate an ordinary least squares (OLS) model of the following form:

$$At\_Price_{mt} = \beta_0 + \beta_1 Compet_{mt} + \mathbf{X}'_{mt}\beta_2 + \alpha_t + \varepsilon_{mt}, \qquad (10)$$

where At_Price_{mt} is the share of *observed* appraisals that equal the transaction price in MSA m in year t, $Compet_{mt}$ is a measure of appraiser competition, $\mathbf{X}_{mt}$ is a vector of MSA characteristics at time t, α_t are year fixed effects that control for nation-wide changes in economic conditions, and

[19] For example, Liaukonyte and Visockyte (2010) notes that HHI cannot directly capture many aspects of a market, such as market dynamics and market size. These other competition measures are not necessarily superior to HHI. Our objective is to show that our main result is robust to various, though maybe individually imperfect, competition measures.

ε_{mt} is the error term with standard properties.[20] Our MSA-level controls, $\mathbf{X}_{mt}$, include house price appreciation over the previous year since evidence suggests that recent appreciation is negatively related to the likelihood that an individual appraisal comes in below price (Ding and Nakamura (2016)). $\mathbf{X}_{mt}$ also includes house price volatility over the previous 20 quarters to control for market-level house price uncertainty. Since market liquidity may impact the appraiser's ability to find comparable sales for the subject property, and thus the precision of the appraisal (Lang and Nakamura (1993)), $\mathbf{X}_{mt}$ also includes the natural logarithm of the total number of sales transaction in MSA m in year t from the Home Mortgage Disclosure Act (HMDA) data. We stress that At_Price_{mt} is based on appraisals that are *observed* by the econometrician. The distinction between observed appraisals and completed appraisals is an important one. As described above, it is likely that many below-price appraisals never make it into standard mortgage data sets. However, our theoretical model makes predictions about the share of *observed* appraisals that are at-price. More specifically, the main prediction of our theoretical model is that appraiser competition increases the share of *observed* appraisals that are at-price. To test this hypothesis empirically, we check whether $\beta_1 > 0$.

VI. Data

A. Sample Construction

Our primary database comes from New Century Financial Corporation (NCEN), one of the largest subprime mortgage lenders in the years leading up to the mortgage crisis. The data includes funded loans and unfunded loan applications. The purchase price and the appraised value – which are critical for our study – are both reported in the data.[21] The appraised value on an individual application can be below, above, or exactly at the agreed upon purchase price. The dependent variable of interest is the MSA share of appraisals in a given year where the appraised value equals the purchase price. Note that this measure is based only on purchases (not refinance loans) since we

[20] We do not lag our appraisal competition measure because our theory suggests a contemporaneous relation between appraiser competition and the share of at-price appraisals. However, appraiser competition may be endogenous. Note that we include a large number of correlates of competition (including a measure of market size) to address this concern. Also, we used the one year lag of our competition measures in estimating equation (10) (OLS) and the one year lag competition measures as instruments for competition in 2SLS and our results remain qualitatively and quantitatively unchanged.

[21] We excluded unfunded loans with missing appraisal values.

need a purchase price to compare the appraised value to. Also, we only include first-lien purchase loans in computing the dependent variable to avoid "double counting" the same transaction. Our second source of data is the Federal Housing Finance Agency's (FHFA) quarterly MSA house price index. To account for local house price trends, we match the NCEN data with the FHFA data and calculate the house price appreciation over the previous year as well as house price volatility over the previous 20 quarters. Finally, we use the HMDA loan activity reports (LAR) data to calculate the number of originated mortgage loans on purchase transactions for each MSA/year.

Since we want to examine the impact of appraiser competition on the share of at-price appraisals, we need to be able to identify individual appraisers to construct our competition measures. An important feature of the NCEN data is that the appraiser's full name is recorded. From this information we are able to track the number of appraisers and each appraiser's market share within geographic locations over time, which allows us to construct our competition measures for each MSA/year.[22] Again, we multiply this index by negative one so that a higher value of our appraiser competition measure represents greater competition. Figure 7 shows the level of appraiser competition (-HHI) for MSAs in our sample in 2005.[23] Perhaps not surprisingly, competition among appraisers is relatively high in the so-called "Sand States" (Arizona, California, Florida and Nevada).

A potential concern with our analysis is that we only observe appraisals (and appraisers) for applications that ended up with NCEN. By using applications from only one lender, our measure of competition assumes that competition in the NCEN data serves as a good proxy for the overall level of appraiser competition within an MSA/year. We believe this is a reasonable assumption with the intuition as follows. Residential appraisers rarely (if ever) work exclusively for one mortgage broker. In this sense, appraisers operate independently from mortgage brokers.[24] If this independence

[22] All of our alternative measures of competition are based off the ability to identify individual appraisers in our data set. Thus, we drop all observations where the appraiser's name is blank. Since appraisers are typically paid a fixed fee for an appraisal, we base HHI on the number of loan applications, rather than the dollar value of both refinance and purchase mortgage loan applications. However, as described above, we need a value (purchase price) to compare the appraisal to, so our dependent variable is based only on purchase loans.

[23] Again, we calculate appraiser competition in each year for each MSA. Appraiser competition within an MSA is highly persistent over time.

[24] Appraiser independence (or lack thereof) is commonly used in the literature to refer to other agents' (e.g. borrower, broker, lender) ability to influence the appraiser's valuation. Here, the term takes on a different meaning. We define an appraiser as independent if she does not work exclusively with a single broker or lender. The distinction is important. For our competition measure to be representative, we require that the appraisers do not work exclusively for a single broker, but we do not require that the appraiser's valuation cannot be influenced by other agents.

holds, then the sample of appraisers in each MSA in the NCEN data should be representative of the population of appraisers in that MSA as a whole. The same logic holds for each appraiser's market share. Tzioumis (2017) uses a similar argument regarding the independence of appraisers and appraiser market share. As a result of appraiser independence, our measure of appraiser competition should provide a reasonable proxy for "true" MSA/year appraiser competition.

Because the construction of our competition measures require the appraiser's name to be filled out, and this field is sparsely populated on non-funded applications prior to 2003, our sample period covers 2003 through 2006.[25] To be included in our estimation sample, we also require that an MSA has at least 30 purchase applications in a given year.[26] Our sample includes 876 MSA/year observations from 266 different MSAs.

B. Summary Statistics

Before reporting the summary statistics at the MSA/year level, we again turn to the *loan-level* distribution of appraised value relative to the the purchase price in our sample. Consistent with previous studies, a large portion (47%) of the appraisals in our initial sample come in exactly at the purchase price (Figure 1). In contrast, only 2% of appraisals are below the purchase price, with the remainder above the purchase price. It is important to note, however, that this is not the full distribution of completed appraisals. Rather, this is the distribution *observed in the data.* Appraisals that are truthfully reported below the transaction price, $e < a < 0$ in the language of our model, will generally not be observed in the data because, as described in the institutional details above, the mortgage broker has little (if any) incentive to submit the appraisal to the lender when it comes in low.

The summary statistics for the 876 MSA/year observations used in our analysis are presented in Table I. The mean share of appraisals that equal the purchase price is 44%, but there is a large range of values for our outcome of interest. The lowest share of at-price appraisals (14%) occurs in the Binghampton, NY MSA in 2006, whereas the largest share of at price appraisals (81%) is in the San Jose-Sunnyvale-Santa Clara, CA MSA in 2004. Our primary independent variable of interest, appraiser competition, ranges from 0.001 to 0.077 (with a mean of 0.011) using the number of

[25] Our study period ends in 2006 because NCEN filed for Chapter 11 bankruptcy in March 2007.

[26] In unreported robustness checks we find that our results remain unchanged using other minimum MSA/year level loan application requirements (e.g., 20, 40, 50, 60).

appraisers per transaction and from -0.396 to -0.002 (with a mean of -0.034) using HHI. Based on HHI, the most competitive appraiser market is the Los Angeles-Long Beach-Santa Ana, CA MSA in 2006, while the least competitive is Lubbock, TX in 2004. We also include in Table I the other three alternative measures of appraiser competition (-CR2, -CR4, and appraisers per capita) used in the robustness tests.[27] As expected, our measures of competition are highly correlated. The correlation between our HHI competition measure and -CR2, -CR4, appraisers per transaction, and appraisers per capita is 0.95, 0.92, and 0.19, and 0.26 respectively. The descriptive statistics for the other control variables used in our analysis are also reported in Table I.

VII. Results

A. Consequences of a Below-Price Appraisal

Before testing the main prediction of our model, we first provide evidence that a below-price appraisal reduces the likelihood of a completed transaction using a multinomial approach. This finding is consistent with the assumption in our model that loan officers have strong incentives to not submit truthfully reported below price appraisals to the lender, which results in the data reporting issue described above. There are three possible underwriting outcomes for loan applications observed in our data: originated, rejected, and withdrawn. An originated loan implies a completed sales transaction. A rejection indicates that New Century denied the loan application. An application can fall into the "withdrawn" category either by formal means (e.g., loan officer withdraws the application) or informal means (e.g., the loan officer lets the application "die"). Note that with a rejection or a withdrawn application we cannot definitively determine whether the sales transaction occurred. However, since a transaction is completed with 100% certainty when a loan is originated, it is reasonable to assume that a rejected or withdrawn application is less likely to result in a completed sales transaction (relative to originated loans).

To account for the polytomous nature of the underwriting outcome for purchase transactions, we model the probability p_{ij} of underwriting outcome $j \in \{originated, rejected, withdrawn\}$ on

[27] In Table I we multiply the number of appraiser per resident by 100 to avoid showing zeros because of rounding. However, in our regression analysis we do not multiply this measure by 100.

loan i with the multinomial logit specification:

$$p_{ij} = \frac{exp(\mathbf{\Gamma}_i'\beta_j)}{\sum_{j=1}^{3} exp(\mathbf{\Gamma}_i'\beta_j)} \tag{11}$$

where $\mathbf{\Gamma}_i$ includes include standard controls used in underwriting,[28] application year fixed effects, MSA fixed effects, and a binary indicator that takes a value of one if the appraisal is below the transaction price. The β_j's recovered from the estimation of the multinomial logit model will be used to determine whether a below-price appraisal affects underwriting outcomes. We compute the marginal effect estimates of a below-price appraisal on the three different underwriting outcomes. Note that the marginal effects of a control variable across the three possible underwriting outcomes will sum to zero. In other words, if a below-price appraisal lowers the probability that a loan is originated, it must decrease the probability of one or both of the other outcomes.

Column (1) of Table II shows that a below-price appraisal reduces the likelihood that a loan is originated by 8.7 percentage points, or a 12% decrease relative to the mean. At the same time, a below-price appraisal increases the probability that a loan application is rejected by New Century and the probability that a loan application is withdrawn. These results suggest that a below-price appraisal has a large impact on the likelihood that a transaction takes place, similar to the findings in Fout and Yao (2016). Note also that our sample only includes applications where New Century receives an appraisal. Applications likely exist where a below-price appraisal kills the transaction but the loan officer never submits the appraisal to the New Century. Thus, the result in column (1) of Table II should be regarded as a conservative estimate of the negative effect below-price appraisals have on the likelihood of a loan origination (and sales transaction).

B. The Relationship Between Appraiser Competition and At-Price Appraisals

Table III presents the coefficient estimates from the regression model of Equation (10). Each column uses a different proxy for appraiser competition. As predicted by our model, the results in Table III provide support for the main prediction from our theoretical model that $\beta > 0$. In

[28]The underwriting controls include (log) FICO Score, combined loan-to-value ratio, debt-to-income ratio, (log) loan amount, a binary indicator for an adjustable rate mortgage, a binary indicator for an investment property, and a binary indicator for a second home. In the interest of brevity, we do not report summary statistics or marginal effect estimates for the control variables used in the loan level regression of equation (11). These numbers are available from the authors upon request.

column (1) we use appraisers per purchase transaction as our measure of appraiser competition. Again, we reiterate that this is the proxy most closely related to the measure of competition in our theoretical model. Appraiser competition is significantly positively related to the share of at-price appraisals using appraisers per transaction. The effect is economically large as well. A one standard deviation increase in appraisers per transaction is associated with a 3.7 percentage point increase in the share of at-price appraisals, or an 8.5% increase relative to the mean.[29] In column (2), appraiser competition (-HHI) is also significantly positively related to the share of observed appraisals that are at-price. A one standard deviation increase in appraiser competition is associated with a 1.6 percentage point increase in the share of at-price appraisals, or a 3.5% increase relative to the mean.[30] Even though the magnitude of the effect is smaller using this measure, the effect is economically significant. This suggests that appraisers are more willing to "shade" reported values up to the transaction price in competitive markets.

Turning to our control variables, column (1) and (2) are very similar, except for one notable difference. Market thickness / liquidity (as proxied by *Ln(MSA Purchases))* is positive and significant in column (1). This provides some evidence that at-price appraisals are more likely to occur within a milieu of active markets with strong demand. The coefficient on recent house price appreciation, although negative, is not significantly related to the share of appraisals that equal the transaction price. However, house price volatility is positively related to the share of at price appraisals. This may be indicative of the fact that appraisers are more willing to "shade" appraisals in markets where it is harder to detect (where there is more uncertainty), other things equal. Alternatively, the temptation to use shortcuts, such as using the purchase price as an anchor, might be greater in markets with greater price uncertainty. Finally, we note that the share of at-price appraisals decreases monotonically over time, *ceteris paribus*.

Using our second alternative measure of appraiser competition (-CR2) in column (3), again we see an economically large and statistically significant positive relationship between appraiser competition and the share of at-price appraisals. A one standard deviation increase in this appraiser competition measure is associated with a 1.8 percentage point increase in the share of at-price

[29]This is calculated as the coefficient estimate times the standard deviation of appraiser competition divided by the share of at price appraisals in Table I (4.684 x 0.008 = 0.037 / 0.443 = 0.085).

[30]That is 0.443 x 0.035 / 0.443. To avoid confusion in this calculation, notice that the average share of at-price appraisals (0.443) is the same as the coefficient estimate of β (0.443).

appraisals, or a 4.1% increase relative to the mean. The magnitude, sign, and significance of the coefficients on the control variables in column (3) are largely unchanged from those reported in column (2). Turning to column (4), we also see that the estimates obtained when using -(CR4) as the proxy for appraiser competition are nearly identical to the results in column (3). Finally, in column (5) we use the number of appraisers per capita and the results are similar to previous columns.

To summarize, the results in Table III provide ample empirical support for our model's prediction that appraiser competition increases the share of at-price appraisals. Regardless of the proxy used, appraiser competition has a large and significant effect on the share of at price appraisals. This suggests that appraisers are more likely to "shade" reported values up to the purchase price in more competitive markets.

VIII. Extensions

A. House Price Growth

In Section VII.B we demonstrate a strong positive relationship between appraiser competition and the share of at-price appraisals that is robust across several different measures of market competition. A natural follow-up question is whether this relationship varies with recent house price appreciation. Similarly, is the relationship between the share of at-price appraisals more (or less) pronounced in boom areas? To be clear, we do not model this in Section IV. Moreover, the theoretical relation between share at-price, appraisal competition, and house prices is ambiguous. For example, where house prices appreciate rapidly it may be easier for an appraiser to select favorable comparable sales that support inflated values, allowing the appraiser to be more susceptible to competitive pressures. On the other hand, high housing demand in boom markets may make appraisers less fearful about future loss of business, and thus less likely to "shade" the value up to the transaction price. We again stress that the interaction between house price growth and appraiser competition is outside the scope of our theoretical model, however, we still view this as an interesting extension of our analysis.

We approach this question in two different ways. First, we estimate equation (10) but also include an interaction term between recent house price appreciation and appraiser competition. The coefficient estimates are reported in Panel A of Table IV. Notice that both appraiser competition and the interaction between competition and recent house price growth are positive across all columns. This suggests that appraiser competition has a larger impact in areas with greater recent house price growth, however, the fact that both of the interacted variables are continuous makes the coefficient estimates alone somewhat difficult to interpret. Thus, to ease interpretation, in Panel B we estimate the marginal effects of a one standard deviation increase in appraiser competition evaluated at the 90th percentile of MSA house price appreciation (0.211) and the 10th percentile of MSA house price appreciation (0.028), respectively, as well as the difference between the two estimates.[31] At the 90th percentile of house price appreciation, the effect of a one standard deviation increase in appraiser competition is significant across all measures and ranges in magnitude from 2.4 percentage points to 5.0 percentage points, or 5.4% to 11.3% relative to the mean. As the coefficient estimates of appraiser competition in Panel A suggest, the effect of a one standard deviation increase in competition at the 10th percentile of house prices is smaller. Indeed, for -(HHI) and appraisers per capita (columns (2) and (5)), the marginal effect estimates at the 10th percentile are not statistically significantly different from zero. The third row of Panel B tests for the difference between the two marginal effect estimates, and provides some support for the idea that the effect of appraiser competition varies with recent house price growth.

A related, but separate question of interest is whether appraiser competition has a more pronounced effect in boom areas. Since the so-called "sand states" (Arizona, California, Florida, Nevada) experienced house price booms in the run-up to the recent financial crisis, we create a binary variable that equals one if the MSA is primarily located in one of the sand states.[32] We then re-estimate equation (10) with the sand state indicator as well as its interaction with appraiser competition. The results are presented in Table V. In column (1), appraisers per transaction is positively related to the share of at-price appraisals in non-sand states, although it falls just outside conventional levels of statistical significance. In contrast, the next three concentration measures of competition are positive and significantly related to the share of at-price appraisals outside of the sand states. Appraisers per capita, reported in column (5), is negatively related to the fraction of at-price appraisals in sand states, but the magnitude of the coefficient is small and statistically in-

[31] These thresholds are based on MSA house price appreciations over the entire sample period.

[32] Alternatively, we could create a boom indicator by looking at the distribution in house price changes over our sample period and arbitrarily assigning a cutoff value to define boom areas.

distinguishable from zero. The main takeaway from this table is related to the interaction between sand state and appraiser competition. Regardless of the measure used, appraiser competition has a much larger impact on the share of at-price appraisals in boom areas as proxied by sand states.

Taken together, the results in this section provide some evidence that the effect of appraiser competition on appraisal accuracy is heightened in areas that experience large house price increases. This includes recent house price growth (Table IV) and sustained house price growth – boom areas – as proxied by sand states (Table V).

B. Appraiser Competition Over Time

We examine whether the effect of appraiser competition varies over time by estimating equation (10) separately for each year and for each of our competition measures. We estimate 20 separate regressions (four years × five competition measures) and report the coefficient estimates on appraiser competition in Table VI. Each regression includes the same controls as in Table III – minus the year fixed effects – but we only report coefficient estimates for the competition measures in the interest of space.[33] There are several key takeaways from this table. First, we note that across all measures and all years, the coefficient estimate on appraiser competition is positive. This suggests that appraiser competition impacted appraisal inflation throughout the entire period covered in our sample. Second, across all measures there appears to be a drop-off in the magnitude of the effect moving from 2005 to 2006. This suggests that something changed in 2006. Perhaps not coincidentally, house prices peaked – and even started declining – in many markets in 2006. The end of the boom period may have made "shading" more difficult or more costly for appraisers. In turn, appraisers may have been less likely to succumb to competitive pressures. This is consistent with the results in Section VIII.A that appraiser competition has a larger impact on the share of at-price appraisals in areas that experienced high recent house price growth. Third, the magnitude of the effect appears to increase in the early years across all measures of competition, again consistent with the idea that competition had a larger impact during booms. However, the timing of the increase and subsequent decrease in the magnitude of the effect vary across measures. For the concentration ratios (-HHI, -CR2, -CR4), the effect of competition increases from 2003 through 2005, then declines in 2006. The effect of the other two measures of competition increase

[33] Full regression results are available from the authors upon request.

from 2003 to 2004, but then the impact declines over the subsequent two years. Finally and most importantly, we note that the proxy for competition that is most closely related to our theoretical model – *Number of appraisers per purchase transaction* – is positive and significantly related to the share of at-price appraisals in every year.

IX. Conclusion

According to the Appraisal Institute "The role of the appraiser is to provide objective, impartial, and unbiased opinions about the value of real property."[34] However, researchers have long questioned whether appraisals are in fact objective, impartial and unbiased, and two consistent findings in the literature seem to be at odds with unbiasedness and objectivity. First, multiple studies provide evidence of an upward bias in appraisals. Second, a large share of appraisals on purchase transactions have an estimated value that equals the negotiated contract price. What drives these facts, however, remains elusive. Obviously, the appraiser's incentives must be considered for any explanation of appraiser bias or inflation. To the authors' knowledge, no previous study has investigated the role of competition in appraisal bias, despite its important influence on appraisers' incentives.

In this paper we argue that competition in the appraisal industry leads appraisers to inflate their estimates of property values in order to win business. Built on the premise that lenders prefer favorable appraisals, our theoretical model predicts more inflated appraisals in more competitive markets, as appraisers cater to lenders' preference. We then empirically test our model prediction using a sample of purchase applications between 2003 and 2006 from a large subprime lender. For each MSA in each year, we measure market competition primarily using the ratio of appraisers to total number of transactions, as well as the conventional Herfindahl-Hirschman Index. Our baseline results indicate that the share of at-price appraisals in a MSA/year increases with the level of competition in that market, confirming our theoretical prediction. In particular, a one standard deviation increase in competition is associated with a 1.6–3.7 percentage point increase in the share of at-price appraisals.

We further investigate the effect of competition in relation to house price growth. Interestingly,

[34] http://www.appraisalinstitute.org/appraisal-profession/.

competition has a larger impact in areas experiencing higher house price growth. In addition, the effect of competition grew significantly in magnitude each year from 2003 to 2005, but dipped in 2006 at the onset of the crisis. Although these observations raise interesting questions, they are beyond the scope of this paper. Nevertheless, our findings suggest that appraisal regulations enacted in response to the mortgage crisis, such as the Home Valuation Code of Conduct, are unlikely to reduce appraisers' propensity to match the transaction price.

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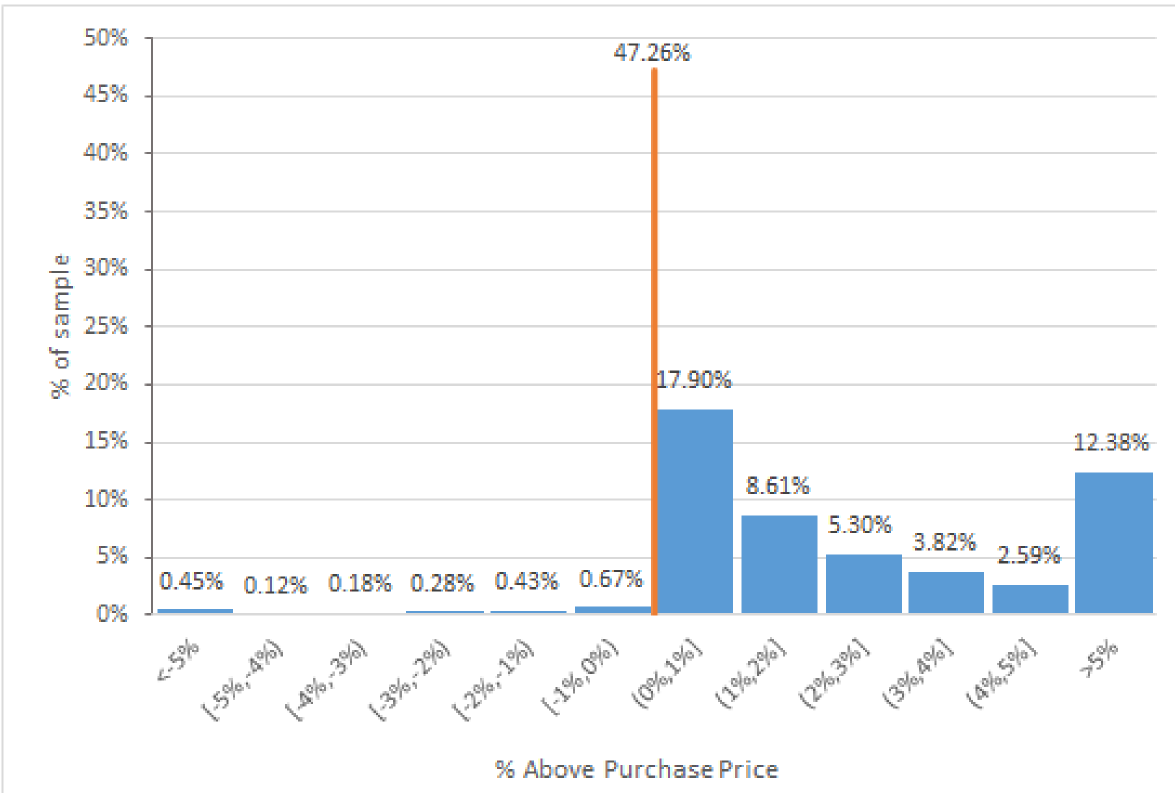
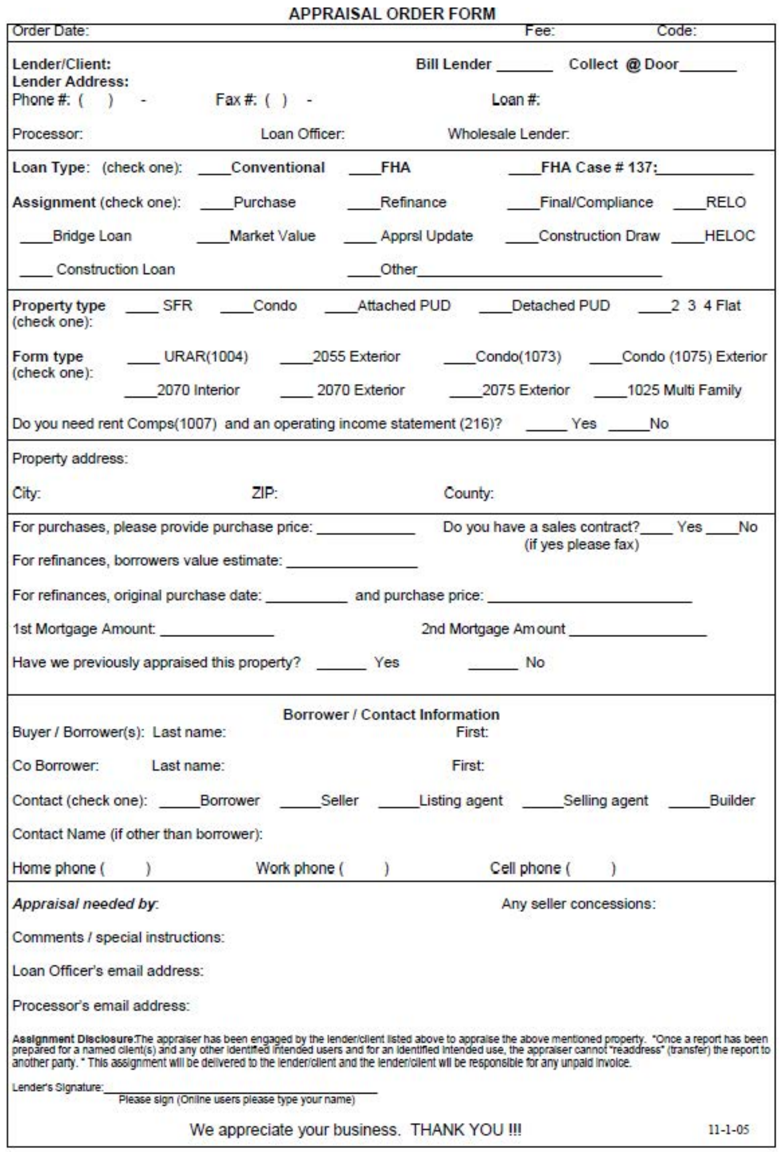


Figure 1: This figure shows the distribution of the appraised value relative to the purchase price for loan applications in our sample.



APPRAISAL ORDER FORM

Order Date: Fee: Code:

Lender/Client: **Bill Lender** ______ **Collect @ Door**______
Lender Address:
Phone #: ( ) - Fax #: ( ) - Loan #:

Processor: Loan Officer: Wholesale Lender:

Loan Type: (check one): ____**Conventional** ____**FHA** ____**FHA Case # 137:**___________

Assignment (check one): ____Purchase ____Refinance ____Final/Compliance ____RELO

____Bridge Loan ____Market Value ____ Apprsl Update ____Construction Draw ____HELOC

____ Construction Loan ____Other______________________

Property type (check one): ____ SFR ____Condo ____Attached PUD ____Detached PUD ____2 3 4 Flat

Form type (check one): ____ URAR(1004) ____2055 Exterior ____Condo(1073) ____Condo (1075) Exterior

____2070 Interior ____ 2070 Exterior ____2075 Exterior ____1025 Multi Family

Do you need rent Comps(1007) and an operating income statement (216)? _____ Yes _____No

Property address:

City: ZIP: County:

For purchases, please provide purchase price: ___________ Do you have a sales contract?____ Yes ____No (if yes please fax)

For refinances, borrowers value estimate: _______________

For refinances, original purchase date: _________ and purchase price: ______________________

1st Mortgage Amount: _____________ 2nd Mortgage Amount _______________

Have we previously appraised this property? ______ Yes ______ No

Borrower / Contact Information

Buyer / Borrower(s): Last name: First:

Co Borrower: Last name: First:

Contact (check one): _____Borrower _____Seller _____Listing agent _____Selling agent _____Builder

Contact Name (if other than borrower):

Home phone ( ) Work phone ( ) Cell phone ( )

***Appraisal needed by*:** Any seller concessions:

Comments / special instructions:

Loan Officer's email address:

Processor's email address:

Assignment Disclosure The appraiser has been engaged by the lender/client listed above to appraise the above mentioned property. "Once a report has been prepared for a named client(s) and any other identified intended users and for an identified intended use, the appraiser cannot "readdress" (transfer) the report to another party." This assignment will be delivered to the lender/client and the lender/client will be responsible for any unpaid invoice.

Lender's Signature:________________________________
Please sign (Online users please type your name)

We appreciate your business. THANK YOU !!! 11-1-05

Figure 2: Sample Appraisal Order Form.

SAMPLE

AGREEMENT TO PURCHASE REAL ESTATE

The undersigned (herein "Purchaser") hereby offers to purchase from the owner (herein "Seller") the real estate located at _________________________ in the city of______________________, County of_______________, State of_______________________, the legal description of which is:____

____

____

upon the following terms and conditions:

1. Purchase Price and Conditions of Payment

The purchase price shall be __________________________________Dollars ($__________) to be paid in accordance with subparagraph______________________, below:

A: Cash. The purchase price shall be paid in its entirety in cash at the time of closing the sale.

B: Cash Subject to New Mortgage. The purchase price shall be paid in cash at the time of closing the sale subject, however, to Purchaser's ability to obtain a first mortgage loan within _________days after the acceptance of this offer by Seller in the amount of $____________, payable in not less than ____________monthly installments, including interest at a rate not to exceed ___________% financing. If such financing cannot be obtained within the time specified above then either Purchaser or Seller may terminate this agreement and any earnest money deposited by Purchaser will be promptly refunded.

C: Cash Subject to Existing Mortgage. The purchase price shall be paid in cash at the time of closing the sale after deducting from the purchase price the then outstanding balance due and owing under the existing mortgage in favor of ____________, dated____________, 20___, in the original amount of $______________; of such mortgage debt is approximately $_______________ as of ________________, 20____.

D: Cash With Assumption of Existing Mortgage. The purchase price shall be paid in cash at the time of the closing of the sale after deducting from the purchase price the then outstanding balance due and owing under the existing mortgage in favor of ______________, dated________________, 20___,having a present balance of approximately $_________________________, as of ______________, 20___, which the purchaser hereby assumes and agrees to pay in accordance with its terms and to perform all of its provisions; purchaser shall pay any and all payments coming due after the closing of the sale. Any transfer fees required by the mortgage shall be paid by_______________.

E: Sale by Land Contract. The purchase price shall be paid in accordance with the certain land contract attached hereto and incorporated into this contract by this reference. The down payment to be made at the time of closing this sale shall be $____________and the balance of $___________shall be paid at the rate of __________% per annum.

2. Earnest Money Deposit

As earnest money Purchaser deposits $_________________with the broker which shall be applied to the purchase price at the time of closing the sale. In the event that this offer is not accepted by Seller this earnest money deposit shall be promptly refunded to Purchaser by the broker. In the event that this offer is accepted by Seller and Purchaser shall fail to perform the terms of this agreement the earnest money deposit shall be forfeited as and for liquidated damages suffered by Seller. Seller is not, however, precluded from asserting any other legal or equitable remedy, which may be available to enforce this agreement.

Figure 3: Sample Sales Contract.

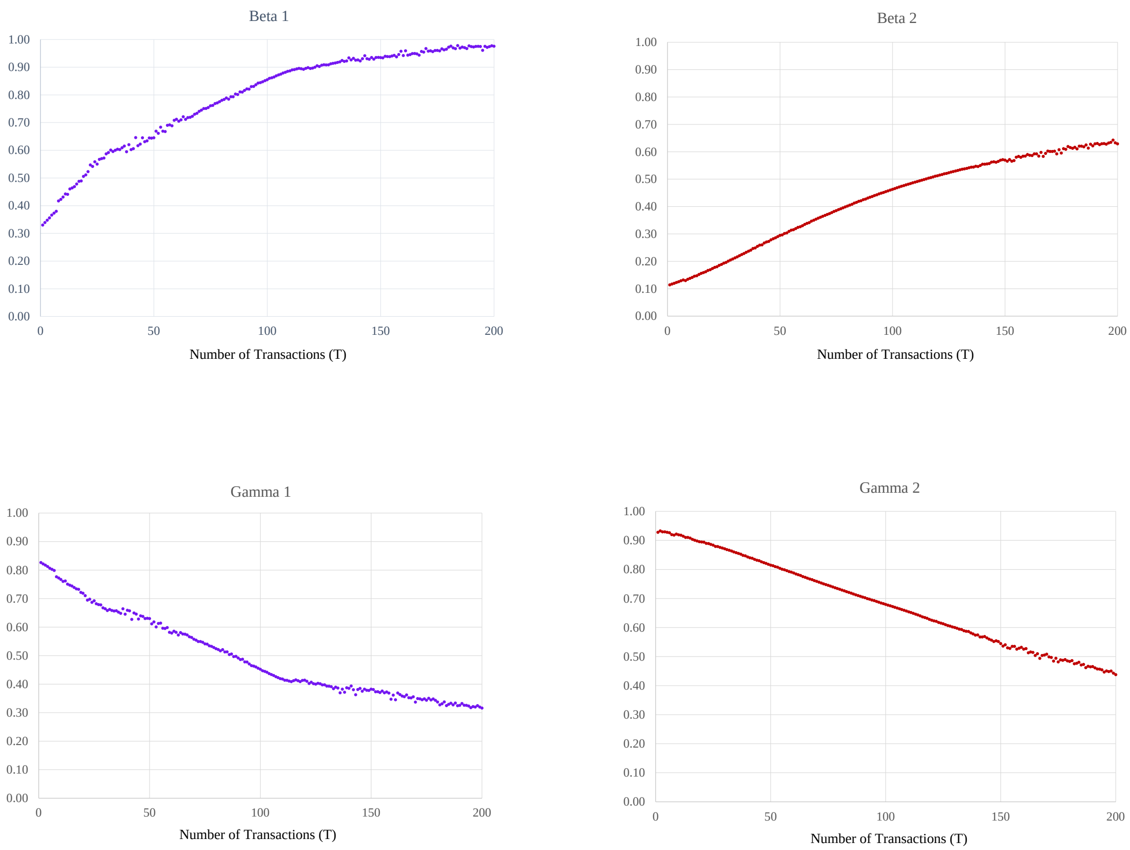


Figure 4: Response Functions (β_1, β_2, γ_1, γ_2)

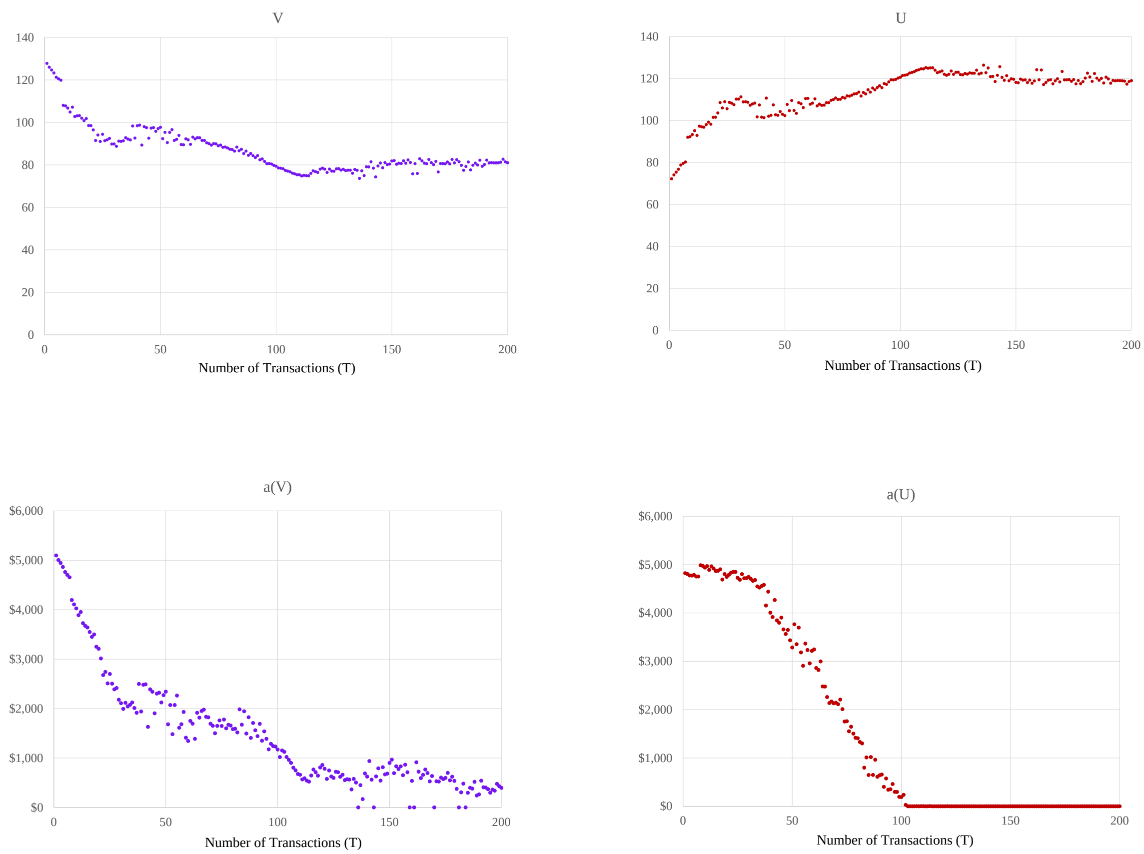


Figure 5: Response Functions (V, U, $a(V)$, $a(U)$)

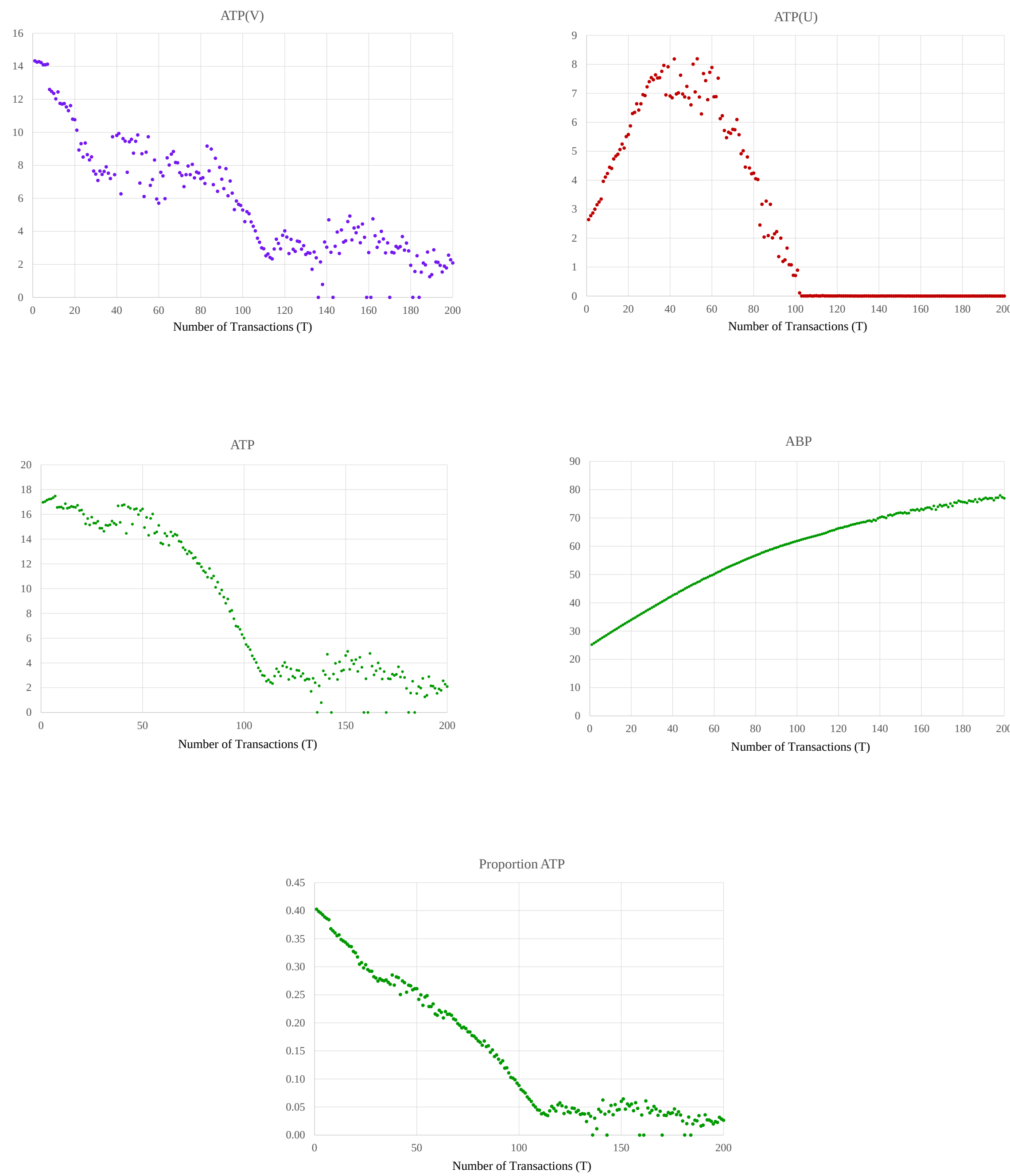


Figure 6: At-price appraisals by V appraisers ($ATP(V)$), at-price appraisals by U appraisers ($ATP(U)$), Total at-price appraisals ((ATP)), above-price appraisals (ABP), and proportion of at-price appraisals ($PropertionATP$)

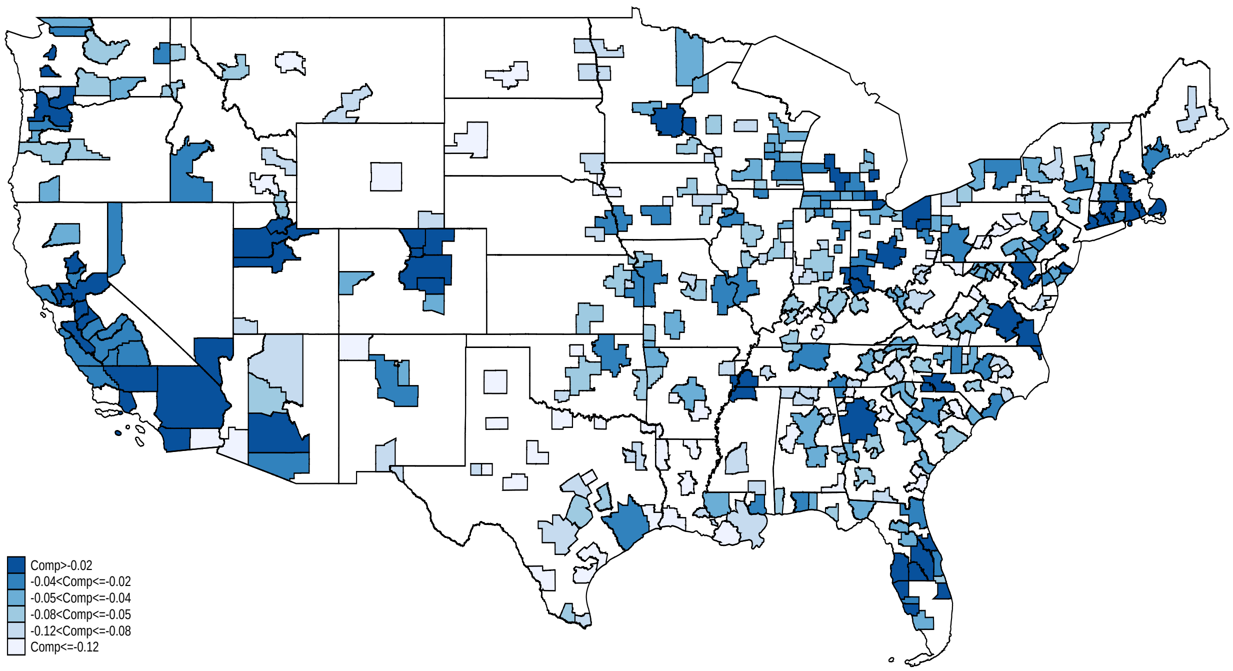


Figure 7: This figure shows the the level of appraisal competition (-HHI) for the MSAs in our sample in 2005.

Table I: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
MSA Share at Price	876	0.443	0.131	0.138	0.810
Appraiser Competition Measures:					
Number of appraisers per purchase transaction	876	0.011	0.008	0.001	0.077
-(HHI): -(Market concentratiion (MSA/Year))	876	-0.034	0.035	-0.396	-0.002
-(CR2): -(Concentration ratio of two largest appraisers (MSA/Year))	876	-0.155	0.100	-0.782	-0.022
-(CR4): -(Concentration ratio of four largest appraisers (MSA/Year))	876	-0.243	0.136	-0.837	-0.039
Number of appraisers per capita (× 100)	876	0.026	0.019	0.001	0.142
Ln(MSA purchases)	876	9.520	1.083	6.905	12.337
MSA price appreciation (annual)	876	0.100	0.076	-0.002	0.412
Price volatility (20-quarter rolling)	876	0.011	0.006	0.003	0.036
Application year = 2004	876	0.237	0.426	0	1
Application year = 2005	876	0.281	0.450	0	1
Application year = 2006	876	0.295	0.456	0	1
Share threshold CLTV (100%, 90%, 80%)	876	0.664	0.111	0.185	0.938

Note: This table presents summary statistics for 876 MSA/year observations in our sample. MSAs are required to have at least 30 purchase applications in a year in the NCEN data to be included in the sample.

Table II: Marginal Effect of a Below-Price Appraisal on Loan Underwriting Outcomes

VARIABLES	(1) Originated	(2) Rejected	(3) Withdrawn
Appraisal below price	-0.087***	0.012***	0.075***
	(0.005)	(0.002)	(0.004)
Observations		362,005	
Log Likelihood		-235,808	
Other Controls		Yes	
Year FE		Yes	
MSA FE		Yes	
Share of applications that were funded	0.745		
Share of applications that were rejected		0.036	
Share of applications that were withdrawn			0.219

Note: This table reports marginal effect estimates of a below-price appraisal on the likelihood of different loan outomes from a multinomial logit model. The control variables include standard credit risk measures: log(FICO Score), combined loan-to-value ratio, debt-to-income ratio, log(loan amount), a binary indicator for an adjustable rate mortgage, a binary indicator for an investment property, and a binary indicator for a second home. Since the probability of the three different outcomes must sum to one conditional on the control variables, the marginal effects must sum to zero across the three different outcomes. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table III: Fraction of at price appraisals

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	% At Price	% At Price	% At Price	% At Price	% At Price
Measure of Competition	Appraisers Per Transaction	-(HHI)	-(CR2)	-(CR4)	Appraisers Per Capita
VARIABLES					
Appraiser Competition (MSA/Year)	4.684***	0.444***	0.184***	0.157***	98.095**
	(0.893)	(0.166)	(0.063)	(0.053)	(41.711)
Ln(MSA purchases)	0.025***	0.003	0.002	-0.001	0.014*
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
MSA price appreciation (annual)	-0.172	-0.099	-0.109	-0.123	-0.133
	(0.175)	(0.180)	(0.179)	(0.180)	(0.186)
Price volatility (20-quarter rolling)	4.012*	4.943**	4.912**	4.952**	4.208*
	(2.344)	(2.459)	(2.409)	(2.396)	(2.476)
Application year = 2004	-0.031***	-0.025***	-0.025***	-0.027***	-0.028***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Application year = 2005	-0.103***	-0.099***	-0.099***	-0.100***	-0.102***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Application year = 2006	-0.126***	-0.118***	-0.119***	-0.121***	-0.118***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Constant	0.203**	0.449***	0.482***	0.518***	0.318***
	(0.083)	(0.075)	(0.074)	(0.077)	(0.080)
Observations	876	876	876	876	876
R-squared	0.198	0.152	0.156	0.158	0.156

Note: The dependent variable is the fraction of appraisals where the appraised value equals the sales price. Observations are at the MSA/year level. Column (1) uses the number of appraisers in an MSA/year divided by the number of purchase transactions in the same MSA/year. Column (2) uses the appraiser Herfindahl-Hirschman index as our measure of competition. Column (3) uses the concentration ratio (CR2) of the top two market shareholders (appraisers) as our measure of appraiser competition. Column (4) uses the concentration ratio (CR4) of the top four market shareholders (appraisers) as our measure of competition. Column (5) uses the number of appraisers in an MSA/year divided by the MSA's population. MSA cluster robust standard errors are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table IV: At-price appraisals, competition, and house price growth

	(1)	(2)	(3)	(4)	(5)
Panel A: Coefficient Estimates					
Dependent Variable	% At Price	% At Price	% At Price	% At Price	% At Price
Measure of Competition	Appraisers Per Transaction	-(HHI)	-(CR2)	-(CR4)	Appraisers Per Capita
VARIABLES					
Appraiser Competition (MSA/Year)	3.876**	0.094	0.098	0.072	27.789
	(1.494)	(0.213)	(0.079)	(0.065)	(61.553)
Appraiser Competition x MSA Price Appreciation	5.310	6.288*	1.310	1.213*	483.530
	(9.997)	(3.202)	(0.932)	(0.659)	(334.054)
Ln(MSA purchases)	0.024***	-0.000	-0.001	-0.004	0.014*
	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
MSA price appreciation (annual)	-0.234	0.057	0.064	0.136	-0.284
	(0.205)	(0.195)	(0.212)	(0.225)	(0.207)
Price volatility (20-quarter rolling)	4.024*	4.834*	4.793**	4.772**	4.292*
	(2.349)	(2.463)	(2.413)	(2.408)	(2.475)
Application year = 2004	-0.031***	-0.026***	-0.027***	-0.028***	-0.027***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Application year = 2005	-0.102***	-0.099***	-0.100***	-0.101***	-0.101***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Application year = 2006	-0.125***	-0.118***	-0.120***	-0.121***	-0.116***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Constant	0.214**	0.473***	0.492***	0.527***	0.333***
	(0.085)	(0.075)	(0.074)	(0.076)	(0.082)
Observations	876	876	876	876	876
R-squared	0.198	0.159	0.159	0.165	0.159
Panel B: Marginal effect of one standard deviation increase in : competition at:					
(a) 90th percentile of Price Appreciation	0.040***	0.050**	0.038**	0.045***	0.024***
	(0.010)	(0.019)	(0.016)	(0.015)	(0.009)
(b) 10th percentile of Price Appreciation	0.032***	0.009	0.013**	0.014*	0.008
	(0.010)	(0.006)	(0.007)	(0.008)	(0.010)
Difference (a - b)	0.008	0.040*	0.024	0.030*	0.017
	(0.015)	(0.021)	(0.017)	(0.017)	(0.011)

Note: Panel A reports the coefficient estimates from a regression where dependent variable is the fraction of appraisals where the appraised value equals the sales price. Observations are at the MSA/year level. Column (1) uses the number of appraisers in an MSA/year divided by the number of purchase transactions in the same MSA/year. Column (2) uses the appraiser Herfindahl-Hirschman index as our measure of competition. Column (3) uses the concentration ratio (CR2) of the top two market shareholders (appraisers) as our measure of appraiser competition. Column (4) uses the concentration ratio (CR4) of the top four market shareholders (appraisers) as our measure of competition. Column (5) uses the number of appraisers in an MSA/year divided by the MSA's population. MSA cluster robust standard errors are reported in parentheses. Panel B reports the marginal effect estimates for one standard deviation increase in appraiser competition evaluated at the 90th percentile of house price appreciation (0.211) and 10th percentile of house price appreciation (0.028), respectively, as well as the difference between the two estimates. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table V: Fraction of at price appraisals (Sand versus Non-sand states)

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	% At Price	% At Price	% At Price	% At Price	% At Price
Measure of Competition	Appraisers Per Transaction	-(HHI)	-(CR2)	-(CR4)	Appraisers Per Capita
VARIABLES					
Appraiser Competition (MSA/Year)	1.547	0.290**	0.118**	0.098**	-40.808
	(0.962)	(0.141)	(0.056)	(0.048)	(40.898)
Appraiser Competition x Sand State	4.805***	1.484**	0.432**	0.340**	216.538***
	(1.831)	(0.631)	(0.190)	(0.134)	(59.015)
Sand State	0.001	0.106***	0.124***	0.136***	-0.000
	(0.031)	(0.028)	(0.034)	(0.036)	(0.031)
Ln(MSA purchases)	0.018**	-0.002	-0.003	-0.006	0.010
	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)
MSA price appreciation (annual)	-0.285*	-0.248	-0.245	-0.249	-0.276
	(0.168)	(0.159)	(0.156)	(0.156)	(0.173)
Price volatility (20-quarter rolling)	2.538	2.891	2.764	2.754	2.989
	(2.232)	(2.198)	(2.138)	(2.134)	(2.343)
Application year = 2004	-0.027***	-0.023***	-0.024***	-0.025***	-0.024***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Application year = 2005	-0.088***	-0.087***	-0.088***	-0.090***	-0.087***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Application year = 2006	-0.106***	-0.102***	-0.104***	-0.106***	-0.098***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Constant	0.299***	0.503***	0.528***	0.560***	0.393***
	(0.082)	(0.068)	(0.067)	(0.070)	(0.079)
Observations	876	876	876	876	876
R-squared	0.234	0.191	0.193	0.198	0.197

Note: The dependent variable is the fraction of appraisals where the appraised value equals the sales price. Observations are at the MSA/year level. Sand State is a binary variable that equals one if the MSA is primarily located in Arizona, California, Florida or Nevada. Column (1) uses the number of appraisers in an MSA/year divided by the number of purchase transactions in the same MSA/year. Column (2) uses the appraiser Herfindahl-Hirschman index as our measure of competition. Column (3) uses the concentration ratio (CR2) of the top two market shareholders (appraisers) as our measure of appraiser competition. Column (4) uses the concentration ratio (CR4) of the top four market shareholders (appraisers) as our measure of competition. Column (5) uses the number of appraisers in an MSA/year divided by the MSA's population. MSA cluster robust standard errors are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table VI: Appraiser Competition Over Time

COMPETITION MEASURES	(1) % At Price (2003)	(2) % At Price (2004)	(3) % At Price (2005)	(4) % At Price (2006)
Number of appraisers per purchase transaction	6.481**	7.111***	5.217***	3.384***
	(2.597)	(1.376)	(1.246)	(0.872)
-(HHI)	0.026	0.448***	0.701***	0.339
	(0.470)	(0.162)	(0.251)	(0.292)
-(CR2)	0.017	0.204***	0.270***	0.155
	(0.135)	(0.077)	(0.093)	(0.100)
-(CR4)	0.020	0.195***	0.209***	0.148*
	(0.103)	(0.068)	(0.072)	(0.080)
Number of appraisers per resident	65.580	145.919**	86.100	81.639**
	(67.185)	(65.910)	(54.527)	(40.659)

Note: This table presents coefficients obtained by estimating equation (10) separately for each year and each of our competition measures. We estimate 20 separate regressions (four years × five different competition measures). In all regressions the dependent variable is the fraction of appraisals where the appraised value equals the sales price. The control variables (not reported) are the same as in Table III. Observations are at the MSA/year level. White's heteroskedasticity-robust standard errors are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Appendix A.

The two Bellman equations 6 and 7 give the following functional forms of $J(V)$ and $J(U)$.

$$rJ(V) = \beta_1 Z(a) - \frac{\beta_1 G(a)(\beta_1 - \beta_2)Z(a)}{r + \beta_2 + (\beta_1 - \beta_2)G(a)} \tag{A1}$$

$$rJ(U) = \beta_2 Z(a) + \frac{\beta_2 (1 - G(a))(\beta_1 - \beta_2)Z(a)}{r + \beta_2 + (\beta_1 - \beta_2)G(a)} \tag{A2}$$

The first-order conditions (FOCs) of equations A1 and A2 with respect to a, respectively A3 and A4, give the following implicit functions for the optimal amount of "shading" by V appraisers, $a(V)$, and by U appraisers, $a(U)$, respectively.

$$\begin{aligned} Z'(a).(r + \beta_2 + B.G(a))^2 &= B.[G'(a)Z(a) + G(a)Z'(a)].(r + \beta_2 + B.G(a)) \\ &\quad - B^2.G(a)G'(a)Z(a) \end{aligned} \tag{A3}$$

$$\begin{aligned} Z'(a).(r + \beta_2 + B.G(a))^2 &= -B.[(1 - G(a)Z'(a) - G'(a)Z(a)].(r + \beta_2 + B.G(a)) \\ &\quad + B^2(1 - G(a))Z(a)G'(a) \end{aligned} \tag{A4}$$

where

$$B = \beta_1 - \beta_2 \tag{A5}$$

$$Z(a) = F - h(G(0) - G(a)) \tag{A6}$$

We assume that G follows a uniform distribution with support [-Q/2,Q/2]. Therefore,

$$G(a) = \frac{a}{Q} + \frac{1}{2} \tag{A7}$$

Next, we substitute B, $Z(a)$, $Z'(a)$, $G(a)$, and $G'(a)$ in equations A3 and A4 using A5, A6, and A7 to derive the FOCs for V and U appraisers, respectively A8 and A9, used in the simulation.

$$\begin{aligned} \frac{h}{Q}[r + \beta_2 + B(\frac{a(V)}{Q} + \frac{1}{2})]^2 &= B(\frac{2ha(V)}{Q^2} + \frac{2F + h}{2Q})[r + \beta_2 + B(\frac{a(V)}{Q} + \frac{1}{2})] \\ &\quad - B^2(\frac{ha(V)^2}{Q^3} + \frac{2Fa(V) + ha(V)}{Q^2} + \frac{F}{2Q}) \end{aligned} \tag{A8}$$

$$\frac{h}{Q}[r+\beta_2+B(\frac{a(U)}{Q}+\frac{1}{2})]^2 = B(\frac{2ha(U)}{Q^2}+\frac{2F+h}{2Q}+\frac{h}{Q})[r+\beta_2+B(\frac{a(U)}{Q}+\frac{1}{2})]$$
$$+B^2(\frac{1}{2}-\frac{a(U)}{Q})(\frac{F}{Q}+\frac{ha(U)}{Q^2}) \quad \text{(A9)}$$

After simulation of the endogenous variables, we calculate the number of at-price appraisals by the V group ($ATP(V)$) and U group ($ATP(U)$), the total number of at-price appraisals (ATP), and the number of above-price appraisals (ABP) by both groups.

$$ATP(V) = \beta_1 V\frac{a(V)}{Q}$$

$$ATP(U) = \beta_2 U\frac{a(U)}{Q}$$

$$ATP = ATP(V) + ATP(U)$$

$$ABP = 0.5T[\gamma_1 + \gamma_2(1-\gamma_1)]$$

Next, we compute the proportion of at-price appraisals, the main focus of our empirical analysis, as follows:

$$Proportion\ ATP = \frac{ATP}{ATP+ABP}$$