How Many Listings Are Too Many?
Agent Inventory Externalities and the Residential Housing Market

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Highlights.

- Real estate agents' listing inventories adversely affect home prices and liquidity.
- Theory suggests this is driven by dilution of agent effort and agency costs.
- Results link greater agent inventory to significantly higher time on market.
- The effect of greater agent inventory on selling price appears to be modest.

Abstract. Given the significant role of real estate agents in the housing market, this study examines how agents' incentives regarding the size of their listing inventories indirectly affect residential home prices and liquidity. The theory shows that taking on additional inventory generates a critical principal agent issue, resulting in the dilution of an agent's selling effort and, ultimately, creating an externality that adversely impacts housing market outcomes across listings. It remains an empirical question whether diluted sales effort leads to lower prices, longer time on market, or both. The empirical results reveal significant inventory externality effects, as greater agent inventory tends to reduce selling price and substantially reduce liquidity for clients' properties in this market.

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I. Introduction

A popular view in real estate brokerage is that visibly busy agents are productive agents,[1] conflating ubiquitous advertisements or numerous FOR SALE signs creating exposure for a particular agent's listings with performance. But what casual observers define as indicators of productivity may also signal potential drawbacks for clients and the residential housing market. This paper considers whether agents have an incentive to take on too many listings—at least from the point of view of their clients. Additional listings may represent additional broker commissions, but they also place greater claims on the broker's time and energy, which in turn can have adverse sales performance consequences for their clients. This paper focuses on the relationship between agents' inventory of listings and sales performance (in terms of selling price and liquidity) in order to ascertain the degree, if any, to which agent listing inventories adversely affect client sales outcomes.

The compensation structure in the real estate brokerage industry constantly puts agents in situations where they must balance their own interests with various clients' interests. Agents are rewarded only if the property sells, as traditional full service broker compensation does not take into account the effort exerted to sell a particular property (Kurland, 1991). The exclusive ownership of listings means that, the more listings a broker secures, the greater the probability of receiving more commission income. The theory offered here focuses on how the incentive to acquire listings drives the relationship between listing inventory and market outcomes. Intuitively, the theory implies that, even if broker effort to obtain new listings does not divert effort from sales activities in general, adding to the inventory nonetheless forces the broker to reallocate marketing effort among all houses in the expanding inventory of listings. After a certain point, greater inventory increases the total amount of sales effort needed to service clients, thereby increasing the marginal cost of selling effort. The resultant higher opportunity cost of agent sales effort reduces sales effort allocated to individual houses, with the resultant negative external effects on realized sales performance. Whether the lower sales performance is

[1] This paper uses broker and agent interchangeably to refer to licensed real estate salespersons.

reflected in lower selling prices, longer time on the market or both remains an empirical question.

This paper is organized as follows. The next section reviews the relevant literature on agency in real estate. The third section presents a simple model of agent behavior illustrating how greater agent inventory impacts housing market outcomes in terms of sale price and/or liquidity for individual client properties. The fourth section of the paper describes the sample and the data. Section five presents the empirical framework, explaining how a three stage least squares (3SLS) methodology can be applied to examine the sales performance effects of agent inventory within a simultaneous price and liquidity framework. In addition, a new measure is developed to account for varying overlaps of agent inventory and distance between listings in the inventory. Section six and seven report the empirical results showing that greater listing agent inventory has significant and negative effects on selling prices and liquidity of properties. Section eight concludes.

II. Principal-Agent Issues in Real Estate Brokerage

When clients acquire brokerage services for the sale of property, a contract is negotiated between the client and agent. This contract gives the client an implicit expectation that the listing agent's priorities are at least somewhat aligned with his or her own. Clients generally want to sell their properties as quickly as possible and at the highest possible price. Given that the listing agent receives a commission only if a buyer is found (either by the agent or a cooperating broker), it is therefore understandable why the client may expect the agent to market the property to locate potential buyers. Generally, clients may not expect to receive substantially reduced service as a result of the reallocation of agent effort to selling another, more expensive home or one that offers a higher commission. Nonetheless, agents have multiple clients, most with similar expectations of primary focus on his or her individual property who are likely to be disenchanted with the listing agent if their expectations are not met. Depending on individual utility and holding costs, some sellers will choose a pricing strategy of setting list price at or below market value with the anticipation of a quicker transaction, while others may choose an exposure strategy of pricing above market value and waiting for a buyer to be matched (Benjamin and Chinloy, 2000; Genesove and Mayer, 1997).

While it is standard operating procedure for brokers to use comparable properties as a basis for suggesting an initial listing price, they have considerable latitude choosing comparable properties, which presents an opportunity to support a wide range of asking price recommendations. Recognizing that many real estate agents tend to focus on a pricing strategy (Benjamin and Chinloy, 2000) coupled with assumption that agents want to sell their entire inventory, agents have incentives to suggest list prices that promote faster sales (Yavas and Yang, 1995; Knight, 2002; De Wit and van der Klaauw, 2013). The unanswered question is whether the incentive to do so increases with greater inventory. At the least, it is possible that the effects of managing larger listing inventories may have differential effects on selling price and selling time for individual properties.

Sellers may be drawn to list with an experienced broker with a large inventory of listings. Nonetheless, it is possible that these sellers do not fully appreciate the complexity of an agent's various roles and responsibilities beyond listing and selling their home, some of which lead to inherent principal-agent conflicts. Indeed, the real estate and residential housing literature has not yet fully digested the complex interactions of agent's actions in terms of the logistics required to manage the acquisitions of new listings, marketing and negotiating existing listings all the way through closing and the renegotiation of expiring listings (Turnbull and Dombrow, 2007). The agent's overall burden of responsibilities grows with each additional listing. As a result (as shown in the next section) we may expect the proportion of effort that the agent dedicates to a given property decreases as inventory rises.

Research on principal-agent issues in brokerage is increasingly intertwined with the literature concerned with modeling pricing and liquidity in housing markets. Principal-agent issues are relevant for commissions, firm size, vacancies and geographic specialization (Zorn and Larsen, 1986; Knight, Sirmans, and Turnbull, 1994; Yang and Yavas, 1995; Yavas and Yang, 1995; Knight, 2002; Benefield, Rutherford and Allen, 2012; Read, 1993; Brastow, Springer and Waller, 2012). Miller (1978), Anglin, Rutherford, and Springer (2003) and Horowitz (1992) find that a higher list price leads to longer marketing time. Knight's (2002) empirical study of listing price changes concludes that a greater difference between list price and selling price generally leads to a longer time on market and ultimately a lower selling price.

The principal-agent relationship between seller and listing agent arises out of a key information asymmetry, as sellers have difficulties monitoring broker effort. Most sellers of owner-occupied homes are infrequent market participants which likely exacerbates asymmetric information problems. Asymmetric information also provides an opportunity for agents to misrepresent market information (Arnold, 1992; Hort, 2000; Garmaise and Moskowitz, 2004). In addition, pure commission-based compensation induces broker moral hazard in part because it does not efficiently allocate risk between seller and broker (Sirmans and Turnbull, 1997; Grossman and Hart, 1983; Anglin and Arnott, 1991). Geltner, Kluger and Miller (1991) look at the principal-agent conflict from two dimensions, the level of selling effort and the reservation price of the property. They posit that the principal-agent conflict is greater near the beginning of the listing contract as brokers are more likely to rationally procrastinate at that point, with increasing effort over time as the contract nears expiration. As a whole, the principal-agent literature in real estate suggests that this relationship is critical to understand and examine further.

In an examination of the moral hazard induced by dual agency, Gardiner, Heisler, Karlberg and Liu (2007) analyze the effect of dual agency disclosure. They find that legislation requiring the disclosure of dual agency significantly reduced the impact of dual agency on selling price from 8% to 1.4%. The liquidity of dual agency properties also significantly improved following the legislation. The legislation requiring the disclosure of dual agency also reduced the frequency of dual agency from 44% to 28%. These results provide ancillary evidence of substantial principal-agent conflict prior to enacting the legislation. Brastow and Waller (2013), in an examination of the timing of the occurrence of dual agency transactions, found that such transaction are more likely to occur shortly after the listing contract is signed or near contract expiration. The authors conclude that dual agency transactions are the result of informational incentives and/or principal-agent incentive conflicts.

Rutherford, Springer and Yavas (2005) and Levitt and Syverson (2008) examine the selling price and marketing duration of owner-agent properties relative to client properties. Rutherford, Springer and Yavas (2005) find that agent-owned homes, while spending approximately the same amount of time on the market, listed for 4.1% higher than comparable client homes and sold for a 4.5% premium. Levitt and Syverson (2008) find empirically that agent-owned homes are marketed for almost 10 days longer and sell for 3.7% more than client-owned properties, suggesting that agents may encourage clients to sell their homes prematurely at reduced prices.

Turnbull and Dombrow (2007) compare individual agent and brokerage firm effects and find that greater scale of listing or selling activities at the firm level decrease selling price and liquidity. In an investigation of agent specialization, Brastow, Springer and Waller (2012) find that more listings dilute agents' efforts and increase their focus on higher priced properties. Clauretie and Daneshvary (2008) examine principal-agent conflict between agent marketing and client reservation price coaxing. Two possibilities include that the broker expends less than the optimal level of sales effort and that the broker encourages the homeowner to lower the reservation price in order to induce a faster sale. They conclude that properties selling near the end of the listing contract have significantly lower prices, indicating that brokers do expend more effort on persuading the homeowner to lower their reservation price at that point. Waller, Brastow and Johnson (2010) find ancillary evidence of this particular principal-agent problem in that longer listing contracts lead to decreased liquidity as a result of broker effort.

III. Agent Listing Inventory, Home Price, and Liquidity

We offer a simple search model in the spirit of Rutherford et al. (2005) to examine the listing agent's effort allocation problem. We assume that the seller of the property sets the asking price.[2] Following Rutherford et al. (2005), we adopt a simple bargaining model for the negotiation stage of the game, and the seller's asking price is treated as a take-it-or-leave-it offer to the buyer.[3] As a result, a buyer will accept an asking price if and only if the asking price is below his

[2] Sellers often consult real estate agents on how to set the asking price. It is well established in the literature that real estate agents have incentives to advise a suboptimal asking price (Arnold, 1992; Rutherford et al. 2005). The influence of real estate agents on asking price does not affect our main conclusions and so is suppressed.

[3] This model, like most agency models, suppresses the buyer-seller negotiation process. See Harding, Rosenthal and Sirmans (2003), Merlo and Ortalo-Magne (2004) and Turnbull and Zahirovic-Herbert (2011) for empirical analyses of bargaining issues.

reservation price. The density function of buyers' reservation prices is given by $f(\cdot)$ over the interval $[\underline{p}, \overline{p}]$, where f is continuous everywhere. As a member of the local multiple listing service (MLS), the listing agent submits the listing to the MLS. Along with the information about the property, the listing agent also indicates the percentage of the price that he or she will pay as commission if another MLS agent finds the buyer. The MLS then makes available this information to all other members of the MLS.[4]

There are a large number of other brokers who are members of the MLS. The one that identifies the buyer for the listing is the selling agent. Following the current prevailing practice in the full service industry, the listing agent receives *k* proportion of the price as commission from the seller upon the sale of the property. Out of this commission, the listing agent pays $k_s, k_s < k$, proportion of the price to the selling agent. The listing agent retains the entire commission if he or she finds the buyer. We assume that the total commission rate, *k*, and the selling agent's share, k_s, is determined in the market and exogenous to the individual agent.

Consider a risk neutral listing agent deciding how many identical contracts *n* to service with sales or search effort *L* dedicated to each. The probability that the agent finds a buyer for a particular house in its listing inventory is a function of search effort, $\psi(L)$, where search effort increases this probability at a decreasing rate ($\psi' > 0$, $\psi'' < 0$). The probability that another member of the MLS contacts a buyer for a particular house is ϕ. Given the large number of MLS members and the competition among them to sell the property, the probability of a sale by another MLS member is exogenous to the listing agent. The agent's search cost is an increasing convex function of the search effort per house and number of houses in the inventory, $C(nL)$, with $C' > 0$ and $C'' > 0$. The marginal cost of acquiring an additional listing for the agent's inventory is *v*; the total cost of listing acquisitions is *vn.*

The listing agent's problem is:

[4] While the discussion focuses on MLS listed properties, the model can be applied to non-MLS properties by assuming a lower probability of co-brokerage, φ, for brokers not participating in the MLS.

$$\max_{L,n} \Pi(L,n) = n\left[\psi(L)\int_{P}^{\bar{p}} kPf(p)\,dp + \varphi\int_{P}^{\bar{p}} (k-k_s)Pf(p)\,dp\right] - C(nL) - vn$$

The first-order conditions are

$$n\psi'(L)\int_{P}^{\bar{p}} kPf(p)\,dp - nC'(nL) = 0 \tag{1}$$

$$\left[\psi(L)\int_{P}^{\bar{p}} kPf(p)\,dp + \varphi\int_{P}^{\bar{p}} (k-k_s)Pf(p)\,dp\right] - LC'(nL) - v = 0 \tag{2}$$

The first condition requires that sales and search effort balances the marginal expected return from the increased probability of selling a house from the inventory with the marginal cost of the effort. The second condition requires that the expected commission revenue from an addition to the inventory of listings (the first term in (2)) equals the marginal effort cost of servicing the listing, *LC'*, plus the marginal cost of acquiring the listing, *v*. Totally differentiating the system (1) and (2) and solving for the comparative statics of marginal listing acquisition cost on search effort and inventory size in the usual way yields, respectively,

$$\frac{\partial L^*}{\partial v} = \frac{C'(nL) + nC''(nL)L}{\det H_2} > 0 \tag{3}$$

$$\frac{\partial n^*}{\partial v} = \frac{\det H_1}{\det H_2} < 0 \tag{4}$$

where H is the negative definite Hessian matrix of the agent’s expected profit function. Subscripts indicate the appropriate principal minors of H. These results show that lower agent productivity (i.e., greater marginal cost) of acquiring additional listings increases the search effort allocated to the typical listing in the agent’s inventory (3) and decreases the agent’s optimal inventory (4). These comparative statics also imply a testable relationship between agent inventory and sales performance: agents with greater inventory will also exert less sales and search effort on each house in its inventory. The extent to which the lower sales effort leads to lower expected selling prices and/or longer marketing duration cannot be ascertained from the theory and remains an empirical question.

IV. Data

The data for this study consist of residential properties obtained from a Virginia multiple listing service (MLS). The initial data included over 21,450 properties marketed and sold, withdrawn or expired for the period April 1999 through June 2009. As noted by Levitt and Syverson (2008), MLS data are entered by real estate agents and can be incorrect or incomplete. As a result, the data are carefully vetted. After culling for incomplete, missing or illogical data that suggest data entry errors, the final data set comprises 12,388 *sold* properties.[5] The data collected from the MLS include typical property characteristics (square footage, bedrooms, baths, etc.), location, and market and calendar information (list date, sale date, length of listing contract). Table I presents a complete variable legend.

The average property in the sample has a listing and selling price of $173,631 and $168,096, respectively. The average listed property is 26.42 years of age, with 1,924 square feet, 3.2 bedrooms, and 2 bathrooms with an average contract listing duration of 187 days and time on market of 111 days. A more complete set of summary statistics is presented in Table II.

There are differences in the performance of above average-volume agents[6] and below average-volume agents. In particular, above average-volume agents list properties for significantly higher prices ($169,684 vs. $158,872) and sell for significantly higher prices ($158,673 vs. $147,997). These agents also have significantly longer listing contracts (208 vs. 181 days) and longer times on market (137 vs. 115 days). The above average-volume agents sell smaller properties (1,813 vs. 1,853), newer properties (23 vs. 32 years), more new construction homes (35% vs. 12%) and a lower percentage of vacant properties (19% vs. 25%). Similarly, these agents list more properties with brick exterior (60% vs. 56%), ceramic tile (30% vs. 24%)

[5] Consistent with other real estate studies, we cull mobile homes and other outliers from the data set. For example, we confine all regressions to homes with a sale price of greater than $25,000, and in some cases trim extreme outliers for our variables of interest (which are noted in footnotes below). The primary findings of this study are not sensitive to dropping these observations, however. As an additional quality check, a sample of the MLS data was compared to county government records which contain data on price and housing characteristics. The MLS data were 100% accurate.

[6] Defined as those agents with an average of 7 or more listings on the market over the period 1999-2009.

and garages (36% vs. 34%). Hence, it is important to control for an array of property characteristics when determining the impact of agent inventory on price and liquidity.

V. Empirical Methodology

This section summarizes our empirical approach to estimating price and liquidity within a simultaneous system. It also describes the method used to econometrically identify the system of price and liquidity equations.

A. Identifying the Price-Liquidity Simultaneous System

Housing markets are search markets; and, search theory has shown that price and liquidity are jointly determined in such environments. Shifts in buyers' valuation over time or across neighborhoods lead to changes in the average time properties take to sell and in the prices at which they sell (Krainer, 2001). This creates technical problems when empirically modeling housing market outcomes, as it implies that selling price and liquidity (or marketing duration) are simultaneously determined by identical factors. That is, the vector of factors that determine a house price is identical to the vector of factors that determine how long it takes to sell, resulting in an under-identified system of equations. While a number of empirical studies acknowledge and model this simultaneity,[7] the methods to identify price and liquidity equations have generally been *ad hoc* as authors make a case that some factors only affect price and not liquidity, and vice versa. A series of papers starting with Turnbull and Dombrow (2006) and Zahirovic-Herbert and Turnbull (2008) take a different approach, offering an identification method based on the implicit cross-equation parametric restrictions that arise when incorporating variables that capture neighborhood market conditions.

Drawing from Krainer's (2001) search market theory, Turnbull and Dombrow (2006) explain that a home's expected liquidity, E[T], measured as a home's marketing duration or time

[7] For example, see Sirmans, Turnbull, and Benjamin (1991), Yavas and Yang (1995), Forgey, Rutherford, and Springer (1996), Huang and Palmquist (2001), Rutherford, Springer, and Yavas (2001), Knight (2002), Turnbull and Dombrow (2006).

on market, and expected house price, E[P], are simultaneously determined in search equilibrium and the relationship between them can be implicitly defined as:

$$F(\mathrm{E}[P], \mathrm{E}[T], \mathbf{X}, \mathbf{C}) = 0 \quad (5)$$

where **X** is a vector of house (and market) characteristics and **C** are neighborhood market conditions. Regarding the latter, they argue that there may be a localized competition effect when the number of nearby homes on the market increases, as this supply ought to negatively impact the price and liquidity of a nearby home. Alternatively, the increased traffic generated from additional nearby homes on the market could positively impact a home's price and liquidity, a type of shopping externality. Regardless of the specific relationship between the supply of houses for sale in a given neighborhood and the selling price and liquidity of the subject property, the relationship between expected price and liquidity in (5) can be restated in terms of realized price and time on market as separate functions with jointly distributed stochastic errors ε_p and ε_T

$$P = \varphi_p(T, \mathbf{X}, COMP) + \varepsilon_p \quad (6)$$

$$T = \varphi_T(P, \mathbf{X}, COMP) + \varepsilon_T \quad (7)$$

The neighborhood competition measure, *COMP*, is the (distance weighted) number of houses for sale in the surrounding neighborhood at the same time the subject property is for sale It is this neighborhood competition variable, *COMP*, that characterizes market conditions vectors in the simultaneous equations above. In addition to *COMP*, the authors generate a related variable, defined as the listing density (or *LD*), which is the number of neighborhood listings on the market at the same time as the subject property, measured per day on the market (Turnbull and Dombrow, 2006; Zahirovic-Herbert and Turnbull, 2008).

These two market conditions variables provide the solution to the identification problem. To see how, note that the coefficient on the *COMP* variable is the partial derivative $\partial\varphi_p/\partial COMP$ when regressing sales price on the right-hand side variables in (7). The authors also point out that time on the market is included as an explanatory variable in (6), so changing competition while holding selling time constant yields the partial derivative with respect to listing density; that is,

$\partial\varphi_p/\partial COMP \equiv \partial\varphi_p/\partial LD$ in (6). The import of this parametric restriction is that the equation system (6)-(7) can be rewritten as:

$$P = \varphi_p(T,\mathbf{X},LD) + \varepsilon_p \quad (8)$$

$$T = \varphi_T(P,\mathbf{X},COMP) + \varepsilon_T \quad (9)$$

which is an identified system of equations.

B. Baseline Empirical Model

Following Krainer (2001) and a number of empirical studies, including those cited above, we specify two market equations in which sales price and liquidity, measured by time on market, are jointly determined. The empirical system takes the form

$$lnSP = \alpha_0 + \alpha_1 lnTOM + \alpha_2 Inventory + \alpha_3 LD + \sum_{i=4}^{N} \alpha_i X_i + u \quad (10)$$

$$lnTOM = \beta_0 + \beta_1 lnSP + \beta_2 Inventory + \beta_3 COMP + \sum_{i=4}^{N} \beta_i X_i + v \quad (11)$$

where *Inventory* represents the total number of listings an agent has currently listed at the time of a home's initial listing on the MLS and captures the degree to which an agent's efforts are spread across concurrently marketed properties. *LD* and *COMP* are the listing density and competition variables as constructed by Zahirovic-Herbert and Turnbull (2008). The X_i are property characteristics[8] commonly used in hedonic models, which include time and macroeconomic control variables[9] as well as location controls.[10] These control variables are critical determinants

[8]We use the following property-specific variables: square footage, age, acreage, number of bedrooms, bathrooms, length of the listing contract, whether the home is a one-story, new, vacant, whether it has a brick exterior, hardwood floors, a pool, fenced yard, walk-in closet.

[9]We use the following time and macroeconomic controls: year the home sold, season the home sold, Consumer Sentiment Index, fixed rate mortgage interest rate at the sale date, Virginia unemployment rate, and the Leading Economic Indicator Index. The macro controls are monthly aggregates, which correspond to the month the home was sold.

[10] Hedonic analysis of the housing market requires some control for spatial heterogeneity because location itself is a key source of differences in housing prices. Following Pope (2008) and other studies, we chose census block groups to control for unobserved heterogeneity *across* these areas so that the explanatory variables' effects are identified

of a home's price and liquidity, commonly used in hedonic real estate studies, and they control for important heterogeneity pertinent to agent inventory. The cross equation correlation of the error terms for (10)-(11) requires a 3SLS estimation approach (Belsley 1988).

While agent inventory may exhibit a linear effect on price and liquidity, we also wish to consider non-linear and other alternative ways to measure the inventory effect. We distinguish inventory by category, representing homes whose agents either have low, high, or very high inventory (with medium being the excluded category), which takes the following form:

$$lnSP = \alpha_0 + \alpha_1 lnTOM + \alpha_2 VeryHigh + \alpha_3 High + \alpha_4 Low + \alpha_5 LD + \sum_{i=6}^{N} \alpha_i X_i + u \quad (12)$$

$$lnTOM = \beta_0 + \beta_1 lnSP + \beta_2 VeryHigh + \beta_3 High + \beta_4 Low + \beta_5 COMP + \sum_{i=6}^{N} \beta_i X_i + v \quad (13)$$

Roughly half of all listings are represented by agents with medium inventory, where the agent is representing anywhere from two to seven additional listings. This is the reference group. Nearly 10% of listings are represented by agents with *VeryHigh* inventory where agent inventory exceeds 15 or more additional listings. Nearly 17% of listings in our data set are represented by agents with a *High* or above average number of listings, from 8 to 14 additional listings. Nearly 20% of homes sold with listing agents having one or zero additional inventory on the market, which characterizes the *Low* dummy variable above. The bulk of the *Low* listings are likely represented by agents who work part-time. Breaking inventory out by category allows us to differentiate the effect by discrete intervals, which allows us to interpret different marginal effects of inventory size on sales outcomes.

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from variation *within* a given area (or even in a given year, as is the case for time fixed effects). According to the U.S. Census, census tracts are "small, relatively permanent statistical subdivisions of a county...designed to be homogenous with respect to population characteristics, economic status, and living conditions."[10] Yet, census block groups are *subsections* of census tracts and the smallest spatial area for which the U.S. Census tabulates sample data. This study uses block groups from the 2000 census, which on average contain between 600 to 3,000 people, usually around 1,500. Our sample of houses falls within a total of 163 census block groups in central Virginia.

C. Measuring Inventory with Distance-weighted Overlapping Listings

The inventory variables above represent additional agent inventory on the market *at the list date* of the property on the MLS. However, inventory varies as active agents sell some inventory and take on new inventory throughout the marketing period of a given home. The variables above represent a snapshot of agent inventory at the initial list date and may not reflect the external effect or agency costs of agent inventory as it evolves throughout the marketing period.[11] Given the limitations of these measures, we construct alternative measures to encapsulate the effect of agent inventory based on the distance-weighted inventory that overlaps on the market with the subject property. An additional contribution of this study is to approach this externality in a more holistic way, accounting for both the time overlap of agent inventory and a spatial component of weighting our measure by distance among inventory.

The inventory measure we develop is similar to the Turnbull and Dombrow (2006) approach to measuring the effects of nearby homes on the market at the same time as the subject property. They measure competition from nearby homes by constructing a sum of overlapping days on the market, weighted by distance. Their competition variable increases with the number of competing properties, the number of days competing properties are simultaneously on the market, and their proximity to the subject property. Adapting their approach, we construct analogous measures for the other houses in the agent's inventory that are on the market at the same time as the subject property. The coefficient on this variable (and its listing density counterpart) indicates the extent to which nearby houses in the same agent's inventory represent competing houses (reducing selling price and/or increasing marketing time) or produce shopping externalities (increasing price and/or reducing selling time) over and above the effects captured by the *COMP* and *LD* variables.[12] The *Inventory Density* and *Inventory Competition* variables below measure the number of distance-weighted houses j in the agent's inventory that are on the market the same time as property i:

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[11] Despite not encompassing the entire inventory effect, the impact of each list date inventory variable is still important to estimate. As we explain later in the paper, the number of additional listings an agent has at the time of the list date is information that sellers can conceivably ask the agent before agreeing to an exclusive listing contract.

[12] See, e.g., Zahirvoic-Herbert and Turnbull (2008) for a different application of this marginal effects approach.

$$Inventory\ Density(i) = \sum_j (D(i,\ j)) \frac{\min[s(i), s(j)] - \max[l(i), l(j)]}{s(i) - l(i) + 1}$$

where *D(i,j)* is the distance between houses *i* and contemporaneous agent inventory property *j*, *s(i)* is the sales date for *i*, *l(i)* is the listing date for *i*, *l(j)* is the list date for contemporaneous agent inventory property *j*, and *s(j)* is the sell date for *j*. To calculate *Inventory Density*, we first divide the overlapping time on the market for the house *i* with a competing property *j*, which is given by $\min[s(i), s(j)] - \max[l(i), l(j)]$, by the entire time on market of property *i*. This quotient gives the proportion of house *i*'s marketing time during which property *j* is also listed. We then weight it by $D(i, j)$, which is strictly increasing in is the distance between houses *i* and *j*. Finally, we sum across all competing listings to gauge the aggregate inventory effect for each property. We further construct alternative measure analogous to Turnbull and Dombrow (2006), *Inventory Competition*. Instead of looking at the proportion of marketing duration when competition is present, we measure competition directly using the number of overlapping days in *Inventory Competition*. Specifically,

$$Inventory\ Competition(i) = \sum_j (D(i,\ j)) \left\{ \min[s(i), s(j)] - \max[l(i), l(j)] \right\}.$$

This approach provides two benefits. First, it accounts for all inventory overlapping with the subject property throughout the *entire* marketing period. This recognizes that only those properties that are on the market at the same time are likely to place a burden on the agent's time or effort, and the longer the overlap, the larger the burden. Second, the construction of this variable allows the agent inventory effect to vary with distance between the subject and other listed properties. The intuition here is straightforward, which is that agent inventory located farther away from a property may have a different externality effect than one nearby. Listing properties farther away from one another increases agent travel time (and its subsequent opportunity cost) and may requires additional effort to exploit location-specific factors relative to properties listed nearby. Hence, *Inventory Density* and *Inventory Competition* are increasing in distance to contemporaneous agent inventory and increasing in both additional agent inventory properties and marketing time overlap.[13] The modified empirical model is[14]

$$lnSP = \alpha_0 + \alpha_1 lnTOM + \alpha_2 Inventory\ Density + \alpha_3 LD + \sum_{i=4}^{N} \alpha_i X_i + u \quad (14)$$

$$lnTOM = \beta_0 + \beta_1 lnSP + \beta_2 Inventory\ Competition + \beta_3 COMP + \sum_{i=4}^{N} \beta_i X_i + v \quad (15)$$

Finally, we explore different forms of the inventory measures to allow for varying marginal distance effects. The original listing density and competition variables based on Turnbull and Dombrow (2006) assume competing properties are located within one mile radius of the subject property, and marginal effects of competition diminish (in absolute value) at a decreasing rate with distance. Therefore, we estimate a form more closely analogous to the original listing density and competition variables, where distance is allowed to vary as a quadratic:

$$Inventory\ Density(i) = \sum_j (D(i,j))^2 \frac{\min[s(i),s(j)] - \max[l(i),l(j)]}{s(i) - l(i) + 1}$$

$$Inventory\ Competition(i) = \sum_j (D(i,j))^2 \{\min[s(i),s(j)] - \max[l(i),l(j)]\}$$

where the terms are defined the same as above. We estimate the impact these measures have in the following 3SLS model:

[13] An example could help clarify the interpretation of the inventory competition measure. Consider an average home that was on the market for 110 days. Suppose an agent that represented that house also represented 7 additional properties that were on average 8 miles from that home. Further suppose that the other properties were listed around the same time and overlapped for on average 102 days. The inventory competition measure for this home would thus be 7 listings x 8 miles apart x 102 days overlap = 5,712. While this inventory competition calculation is arbitrary, this example illustrates approximately an average listed property's inventory competition.

[14] In all inventory density and competition models (equations 14-15 and 16-17), the top 1% are trimmed from each variable calculation. Many MLS listings include extreme outliers with respect to distance, where a seller, for example, may list a vacation home on the Outer Banks (in NC) with a familiar agent in a Virginia MLS, despite the fact that the listing may be hundreds of miles away. These outliers generate extraordinarily high listing density and competition values.

$$lnSP = \alpha_0 + \alpha_1 lnTOM + \alpha_2 Inventory\ Density\ (D^2) + \alpha_3 LD + \sum_{i=4}^{N} \alpha_i X_i + u \quad (16)$$

$$lnTOM = \beta_0 + \beta_1 lnSP + \beta_2 Inventory\ Competition\ (D^2) + \beta_3 COMP + \sum_{i=4}^{N} \beta_i X_i + v \quad (17)$$

Further, we estimate a variation of the simultaneous equation above by allowing the measures to vary based on whether the agent inventory is located nearby (within one mile) or farther away. The original Turnbull and Dombrow (2006) listing density and competition variables were trying to capture relevant nearby market competition, which they defined as locations with one mile of a given home *i*. We are also interested in whether or not widely spread agent inventory exacerbates the inventory externality effect on client properties relative to narrowly clustered inventory. Therefore, we modify the inventory density and competition variables to allow homes within one mile of agent inventory to have different price and liquidity effects than homes farther away from agent inventory. Specifically, we redefine *Inventory Density* and *Inventory Competition* as the following:

$$Inventory\ Density(i) = \begin{cases} \sum_j (1 - D(i,j))^2 \dfrac{\min[s(i), s(j)] - \max[l(i), l(j)]}{s(i) - l(i) + 1}, & \text{if } D(i,j) < 1 \\ \sum_j D(i,j)^2 \dfrac{\min[s(i), s(j)] - \max[l(i), l(j)]}{s(i) - l(i) + 1}, & \text{if } D(i,j) \geq 1 \end{cases}$$

$$Inventory\ Competition(i) = \begin{cases} \sum_j (1 - D(i,j))^2 \{\min[s(i), s(j)] - \max[l(i), l(j)]\}, & if\ D(i,j) < 1 \\ \sum_j D(i,j)^2 \{\min[s(i), s(j)] - \max[l(i), l(j)]\}, & if\ D(i,j) \geq 1 \end{cases}.$$

VI. Empirical Results

A. Baseline Results – Inventory at List Date

The first set of results reveal a significant relationship between additional agent inventory and price and liquidity. Table IV reports the baseline estimates, which show that an increase in agent inventory is associated with a slight discount in price and a substantial increase in time on market. The magnitude of the marginal effects are small, which is consistent with the expectation that one additional listing may not impose a very high marginal cost. The first model (1a) and (1b) report the baseline estimates and indicate that a one standard deviation increase in agent inventory (9 listings) reduces the sale price by only 0.6% and increases marketing time by 13.6%, or approximately $1,000 and 15 days on average, respectively.

The estimates in the columns (2a) and (2b) in Table IV indicate that breaking out inventory into categories generates interesting differences across inventory levels.[15] While categories may not help us pin down the general relationship between inventory and sale price/liquidity, it does help us understand the effect as it relates to the reference group (or the "typical" listing inventory). If the listing agent representing a seller has a very high (*VeryHigh*) number of other listings (i.e., 15+), that home generally sells for approximately 3% less and remains on the market for 129% longer than a home listed with an agent with a more modest inventory (i.e., 2 to 7 listings). This amounts to 142 days longer than the reference group whose time on market is on average 110 days. Despite the fact that this group represents a relatively small number of listings (approximately 10% of the sample), the result is still striking. Agents representing 15 or more listings may be trying to represent "too many" clients at one time, resulting in a substantially longer marketing duration and an important source of illiquidity for numerous homes in this market.

Table IV does not completely impugn high inventory. Agents with *High* or above average inventory (i.e., 8 to 14 listings) do not seem to have a discernible impact on the sale price and

[15] To account for the potential non-linear effect of agent inventory, we also experimented with adding a quadratic term of *inventory* to our baseline model. The quadratic term failed to pick up any non-linear effect and was statistically insignificant in both the price equation and the TOM equation.

time on market of the homes they represent relative to the reference group.[16] While the overall effect of additional agent listings may still be negative for all groups, as the initial results indicate, regressions (2a) and (2b) in Table IV suggest that the largest effects are likely at the top inventory range. At the other end of the spectrum, Table IV reports that an agent representing at most one other listing also has a negative impact on price and liquidity. However, this is likely a part-time agent effect, as agents who represent few homes may have a different level of experience, skills, and motivation than agents representing more listings as part of a full-time career. Properties represented by agents with *Low* inventory sell for a slight discount (about 1%) and stay on the market approximately 35% longer than the reference group.

B. Inventory Density and Competition Results

In order to probe more deeply into the inventory effect, Table V reports the model estimates for models including the *Inventory Density* and *Inventory Competition* variables defined earlier. Qualitatively, the results are consistent with the notion that additional agent inventory adversely impacts selling price and marketing duration. Regressions (3a) and (3b) in Table V indicate that a one standard deviation increase in inventory density and competition reduce price by 0.8% and increase time on market by 26%. Intuitively this means, for example, that a home who is represented by an agent who has taken on 9 additional listings that are (on average) 9 miles apart and overlap with the home's marketing period 110 days leads to an increase in time on market of nearly a month.[17] Similar to the baseline results, the price effect is slight, but the agent inventory impact on time on market is substantial, particularly for agents representing a high number of listings which are located farther away from one another.

The next columns of Table V tell a similar story, showing that the inventory effect is not particularly sensitive to variations of how distance is factored into the calculation. Regressions (4a) and (4b) in Table V show the effects when the inventory measure is based on quadratic distance weights. This approach allows properties that are 8 miles apart to have a far greater

[16] It is important to remember that this does not say that the effect of additional listings is nil for this group. Rather, it says that the marginal impact for this group is equal to that of the reference group of agents.

[17] There are countless additional configurations of distance, number of listings, and overlap that will generate a number close to 9,291 (the standard deviation of the inventory competition variable), but this combination was chosen for illustrative purposes.

multiplicative effect than properties that are 2 miles apart. The results indicate that a one standard deviation increase in these variations of the inventory density and competition variables are associated with a 1% lower sale price and a 19% longer time on market. Generally speaking, these results are consistent with the previous findings.

The final columns in Table V allow agent inventory within one mile to be estimated separately from those whose distance exceed one mile. When distance exceeds one mile, agent inventory has a very similar impact as compared to the two other regressions in this table. For these observations, a one standard deviation increase in inventory density and competition reduces price by 2% and increases time on market by 13%. However, the estimates for inventory density and competition *within* one mile are different, particularly for time on market. For inventory density and competition within one mile, a one standard deviation increase is associated with a 2% lower sale price and a 3% higher time on market.[18] The effect on time on market appears muted for inventory competition within one mile. It appears that additional listings still require additional time and effort on behalf of the listing agent, but if the additional listing is, say, a neighboring property, the listing agent may not have to devote as much additional effort toward the listing as one across town. The agent may even show the properties to interested buyers (or buyers' agents) in tandem—giving rise to a shopping externality effect not present for more distant listings. This cross-sectional test is consistent with the notion that not all listings exert a uniform externality, and factors like distance have a predictable but varied effect.

VII. Identification Strategy, Robustness, and Alternative Models

A. Interaction Models and Agency Identification

It is clear from the results in the previous section that there is a relationship between agent inventory and sales outcomes that sellers care most about: selling price and time on

[18] Like the original Turnbull and Dombrow (2006), the distance in this calculation is inversely weighted (as $(1\text{-}D)^2$), where a *closer* proximity represents a higher value of the variable calculation.

market. Greater agent inventory is associated with a slightly lower price and a significantly higher time on market. However, if the effects reflect the incentives underlying our theoretical prediction then we should see variation in outcomes when the agent's incentives change. In this section, we employ a straightforward method of incorporating interaction terms to examine whether the agent inventory effect is a result of incentives and if the empirical relationship is properly identified.

As noted earlier in the paper, Levitt and Syverson (2008) looked at market distortions flowing from the agent compensation scheme and the information asymmetry between agent and owner, comparing agent owned homes and non-agent owned homes to identify the consequences of the principal-agent conflict. We employ a similar approach by incorporating an owner agent interaction into equations (14) and (15) to disentangle the agency cost effect. When an agent is marketing his/her own property, there is no principal-agent conflict (since the principal is the agent). Agents feel the full costs of taking on additional listings and have a greater incentive to account for those costs when deciding to accept (or seek out) new listings. Therefore, an owner-agent interaction term allows us to compare the effect of additional inventory when there is a principal-agent conflict and when there is not.

Additional inventory has a much smaller effect on marketing time in particular for agent-owned houses on the market. Regressions (6a) and (6b) in Table VI show this result. (The first two columns reproduce regressions (3a) and (3b) from Table V for easier reference.) Agents generally sell their homes for approximately 1.6% more than client properties. While there does not appear to be a different inventory effect on the price of agent-owned houses, additional inventory competition has approximately half the effect on time on market for agent-owned as it does for client properties. A one standard deviation increase in inventory competition increases time on market by 26% for clients, but only 12% for agents. In sum, it appears that agent-owned homes still take longer to sell with additional inventory but not as long as client properties. This supports the theory outlined above, that the inventory effect is driven primarily by agent incentives and this inventory externality is reduced when agents are more directly internalizing the cost of this externality.

It also seems reasonable that new construction may be easier for listing agents to market. In this sample new homes sell for an 18% premium and sell more rapidly than existing houses.

Agents marketing new homes generally work with builders or developers and may be able to manage a larger inventory more effectively. If so, we expect a larger inventory to also have a weaker effect on sales performance for new homes. While all of the models control for new construction, we have not yet explored whether the marginal effect of greater inventory affects new home sales the same way it affects existing home sales. Regressions (7a) and (7b) in Table VI include interaction variables to pick up any new home differential effects. The results show that inventory does not have a different new house effect on price, but inventory competition has roughly half the effect on the marketing time of new homes relative to existing homes, which are results that are qualitatively consistent with our expectation.

B. Listing Office and Agent Fixed Effects Models

To test the robustness of our core results, we explore two alternative sources of the agent inventory effect identified in the previous section. First, an agent's inventory may differ depending on the realty office or brokerage for which he or she works. Each office may differ along countless dimensions, from reputation to company policies to location to support staff, all of which may contribute to variation in agent inventory and the effect on sale outcomes. Second, each agent is different, and these differences may contribute to the variation in agent inventory itself. Agent inventory may vary across agents as a result of ability, reputation, and ambition, among countless other unobservable dimensions from a researcher's standpoint. Hence, we estimate two alternative models that incorporate fixed effects for properties' listing office and listing agent, in order to control for unobserved heterogeneity across listing offices/agents so that the explanatory variables' effects are identified from variation within a listing office/agent.[19]

Table VII reports the results of estimating equations (14) and (15) with agent and listing office fixed effects.[20] When the fixed effects for the 170 separate listing offices are incorporated into the model, the results for the 3SLS regressions (8a) and (8b) in Table VII are nearly identical to the core results from the previous section, albeit slightly larger, and also significant at the 1% level. Indeed, when the fixed effects for the 1291 listing agents are included, the results

[19] In the MLS data used in this study, there were 170 offices represented, with a total of 1291 listing agents.
[20] The first two columns (4a and 4b) repeat the results from Table V for ease of comparability with the modified estimations in the columns to the right.

for the 3SLS regressions (9a) and (9b) are qualitatively consistent with the core results. The inventory effect on price is relatively small once we account for the unobserved heterogeneity of the listing agent, but the effect on price was relatively small with agent fixed effects. However, the inventory effect on liquidity is actually larger in the agent fixed effects model, and still significant at the 1% level.[21] Thus, even after controlling for unobserved heterogeneity across listing offices/agents, there is a consistent and significant *within* listing office and *within* listing agent inventory effect, reinforcing the case that the agent incentives are at the heart of the empirically robust inventory effect on price and liquidity.

C. Selection Bias and Alternative Modeling Approaches

One concern about the 3SLS estimation approach is that it only utilizes a sample of sold properties; yet, some homes in this market remain unsold. Omitting unsold homes from the analysis may introduce selection bias. Unlike tax data, one benefit of using MLS data is that it contains both sold and unsold observations within the sample. As a robustness check, we explore alternative specifications that utilize the full sample of unsold and sold homes to ensure that selection bias is not the primary driver of the main results above. In addition, we can estimate whether agent inventory also affects the probability of sale, which is an alternative measure of liquidity used in the literature.

We first estimate a two-stage Heckman sample selection model to correct for potential selection bias, utilizing the full sample of sold and unsold properties. This approach corrects for the selection bias by estimating an OLS sale price equation with identical covariates as equation (14) above with the addition of λ (i.e. the inverse Mills ratio). The inverse Mills ratio (IMR) is evaluated at $Z\gamma$ in the first stage, where $Z\gamma$ was estimated by the following bivariate probit (where *Sold* is a dummy variable equaling 1 if the property sold, 0 otherwise):

$$(Sold = 1|Z) = \phi(Z\gamma) + \varepsilon, \quad (18)$$

[21] Listing office and listing agent fixed effects were also added to the other specifications in the previous sections, but were omitted here for brevity. The results were broadly consistent across the board, with the exception of a number of unreported control variables. Particularly in the listing agent fixed effects case, where more than 2500 variables are contained within the system of equations, there was substantial loss of degrees of freedom and little within-variation for some variables.

where Z represents the same variables in liquidity equation (15) above, with the exception of substituting list price for sale price so the full sample can be used.[22] The inverse Mills ratio is subsequently used a regressor in the price equation to correct for selection bias by adjusting the conditional error terms so they will have means of zero.

Second, we model liquidity using a common alternative methodology, estimating a parametric hazard model that assumes the baseline distribution follows a Weibull distribution (e.g. see Rutherford, Springer, and Yavas (2005) of Rutherford and Yavas (2012)). For t, (time on market) as measured in days, we estimate a Weibull[23] distribution with covariates as having a conditional density:

$$f(t \mid x_i) = \exp(x_i \beta)\alpha t^{\alpha-1} \exp[-\exp(x_i \beta) t^{\alpha}] \qquad (19)$$

where x_i are the same covariates from the prior liquidity equation (18 above) so that the full sample could be used in the hazard estimation:

$$\lambda(t; x_i) = \exp(x_i \beta)\alpha t^{\alpha-1}. \qquad (20)$$

This estimation allows for the estimation of the relation between agent inventory and time on market (in accelerated failure-time form) as well as probability of sale (in log-relative hazard form).

Table VIII shows the results from the alternative models that utilize the full sample of sold and unsold properties. Both stages of the Heckman selection model are displayed in columns [10a] and [10b], showing that agent inventory adversely impacts a home's sale price and probability of sale. In particular, a one standard deviation increase in an agent's inventory density is associated with an approximate 4% reduction in sale price on average. This effect is somewhat larger than the 3SLS estimate above, which is intuitive given that selection bias, in this instance, will likely lead to more a conservative estimate of the inventory effect for samples that only include sold properties. The hazard model results confirm the negative association

[22] It is sensible to use nearly identical covariates as the time on market equation, given that probability of sale is an alternative measure of liquidity. There are two additional differences from equation (15), namely that we drop listing contract length and we substitute the 30 year fixed mortgage rate at *sale* date for the 30 year fixed mortgage rate at *list* date so we can estimate the full sample.

[23] The results are not very sensitive to the choice of a Weibull distribution. Other parametric distributions (gamma and exponential) and semi-parametric models (Cox proportional) were also explored, yielding similar results.

between agent inventory and a home's probability of sale, showing in column [11b] that a one standard deviation increase in an agent's inventory competition leads to a 37% reduction in a home's hazard rate. Using the full sample of sold and unsold properties, the accelerated failure-time form estimates show that a one standard deviation increase in inventory competition increases time on market by about 22%. This effect is not drastically different than the analogous 3SLS estimate of 26%, providing evidence that a large selection bias for time on market is unlikely, and evidence that the initial 3SLS time on market estimates are robust.

VIII. Conclusion

There are a variety of potential principal-agent conflicts in housing transactions, and the empirical literature is just beginning to sort out which are important and which are not. This paper examines how broker listing inventory affects the principal-agent relationship, and specifically, it focuses on how agent effort to secure additional listing contracts influences sales performance and market outcomes for existing listings. The theory implies a negative external impact of agent inventory on house selling price and liquidity, a relationship supported by the empirical results. While the adverse impact on price is modest, the effect of agent inventory on liquidity is substantial. Using a simple measure based on the agent listing inventory at the subject house listing date, 9 additional listings (one standard deviation) increases time on market by 14%. A richer inventory measure taking into account distance-weighted overlapping listings yields a 26% effect on liquidity.

Overall, the results imply that agent incentives to secure additional contracts and potential commissions generate negative externalities for other properties in their inventory. Greater inventory diverts selling effort from existing inventory, resulting in longer time on market for all houses in the inventory. Agent effort to list properties has a direct effect on selling effort itself—a relationship previously overlooked. Further, the effect appears to be causal as well, in light of the identification strategy of employing an owner-agent interaction. Considering the primary results (where the principal-agent conflict is present) in contrast of the owner-agent results (absent the principal-agent conflict), it is clear than agent incentives drive this effect. Thus, the results provide new evidence probing more deeply into agent moral hazard arising from the multifaceted principal-agent conflicts which permeate the transaction process and underlie particular (in)efficiencies in the residential housing market.

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Table I
Variable Legend

Variable	Description
SP	Selling price
TOM	Number of days on market
LOC	Length of listing contract
Inventory	Amount of agent inventory at listing date
Low Inventory	Dummy variable, 1 if Inventory<3, 0 otherwise
Medium Inventory	Dummy variable, 1 if Inventory >1 & <8, 0 otherwise
High Inventory	Dummy variable, 1 if Inventory>7 & <15, 0 otherwise
Very High Inventory	Dummy variable, 1 if Inventory>14, 0 otherwise
SQFT	Square footage
Age	Age of property
Vacant	Dummy variable, 1 if property is vacant, 0 otherwise
New	Dummy variable, 1 if property is new construction, 0 otherwise
Bedrooms	Number of bedrooms
Bathrooms	Number of bathrooms
Finished Basement	Dummy variable, 1 if property has finished basement, 0 otherwise
Hardwood	Dummy variable, 1 if property has hardwood flooring, 0 otherwise
Brick	Dummy variable, 1 if property has brick exterior, 0 otherwise
Fenced Yard	Dummy variable, 1 if property has a fenced yard, 0 otherwise
Pool	Dummy variable, 1 if property has a pool, 0 otherwise
Walk-in closet	Dummy variable, 1 if property has walk-in closet, 0 otherwise
One Story	Dummy variable, 1 if property has one main floor, 0 otherwise
FRMD	30 year fixed mortgage rate at sale date
Consumer Sentiment	Consumer sentiment (as defined by U M CSI) at sale date
Virginia Unemp.	Virginia Unemployment at sale date
LEI	Leading Economic Index value at sale date
Census Block Groups	Geographical dummy variables for census block groups 1-163
Listing Office Fixed Effects	Dummy variables that correspond to each of the 170 realty offices and their corresponding listings
Listing Agent Fixed Effects	Dummy variables that correspond to each of the 1291 listing agents and their corresponding listings
Year	Time control variables (year dummies)
Season	Season controls (season dummies for fall, spring, winter, summer)
LD	Listing density (defined in the Section 5)
COMP	Competition (defined in Section 5)

Table II
Summary Statistics

	Mean	*Std. Dev.*
Sale Price ($)	168,096	103,738.50
Time on Market (days)	110.55	88.79
List Price ($)	173,631	126,893.70
Sold	0.61	0.48
Inventory	6.78	8.963665
Low Inventory	0.19	0.39
Medium Inventory	0.54	0.49
High Inventory	0.17	0.37
Very High Inventory	0.09	0.29
Inventory Density	44.87	59.66
Inventory Competition	5,706.15	9,291.69
Inventory Density (distance squared)	709.24	1,298.41
Inventory Comp. (distance squared)	91,548.39	191,824.2
Inventory Density (dist. sq. & < 1 mile)	0.35	1.29
Inventory Density (dist. sq. & > 1 mile)	708.69	1,302.93
Inventory Comp. (dist. sq. & < 1 mile)	53.87	214.07
Inventory Comp. (dist. sq. & > 1 mile)	90,233.87	190,441.20
Square Feet	1,924.02	782.09
Age (years)	26.42	28.15
Vacant	0.33	0.47
Bedrooms	3.20	0.78
Baths	2.04	0.69
Length of Contract (days)	186.83	102.98
One Story	0.39	0.49
New	0.16	0.37
Finished basement	0.27	0.44
Hardwood	0.55	0.50
Brick	0.54	0.50
Pool	0.17	0.37
Fenced Yard	0.17	0.37
Walk-in Closet	0.21	0.41
Acreage	2.04	7.67
Avg. Fixed Rate Mortgage at Sale Date	6.13	0.49
Virginia Unemployment Rate	3.57	0.59
Consumer Sentiment Index	86.17	10.45
Leading Economic Indicators Index	99.04	6.04
Listing Density	1.80	2.95
Competition	225.98	544.23
Fall	0.19	0.39
Winter	0.26	0.44
Spring	0.30	0.46
Summer	0.25	0.43

Table III

Comparison of Means (Agent Inventory).

Variable	*Agent Inventory <=7* *Mean*	*Std. Dev.*	*Agent Inventory >7* *Mean*	*Std. Dev.*	*t-value*
Sale Price	147996.5	70537.01	158673.4	83500.06	-6.01
List Price	158872.1	93396.33	169684.1	98630.87	-5.89
LOC	180.6872	101.7042	207.7223	128.3483	-12.76
TOM	115.4563	93.32828	136.9373	111.2251	-11.27
Inventory	3.099033	1.868785	18.16977	13.1746	-110.98
$Inventory^2$	13.09601	14.0802	503.6632	930.9198	-52.49
SQFT	1852.87	728.4917	1813.367	780.8674	2.75
Age	31.81765	30.25563	22.60871	29.6586	15.81
Vacant	0.24864	0.432246	0.186747	0.389762	7.59
New	0.124522	0.330192	0.346659	0.475971	-30.61
Bedrooms	3.163208	0.783431	3.060789	0.870482	6.55

Table IV
The Effect of Agent Inventory on a Home's Sale Price and Days on Market – Baseline Models (3SLS)

	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)
	[1a]	[1b]	[2a]	[2b]
Inventory	-0.0007***	0.0152*		
	(-3.07)	(1.77)		
Very High Inventory			-0.0321***	0.8331**
			(-4.44)	(-2.07)
High Inventory			0.0022	-0.0636
			(0.40)	(-0.40)
Low Inventory			-0.0112**	0.3060*
			(-2.14)	(1.65)
Property Characteristics	✓	✓	✓	✓
Macroeconomic Controls	✓	✓	✓	✓
Season Fixed Effects	✓	✓	✓	✓
Census Block Groups	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
Observations	12,388	12,388	12,388	12,388

Notes. This table presents results of simultaneous estimation of the effect of agent inventory on house selling price and liquidity (time on market); z-statistics in parentheses; ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Table V
The Effect of Agent Inventory on a Home's Sale Price and Days on Market –
Inventory Density & Competition Models (3SLS)

	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)
	[3a]	[3b]	[4a]	[4b]	[5a]	[5b]
Inventory Density	-.000146*** (-6.00)					
Inventory Competition		.000028*** (4.48)				
Inventory Density (distance squared)			-.000008*** (-6.80)			
Inventory Comp. (distance squared)				.000001*** (4.21)		
Inventory Density (dist. sq. & < 1 mile)					-.016539*** (-8.47)	
Inventory Density (dist. sq. & > 1 mile)					-.000016*** (-9.43)	
Inventory Comp. (dist. sq. & < 1 mile)						.000141*** (2.62)
Inventory Comp. (dist. sq. & > 1 mile)						.0000007*** (16.69)
Property Characteristics	✓	✓	✓	✓	✓	✓
Macroeconomic Controls	✓	✓	✓	✓	✓	✓
Season Fixed Effects	✓	✓	✓	✓	✓	✓
Census Block Groups	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Observations	12,251	12,251	12,314	12,314	12,110	12,110

Notes. This table presents results of simultaneous estimation of the effect of agent inventory on house selling price and liquidity (time on market), using density and competition variables to represent inventory differentiated by distance and marketing overlap. Z-statistics in parentheses; ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Table VI
The Effect of Agent Inventory on a Home's Sale Price and Days on Market – Interaction Models (3SLS)

	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)
	[3a]	[3b]	[6a]	[6b]	[7a]	[7b]
Inventory Density	-.000146***		-.000146***		-.000164***	
	(-6.00)		(-5.98)		(-5.77)	
Inventory Competition		.000028***		.000028***		.000036***
		(4.48)		(4.68)		(4.75)
Owner Agent			.01647*	-.18581		
			(1.71)	(-0.70)		
Inventory Density * Owner Agent			.00008			
			(1.54)			
Inventory Competition* Owner Agent				-.000015**		
				(-2.00)		
New					.182124***	-2.0993**
					(23.40)	(-2.13)
Inventory Density * New					.000004	
					(0.12)	
Inventory Competition* New						-.000019***
						(-2.86)
Property Characteristics	✓	✓	✓	✓	✓	✓
Macroeconomic Controls	✓	✓	✓	✓	✓	✓
Season Fixed Effects	✓	✓	✓	✓	✓	✓
Census Block Groups	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Observations	12,251	12,251	12,251	12,251	12,251	12,251

Notes. This table presents results of simultaneous estimation of the effect of agent inventory interaction terms (owner agent and new respectively) on house selling price and liquidity (time on market). The first two columns (3a & 3b) are carried over from Table V for comparability. Z-statistics in parentheses; ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Table VII
The Effect of Agent Inventory on a Home's Sale Price and Days on Market – Listing Office and Agent Fixed Effects Models (3SLS)

	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)	3SLS Model Dependent Variable: ln(Sale Price)	3SLS Model Dependent Variable: ln(Days on Market)
	[3a]	[3b]	[8a]	[8b]	[9a]	[9b]
Inventory Density	-.000146***		-.000159***		-.000086***	
	(-6.00)		(-6.25)		(-3.21)	
Inventory Competition		.000028***		.000033***		.000053***
		(4.48)		(4.70)		(2.94)
Property Characteristics	✓	✓	✓	✓	✓	✓
Macroeconomic Controls	✓	✓	✓	✓	✓	✓
Season Fixed Effects	✓	✓	✓	✓	✓	✓
Census Block Groups	✓	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Listing Office Fixed Effects			✓	✓		
Listing Agent Fixed Effects					✓	✓
Observations	12,251	12,251	12,251	12,251	12,251	12,251

Notes. This table presents results of simultaneous estimation of the effect of agent inventory on house selling price and liquidity (time on market) using different fixed effects. The first two columns (3a & 3b) are carried over from Table V for comparability. Z-statistics in parentheses; ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Table VIII

The Effect of Agent Inventory on a Home's Price, Days on Market, and Probability of Sale – Hazard and Heckman Models Using Both Sold and Unsold Homes

	Heckman (OLS – 2nd Stage) Dependent Variable: ln(Sale Price)	Heckman (Probit – 1st Stage) Dependent Variable: Sold	Weibull Hazard Dependent Variable: Days on Market	Weibull Hazard Dependent Variable: Sold
	[10a]	[10b]	[11a]	[11b]
Inventory Density	-0.000662*** (-2.81)			
Inventory Competition		-0.000007*** (-5.56)	0.000024*** (13.79)	-0.00004*** (-13.54)
Lamda (IMR)	1.750357*** (11.95)			
ln_p			0.52311 (43.24)	0.52311 (43.24)
Property Characteristics	✓		✓	✓
Macroeconomic Controls	✓		✓	✓
Season Fixed Effects	✓		✓	✓
Census Block Groups	✓		✓	✓
Year Fixed Effects	✓		✓	✓
Observations	19,604		19,717	19,717
Uncensored Observations	12,251		12,355	12,355

Notes. This table presents results of a two-stage Heckman selection model and Weibull hazard models, utilizing the full sample of sold and unsold homes. The first two columns estimate the inventory effect on sale price using a two-stage Heckman selection model, displaying the coefficient estimates for the variables of interest in the OLS and probit models in each stage. The second two columns are (Weibuill) hazard models that estimate the inventory effect on a home's time on market and probability of sale respectively. The results in column 11a are in accelerated failure-time form, and the results in column 11b are in log relative-hazard form. Z-statistics in parentheses; ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.