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Real Estate Commissions and Homebuying^{*}

Borys Grochulski[†] and Zhu Wang[‡]

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Abstract

We construct a model of home search and buying in the U.S. housing market and evaluate the commission paid to homebuyers' agents. In the model, as in reality, homebuyers enjoy free house showings without having to pay their agents out of pocket. Buyers' agents receive a commission equal to 3% of the house price only after a home is purchased. We show this compensation structure deviates from cost basis and may lead to elevated home prices, overused agent services, and prolonged home searches. Based on the model, we discuss policy interventions that may improve housing search efficiency and social welfare.

Keywords: Search and matching, Housing market, Real estate commission

JEL Classifications: D4, L1, L8, R3

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1 Introduction

Real estate commissions has long been a controversial issue in the U.S. residential housing market. Despite technological advances substantially lowering home search and matching costs over time, real estate agents continue to command a high percentage commission rate. In a typical housing transaction, the seller pays her agent a 6% commission, and half of this amount is passed to the buyer’s agent. In fact, the seller’s agent needs to post the commission rate offered to the buyer’s agent when the house is listed on the Multiple Listing Services (MLS). Using the MLS information in the CoreLogic database, Figure 1 plots the trend of buyer agent commission (BAC) offered in the Houston metropolitan area from 1997 to 2019. In the total sample of 2.58 million houses listed for sale, 96.5% offered to pay 3% of the sale price to buyers’ agents, and the commission rate is quite uniform across years and across houses in different price ranges. For a house sold at \$300,000, a 3% commission means paying \$9,000 to the buyer’s agent, on top of an equal amount paid to the seller’s agent. While buyers do not directly pay the commissions, they are likely to pay them indirectly through higher home prices.

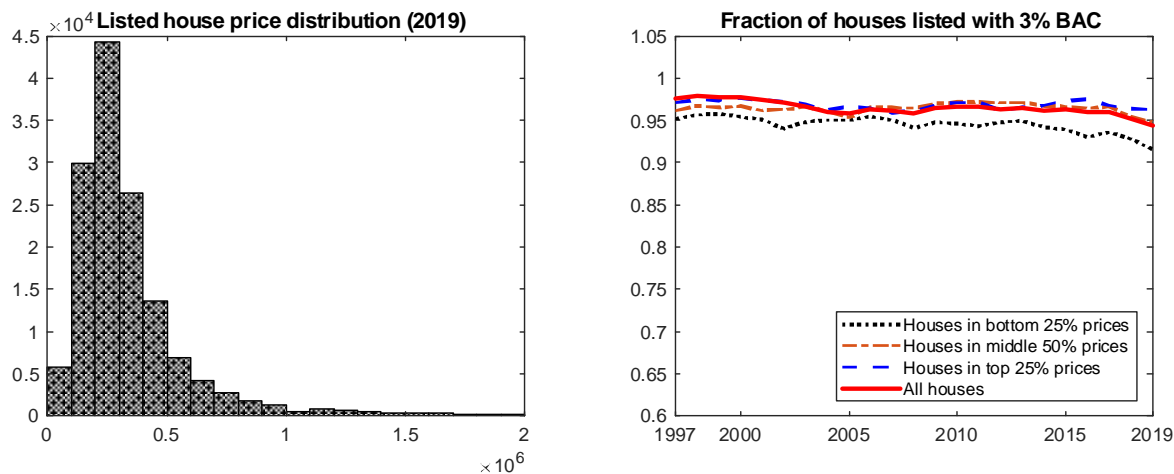


FIG. 1. HOUSE PRICES AND BUYER AGENT COMMISSIONS IN HOUSTON

This level of real estate commission, especially the buyer agent commission, makes the United States an anomaly. According to cross-country surveys from 2002 and 2015, the typical commission rate paid by a seller is less than 2% in the United Kingdom, Ireland, Netherlands, Singapore, Sweden, and Norway, which is much lower than the 6% rate in

the United States. In many countries, such as Australia, Canada, and Denmark, buyers commonly purchase properties without agent representation. Even if a buying agent is involved, the buyer typically pays his agent’s service directly, as in the United Kingdom, China, Japan, and Italy (Barwick and Wong, 2019).

Comparing across industries, the persistently high real estate commission is also puzzling. In the past few decades, the internet has squeezed margins in many sales and advisory professions. In the United States, travel agencies have shrunk from 100,000 employees in 2000 to 52,000 in 2019, as online service providers like Expedia, Priceline, and Kayak have allowed travelers to book their own itineraries. Financial advisors, who used to charge between one and two percent of the assets they managed for clients, have been shifting to fee-for-service models in order to compete with automated advisers and low-cost index funds. In the housing market, however, according to a survey conducted by the National Association of Realtors (NAR), half of buyers now find their homes independently online, yet 87% of them still retain an agent, and the commissions rates have barely budged. Meanwhile, the NAR reached 1.36 million members by December 2018, a historical high (CNN, 2019).¹

Policymakers and industry observers are concerned that real estate commissions deviate from underlying costs. With a uniform percentage rate, the commissions are unrelated to the quantity or quality of the service rendered. Rather, the fee is based solely on the price of the home. However, there is no evidence that buyer agents incur more service costs in buying higher-priced homes than buying lower-priced ones. Also, the way that buyer agents are paid by sellers rather than by buyers directly may mislead buyers into believing and acting as if they receive free services. Currently, there are multiple lawsuits filed against the NAR and major national brokerage companies regarding the real estate commissions (WSJ, 2023)², and a Kansas City jury recently determined in a \$1.8 billion judgement in October 2023 that commissions had been inflated and that brokerages and industry groups conspired to keep them that way (CNN, 2023).³ Meanwhile, real estate agents have been vigorously defending the traditional commission system. They argue

¹See “The internet didn’t shrink 6% real estate commissions. But this lawsuit might.” *CNN Business*, May 15, 2019.

²See “Real-estate commissions could be the next fee on the chopping block.” *Wall Street Journal*, October 18, 2023.

³See “Why are real estate commissions 6%? – and why that may be changing.” *CNN Business*, December 3, 2023.

that such a system serves the interest of their customers well and the commissions cover the service costs, including the free house showings that they provide to homebuyers.

To address the real estate commission controversy, we need a formal analysis. In this paper, we construct a model of home search and buying in the U.S. residential housing market. In the model, as in reality, homebuyers enjoy free house showings without having to pay their agents out of pocket. Buyers' agents receive a commission equal to 3% of the house price only after a home is purchased. We show that such a buyer agent compensation structure deviates from its cost basis in two ways. One is the agents' extra profits, which push up buyers' transaction costs of purchasing a home. As a result, buyers have to be pickier in their home search to justify the purchase. Another distortion comes from the free house showings offered by buyer agents, which lower buyers' marginal cost of home search and induce homebuyers to search too much. Together, the two distortions may lead to elevated home prices, overused agent services, and prolonged home searches.

We then conduct quantitative analysis based on the model. The results suggest that switching to a cost-based commission model, in which buyer agents do not earn extra profits and buyers pay for each house showing, may increase U.S. homebuyers' welfare by more than \$30 billion a year. Most of the consumer welfare gains would come from the redistribution of buyer agents' profits. Net of the redistribution, social surplus (i.e., the sum of consumer welfare and agent profit) would increase by about \$800 million a year.

Implementing such a cost-based compensation system does not necessarily mean policymakers should regulate commission fee levels directly. Rather, we propose shifting to an a la carte compensation model. This model requires that sellers and buyers each pay their agents directly to mitigate the threat of steering by buyer agents. Also, buyers should be able to pay their agents for each task separately, independent of the final price of the purchased home. This would allow buyers to shop for each service they need and bargain for the price. Under such a system, competition among agents would likely align agent compensation with cost, and buyers would not overuse agent services.

We also apply the model to an alternative policy option which would keep the current compensation structure but cap buyer agent commission at a lower percentage. We find that a uniform commission cap would increase consumer welfare but with a side effect on buyers of low-value houses, as buyer agents would find it unprofitable to serve that market segment. Therefore, a commission floor is needed for supporting low-value housing

transactions. Alternatively, a more refined idea is to use nonuniform caps to squeeze agent profits while avoiding the no-service problem, but that may overcomplicate the implementation. In comparison, we argue that the a la carte model we propose would be a better choice because it does not require policymakers to directly control commission fee levels and also addresses the externality issue caused by free house showings.

We focus on homebuyers and buyer agent commission in the analysis. In doing so, we simplify home sellers' decisions and take seller agent commission as given. We also treat the 3% buyer agent commission rate as exogenously determined. In a related paper (Grochulski and Wang, 2023), we explore those issues more explicitly. The reason real estate agents can command a higher-than-cost commission rate is related to the specific industry structure. To facilitate home search and matching, real estate agents pool together home listing information and form the MLS. A seller relies on the seller agent to list the house at the MLS, and the listing is required to specify the commission offered to buyer agents. Sellers are concerned that buyer agents would steer clients away from their properties if they do not offer the prevailing buyer agent commission rate. Empirical studies have shown that these concerns are indeed valid (e.g., Barwick et al. 2017, Barry et al. 2023). As a result, the threat of steering allows buyer agents to command commission above cost. Meanwhile, the level of commission is likely limited by consumers' outside options (e.g., not using agents or MLS) or other factors (e.g., regulatory pressure). All these factors may eventually determine the 3% commission rate in reality, and we take those as given in the background of our analysis.

The high real estate commissions have broader welfare consequences. They impose financial burdens on households, and may induce significant lock-in effects that limit household mobility (Ferreira et al. 2010). Moreover, the lucrative real estate commissions have driven excessive entry of agents and brokerage firms, which causes misallocation of talent and resources (Hsieh and Moretti 2003, Barwick and Pathak 2015). For example, compared with the United Kingdom where real estate commissions are much lower, the United States has around six times more housing transactions but requires twenty-six times more agents. Given that average housing market performance metrics are similar between these two countries, the labor productivity in the U.S. housing brokerage sector is significantly lower (Barwick and Wong, 2019).

Our paper contributes to the growing literature on real estate and real estate brokerage, such as Genesove and Mayer (1997, 2001), Hsieh and Moretti (2003), Levitt and Syverson (2008), Hendel et al. (2009), Genesove and Han (2012), Merlo et al. (2015), Barwick and Pathak (2015), Barwick et al. (2017), Cunningham et al. (2022), and Barry et al. (2023). We complement the existing studies by analyzing distortions in the current buyer agent commission system and discussing potential policy remedies.

While the issues we analyze are from the housing brokerage market, they also connect to many other network markets that feature two-sidedness (Rochet and Tirole, 2003, 2006). For example, in the payment card markets, card networks typically impose a percentage fee to merchants for accepting card payments, and the fee is split between merchant acquirers (comparable to seller agents) and card issuers (comparable to buyer agents). Particularly, the part of the fee received by card issuers is called the interchange fee, which is comparable to the buyer agent commission in our analysis. For both types of networks, percentage fees are not based on costs but rather on users' willingness to pay, which is a form of price discrimination (Wang and Wright, 2017, 2018).⁴ These fees allow the networks to profit and grow, which is arguably necessary for a network at its nascent stage. However, as the network reaches maturity, the extra profits have become increasingly less justifiable. That's why the card interchange fees have been investigated and regulated in many countries (Rysman and Wright, 2014). Our analysis of the real estate commission has a similar flavor, but unlike the static models used in the payment card literature, we consider homebuying in a dynamic search and matching environment and use model calibration and counterfactual simulations to quantify the theoretical findings.

The rest of the paper is organized as follows. The basic model is presented in Section 2. Section 3 solves the market equilibrium under the current commission regime. Section 4 provides welfare analysis, comparing the market equilibrium with counterfactual regimes where pricing distortions are removed. Section 5 uses model calibration and counterfactual simulations to quantify the welfare results derived in the theory. Section 6 applies our analysis to alternative policy interventions that cap the real estate commission. Finally, Section 7 concludes.

⁴For additional studies on why platforms use percentage fees, see Shy and Wang (2011), Johnson (2017), and Hagiu and Wright (2019), among others.

2 Model setup

To study the real estate commission problem, we construct a model of home search and matching.⁵ We consider a market for residential housing, defined by a commuting zone and the house type z that summarizes house characteristics (e.g., square footage, number of bedrooms and bathrooms, amenities, quality of schools, etc.). We assume that z can be ranked and is distributed over the range $[\underline{z}, \bar{z}]$.

Sellers are homogenous and each have a reservation value z for the house they sell. To complete a sale, the seller needs to pay the seller agent and the buyer agent each a commission fee proportional to the sale price. The corresponding commission rates, S (for the seller agent) and B (for the buyer agent), are in percentage terms and publicly known. For simplicity, we assume there are many more sellers than buyers, so buyers do not have to compete against each other. When a buyer and a seller meet, the buyer makes a take-it-or-leave-it offer to the seller to maximize the buyer's surplus. As a result, a house is sold at the price inclusive of commission fees $p_z = z + Sp_z + Bp_z$, which implies

$$p_z = \frac{z}{1 - S - B}. \quad (1)$$

Buyers who are interested in type- z houses search sequentially, and there is no recall. Each period, a buyer has an exogenous probability θ to search.⁶ The buyer then incurs a cost $c_b z$ to visit a house, which captures the buyer's opportunity cost of time.⁷ During the visit, the buyer learns a buyer-home match quality u specific to the home visited. Given a match quality realization u , the buyer's total lifetime expected utility from the housing services generated by the home is $(1 + u)z$. We assume that u is an i.i.d. draw from a cumulative distribution function $F(u)$ over the domain $[0, \bar{u}]$.⁸ We assume

$$(i) \quad E(u) > c_b, \quad \text{and} \quad (ii) \quad p_z < (1 + \bar{u})z, \quad (2)$$

⁵Our model is similar to those studied in the labor search and matching literature (e.g., see Rogerson et al., 2005), but adapted to the housing market context.

⁶We assume there are many more sellers than buyers, so θ mainly depends on the buyer's own schedule constraints rather than the housing market tightness. This simplifying assumption allows us to abstract from congestion externalities among buyers in their home searches, which is a separate issue to study.

⁷The time cost can be measured by the buyer's income, which is positively related to the value of house that the buyer aims for. Therefore, we can reasonably assume the house visiting cost is proportional to the targeted house value.

⁸Alternatively, one could assume that a buyer visits multiple houses in a trip. In that case, u can be reinterpreted as the best draw from all the houses visited during the trip.

so the search cost is not prohibitive, and the match quality can potentially be high enough to make the buyer's search worthwhile.

Once matched with a home of type z and with match quality u , the buyer either buys it or rejects it and stays in the market. He solves the following problem

$$V_z(u) = \max \{(1 + u)z - p_z, \beta W_z\}, \quad (3)$$

where

$$W_z = \theta \left(\int_0^{\bar{u}} V_z(u') dF(u') - c_b z \right) + (1 - \theta) \beta W_z. \quad (4)$$

Here $V_z(u)$ is the value with the realized match quality u , W_z is the value of search prior to finding a match, and β is the time discount factor.

A network of real estate agents work in the market, serving either as sellers' agents or as buyers' agents. To focus our analysis on the buyer agent commission, we take the seller agent commission S as given and assume it is cost-based.⁹ Buyer agents incur a cost c_a per house showing and a closing cost k_a per home purchase. Both c_a and k_a are fixed regardless of house values. However, buyer agents do not charge commissions equal to their costs. Rather, home sellers need to pay a percentage commission rate B to buyer agents, with a minimum fixed-amount commission required for low-value houses. In our analysis, we assume buyer agent commission rate B is exogenously given, and we do not take a stand on the exact reason why the prevailing rate is at 3%.¹⁰

3 Market equilibrium

Given the market environment and real estate commission structure, we now solve the model and derive the equilibrium market outcome.

⁹Similarly, studies on payment card interchange fees (comparable to buyer agent commissions in our context) typically assume merchant acquirers (comparable to seller agents in our context) are competitive and price at cost (e.g., Rochet and Tirole, 2003, 2011). In reality, seller agent commission has become more competitive due to the entry of discount brokers such as Redfin. Sellers who use Redfin typically pay a 1% commission to seller agents, but they still have to pay the prevailing commission rate to buyer agents. In our quantitative exercises, we consider both cases where $S = 3\%$ or $S = 1\%$, and the welfare findings are similar.

¹⁰It is possible that 3% is a focal point established by historical reasons for real estate agents to collude, or it is the constrained profit-maximizing rate above which customers may switch to alternative home search and matching options. Our analysis is consistent with either explanation.

—**Buyer’s decision.** In the buyer’s decision in Eq. (3), the first option (i.e., the value of purchasing the home matched with in the current period) is strictly increasing in u , while the second option (i.e., the value of continuing to search) is independent of u . If the buyer accepts some match quality u^1 , he would also accept any quality $u^2 > u^1$. The buyer’s optimal decision rule, thus, is a threshold rule: for some u^* , all $u > u^*$ are accepted, and all $u < u^*$ are rejected. At u^* , the buyer is indifferent:

$$(1 + u^*)z - p_z = \beta W_z. \quad (5)$$

The following proposition pins down the solution to the buyer’s sequential search problem.

Proposition 1 *Under condition (2), the buyer’s acceptance threshold u^* is interior and uniquely determined as the solution to*

$$(1 + u^*)z - \frac{z}{1 - S - B} = \frac{\beta\theta}{1 - \beta} \left(\int_{u^*}^{\bar{u}} (u' - u^*)z dF(u') - c_b z \right). \quad (6)$$

Proof. See Appendix A. ■

Note that the left-hand side of Eq. (6) is the value of accepting the house with the match value u^* , and the right-hand side is the expected discounted surplus from continuing to search. Therefore, at the threshold value u^* , a buyer is indifferent between buying the house and continuing the search.

In order to see how u^* is uniquely determined, we may define the right-hand side (RHS) of Eq. (6) as

$$h(u) = \frac{\beta\theta}{1 - \beta} \left(\int_u^{\bar{u}} [(u' - u)z] dF(u') - c_b z \right).$$

Note that $h(0) = \frac{\beta\theta}{1 - \beta} (E(u') - c_b) z > 0$ under condition (2), that $h(\bar{u}) = -\frac{\beta\theta}{1 - \beta} c_b z < 0$, and that $h(u)$ is differentiable with the derivative given by

$$h'(u) = -\frac{\beta\theta}{1 - \beta} z (1 - F(u)) < 0.$$

We also have

$$h''(u) = \frac{\beta\theta}{1 - \beta} z f(u) > 0,$$

so that $h(u)$ is convex to the origin. The left-hand side (LHS) of Eq. (6) is a straight line with a positive slope (i.e., $z > 0$) and a negative intercept (i.e., $-\left(\frac{S+B}{1-S-B}\right)z < 0$). Also, the LHS evaluated at \bar{u} is greater than 0 under condition (2). Therefore, the LHS line crosses the RHS curve once and pins down the unique u^* , as shown by Figure 2.

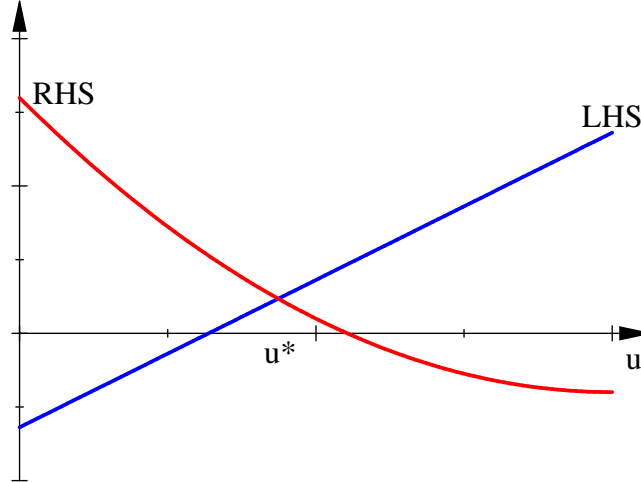


FIG. 2. THE EQUILIBRIUM THRESHOLD VALUE u^*

Equation (6) implies the following results:

Proposition 2 *Everything else being equal, the buyer's threshold value u^* increases with buyer agent commission rate B , decreases with buyer's visiting cost c_b , but does not vary with house type z .*

Intuitively, an increase of B would shift down the left-hand side of Eq. (6) without affecting the right-hand side, resulting in a higher value of u^* . In contrast, an increase of c_b would shift down the right-hand side of Eq. (6) without affecting the left-hand side, so it would lead to a lower value of u^* . Any change of z would be offset on both sides of Eq. (6), so the value of u^* would remain unchanged.¹¹

Proposition 2 suggests that the buyer becomes pickier in his home search if B increases or c_b decreases. Moreover, Eq. (6) yields that $d\left[(1+u^*)z - \frac{z}{1-S-B}\right]/dB < 0$ and $d\left[(1+u^*)z - \frac{z}{1-S-B}\right]/dc_b < 0$. Given Eq. (5), this implies that $dW_z/dB < 0$ and $dW_z/dc_b < 0$, so the buyer's expected welfare decreases in both B and c_b .

¹¹The result that u^* does not vary with house type z is a simplifying modeling choice. Alternatively, if one assumes per-visit cost as $c_b z + c_0$, where c_0 is a constant, Eq. (6) would imply that u^* increases with z . But this alternative assumption would not affect the main findings of the paper.

—**Buyers' searching time.** The solution to the buyer's searching problem implies that in each period, a buyer has the probability $\theta\lambda$ to buy a house, where

$$\lambda = 1 - F(u^*).$$

Let T be the random variable that corresponds to the length of time until a buyer successfully purchases a home. Accordingly, we have $Prob\{T = j\} = \theta\lambda(1 - \theta\lambda)^{j-1}$. Therefore, the mean searching time of a buyer in the market is given by

$$E(T) = \sum_{j=1}^{\infty} j Prob\{T = j\} = \sum_{j=1}^{\infty} j\theta\lambda(1 - \theta\lambda)^{j-1} = \frac{1}{\theta\lambda}. \quad (7)$$

Eq. (7) implies that $E(T)$ increases with u^* , and together with Proposition 1, it is straightforward to obtain the following proposition:

Proposition 3 *Everything else being equal, a homebuyer's mean searching time $E(T)$ increases with buyer agent commission rate B , decreases with buyer's per-visit cost c_b , but does not vary with house type z .*

—**Real estate agent profits.** In our analysis, we focus on buyer agents, and we assume seller agents do not earn extra profits. In each period, with probability θ , a buyer agent incurs a cost c_a to show a house. Following the house showing, the buyer has probability λ to purchase the house at price p_z , in which case the buyer agent incurs a cost of k_a to help close the deal and earns a commission $p_z B = \frac{zB}{(1-S-B)}$. With probability $1 - \theta\lambda$, however, the buyer does not visit or purchase a home, so the buyer agent has to wait for the next period. Accordingly, the buyer agent's expected profit, denoted as π_z , is determined by

$$\pi_z = \theta \left[\frac{\lambda z B}{1 - S - B} - \lambda k_a - c_a \right] + (1 - \theta\lambda)\beta\pi_z,$$

which yields

$$\pi_z = \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[\frac{zB}{1 - S - B} - k_a - \frac{c_a}{\lambda} \right]. \quad (8)$$

Denote by Ω the agent's expected service costs. Similar to above, we can derive

$$\Omega = \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[k_a + \frac{c_a}{\lambda} \right]. \quad (9)$$

Equations (8) and (9) imply that the agent's expected profit increases with house type z , while the agent's expected cost does not vary with z . Moreover, the discounting term $\frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \approx 1$ if β is close to 1, which tends to be the case in our model context given that buyers' home search intervals are typically short. Therefore, ignoring the discounting term, the agent's expected profit is intuitively the difference between the commission to earn $\frac{zB}{(1-S-B)}$ and the costs expected to incur $k_a + \frac{c_a}{\lambda}$.

For a given value of commission rate B , to ensure $\pi_z \geq 0$, it is required that

$$\frac{zB}{1 - S - B} - k_a - \frac{c_a}{\lambda} \geq 0,$$

which implies

$$z \geq \left(k_a + \frac{c_a}{1 - F(u^*)} \right) \frac{1 - S - B}{B}. \quad (10)$$

This explains why buyer agents often require a minimum fixed-amount commission for low-value houses. Denote $\underline{z} = \left(k_a + \frac{c_a}{1 - F(u^*)} \right) \frac{1 - S - B}{B}$. In our analysis, we assume that $z \geq \underline{z}$ always holds, so we focus on the housing sector where buyer agents earn nonnegative profits at the prevailing commission $B = 3\%$.

Note that the rate $B = 3\%$ does not have to be the commission rate that maximizes π_z given by Eq. (8). In reality, real estate agents may face additional pricing constraints not specified in our model (e.g., alternative home search and matching options) that could cap B at 3%. For the purpose of our analysis, we only need to require that $\partial\pi_z/\partial B > 0$ for any $B \leq 3\%$ to consistently explain why real estate agents have been fiercely against reducing the commission rate.

Combining with Proposition 1, Eq. (8) implies the results stated in Proposition 4.

Proposition 4 *Everything else being equal, buyer agent profit increases with the commission rate B (for any $B \leq 3\%$), house value z and buyer's per-visit cost c_b , while decreases with agent service costs k_a and c_a .*

4 Welfare analysis

In our model, buyer agent commission deviates from its cost basis in two ways. One is the extra profits earned by the agent, and the other is the free house showings offered. To evaluate their effects, we compare the market outcome with two counterfactual regimes where we shut down one or both deviations. In Regime I, we assume that the buyer agent offers free house showings but charges a commission Φ per home purchase to break even. In Regime II, the agent passes all the costs explicitly, charging k_a per home purchase and c_a per house showing. To make the counterfactuals directly comparable with the market equilibrium, we fix the seller agent commission at the same dollar amount across different scenarios (i.e., seller agents always receive the same dollar amount $\frac{zS}{1-S-B}$ as in the market equilibrium, which covers their service costs).

Our comparison results show the two deviations distort buyers' decisions, leading to elevated home prices, overused agent services, and prolonged home searches. As a result, consumer welfare and social surplus are lower.

4.1 Counterfactual Regime I

In the counterfactual Regime I, a buyer agent offers free house showings and collects a commission Φ_z per home purchase from the seller to break even. The seller agent receives the same dollar amount of commission $\frac{zS}{1-S-B}$ as in the market equilibrium. As a result, the seller would sell the house for the price:

$$p_z^{\mathbf{I}} = z + \frac{zS}{1-S-B} + \Phi_z. \quad (11)$$

Note that we use the superscript \mathbf{I} to indicate Regime I. Accordingly, a buyer maximizes his expected value of search:

$$V_z^{\mathbf{I}}(u) = \max \{ (1+u)z - p_z^{\mathbf{I}}, \beta W_z^{\mathbf{I}} \}, \quad (12)$$

where

$$W_z^{\mathbf{I}} = \theta \left(\int_0^{\bar{u}} V_z^{\mathbf{I}}(u') dF(u') - c_b z \right) + (1 - \theta_z) \beta W_z^{\mathbf{I}}. \quad (13)$$

With Eqs. (11), (12) and (13), we can solve buyer's purchasing threshold $u_z^{\mathbf{I}}$ like before

(see Appendix A for a general proof):

$$(1 + u_z^{\mathbf{I}})z - \frac{z(1-B)}{1-S-B} - \Phi_z = \frac{\beta\theta}{1-\beta} \left(\int_{u^{\mathbf{I}}}^{\bar{u}} [(u' - u_z^{\mathbf{I}})z] dF(u') - c_b z \right). \quad (14)$$

The buyer takes Φ_z as given when making a decision according to Eq. (14), where Φ_z is chosen ex ante by a planner to bring down buyer agent fee and lead to zero agent profit. Therefore, Eq. (8) implies that Φ_z needs to satisfy

$$\pi_z^{\mathbf{I}} = \frac{\theta\lambda_z^{\mathbf{I}}}{1 - (1 - \theta\lambda_z^{\mathbf{I}})\beta} \left[\Phi_z - k_a - \frac{c_a}{\lambda_z^{\mathbf{I}}} \right] = 0 \quad \implies \quad \Phi_z = k_a + \frac{c_a}{1 - F(u_z^{\mathbf{I}})}, \quad (15)$$

and

$$\Phi_z < \frac{zB}{1-S-B} \quad (16)$$

for any $z > \underline{z} = \left(k_a + \frac{c_a}{1-F(u^*)} \right) \frac{1-S-B}{B}$.

To pin down the solution of $u_z^{\mathbf{I}}$, we can compare Eq. (14) with Eq. (6). While their right-hand sides are the same, condition (16) implies the left-hand side of Eq. (14) is an upward shift relative to that of Eq. (6), so the solution $u_z^{\mathbf{I}}$ to Eq. (14) is smaller than the solution to Eq. (6), i.e., $u_z^{\mathbf{I}} < u^*$. Because the setting of Φ_z takes $u_z^{\mathbf{I}}$ into account, we now verify that the condition $\Phi_z < \frac{zB}{1-S-B}$ is consistent with $u_z^{\mathbf{I}} < u^*$. With $u_z^{\mathbf{I}} < u^*$, for any $z > \underline{z} = \left(k_a + \frac{c_a}{1-F(u^*)} \right) \frac{1-S-B}{B}$, we have

$$z > \left(k_a + \frac{c_a}{1-F(u_z^{\mathbf{I}})} \right) \frac{1-S-B}{B} = \Phi_z \frac{1-S-B}{B}.$$

Therefore, we confirm $\Phi_z < \frac{zB}{1-S-B}$ and $u_z^{\mathbf{I}} < u^*$ are consistent. Also, plugging Eq. (15) into Eq. (14) shows that the solution of $u_z^{\mathbf{I}}$ is not a constant but varies with z .

We then obtain the findings stated in the following proposition:

Proposition 5 *Comparing with the market equilibrium, the counterfactual Regime I yields (i) lower home prices, (ii) shorter buyer searching time, (iii) smaller agent service costs if time discounting is sufficiently small (i.e., β is sufficiently close to 1), and (iv) higher consumer welfare and social surplus.*

Proof. (i) Home prices are lower in Regime I because

$$p_z^{\mathbf{I}} = \frac{z(1-B)}{1-S-B} + \Phi_z < p_z = \frac{z}{1-S-B}.$$

(ii) Buyer's searching time is shorter in Regime I because

$$E(T_z^{\mathbf{I}}) = \frac{1}{\theta(1-F(u_z^{\mathbf{I}}))} < E(T) = \frac{1}{\theta(1-F(u^*))}.$$

(iii) The buyer agent's expected service cost is given by Eq. (9) that

$$\Omega = \frac{\theta\lambda}{1-(1-\theta\lambda)\beta} \left[k_a + \frac{c_a}{\lambda} \right].$$

This yields that

$$\frac{\partial\Omega}{\partial\lambda} < 0 \quad \text{iff} \quad \beta > \frac{1}{1+(c_a/k_a)\theta}. \quad (17)$$

Note that in our model context, because the homebuyer's search interval is short (e.g., likely to be daily or weekly), the time discount can be very small, which means β is very close to 1. Therefore, the condition $\beta > \frac{1}{1+(c_a/k_a)\theta}$ can be easily met. Given that $\lambda_z^{\mathbf{I}} = 1 - F(u_z^{\mathbf{I}})$ is larger compared with the market equilibrium $\lambda = 1 - F(u^*)$ for any $z \geq \underline{z}$, we then have $\Omega_z^{\mathbf{I}}$ is smaller.

(iv) Given that $u_z^{\mathbf{I}} < u^*$, we prove that Regime I yields higher consumer welfare and social surplus than the market equilibrium in the following.

— *Consumer welfare comparison.* We first prove consumer welfare (which equals buyer surplus in our model context) is higher in Regime I (i.e. $W_z^{\mathbf{I}} > W_z$). Recall that in the market equilibrium, we have

$$(1+u^*)z - p_z = \beta W_z. \quad (18)$$

In Regime I, we have

$$(1+u_z^{\mathbf{I}})z - p_z^{\mathbf{I}} = \beta W_z^{\mathbf{I}}. \quad (19)$$

Subtracting these two, we have

$$p_z - p_z^{\mathbf{I}} = \beta(W_z^{\mathbf{I}} - W_z) + (u^* - u_z^{\mathbf{I}})z. \quad (20)$$

Writing out W_z and $W_z^{\mathbf{I}}$, we have

$$W_z = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} -c_b z - p_z \\ + \int_0^{u^*} (1 + u^*) z dF(u') + \int_{u^*}^{\bar{u}} (1 + u') z dF(u') \end{array} \right)$$

and

$$W_z^{\mathbf{I}} = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} -c_b z - p_z^{\mathbf{I}} \\ + \int_0^{u_z^{\mathbf{I}}} (1 + u_z^{\mathbf{I}}) z dF(u') + \int_{u_z^{\mathbf{I}}}^{\bar{u}} (1 + u') z dF(u') \end{array} \right).$$

Subtracting these two yields

$$W_z^{\mathbf{I}} - W_z = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} p_z - p_z^{\mathbf{I}} \\ + \int_0^{u_z^{\mathbf{I}}} (u_z^{\mathbf{I}} - u^*) z dF(u') + \int_{u_z^{\mathbf{I}}}^{u^*} (u' - u^*) z dF(u') \end{array} \right). \quad (21)$$

Note that the last two terms in Eq. (21) imply that

$$\begin{aligned} \int_0^{u_z^{\mathbf{I}}} (u_z^{\mathbf{I}} - u^*) z dF(u') + \int_{u_z^{\mathbf{I}}}^{u^*} (u' - u^*) z dF(u') &= - \left(\int_0^{u_z^{\mathbf{I}}} (u^* - u_z^{\mathbf{I}}) z dF(u') + \int_{u_z^{\mathbf{I}}}^{u^*} (u^* - u') z dF(u') \right) \\ &> - \left(\int_0^{u_z^{\mathbf{I}}} (u^* - u_z^{\mathbf{I}}) z dF(u') + \int_{u_z^{\mathbf{I}}}^{u^*} (u^* - u_z^{\mathbf{I}}) z dF(u') \right) \\ &= - \left(\int_0^{u^*} (u^* - u_z^{\mathbf{I}}) z dF(u') \right) = -(u^* - u_z^{\mathbf{I}}) z F(u^*). \end{aligned}$$

Inserting the inequality into Eq. (21), we have

$$\begin{aligned} W_z^{\mathbf{I}} - W_z &> \frac{\theta}{1 - (1 - \theta)\beta} (p_z - p_z^{\mathbf{I}} - (u^* - u_z^{\mathbf{I}}) z F(u^*)) \\ &= \frac{\theta}{1 - (1 - \theta)\beta} (\beta(W^{\mathbf{I}} - W) + (u^* - u_z^{\mathbf{I}}) z - (u^* - u_z^{\mathbf{I}}) z F(u^*)) \\ &= \frac{\beta\theta}{1 - (1 - \theta)\beta} (W^{\mathbf{I}} - W) + \frac{\theta}{1 - (1 - \theta)\beta} (u^* - u_z^{\mathbf{I}}) z (1 - F(u^*)) \end{aligned}$$

where the second line uses Eq. (20). Simplifying, we get

$$(1 - \beta)(W_z^{\mathbf{I}} - W_z) > \theta(u^* - u_z^{\mathbf{I}}) z (1 - F(u^*)) > 0. \quad (22)$$

— *Social surplus comparison.* We now prove social surplus is higher in Regime I (i.e., $W_z^{\mathbf{I}} + \pi_z^{\mathbf{I}} > W_z + \pi_z$). Denote B_z^* the dollar amount of buyer agent commission in market

equilibrium, so $B_z^* = \frac{zB}{1-S-B}$. We can then rewrite buyer agent profit given in Eq. (8) as follows

$$\pi_z = \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[B_z^* - k_a - \frac{c_a}{\lambda} \right]. \quad (23)$$

Similarly, we can write buyer agent profit in Regime I as follows

$$\pi_z^{\mathbf{I}} = \frac{\theta\lambda_z^{\mathbf{I}}}{1 - (1 - \theta\lambda_z^{\mathbf{I}})\beta} \left[B_z^{\mathbf{I}} - k_a - \frac{c_a}{\lambda_z^{\mathbf{I}}} \right]. \quad (24)$$

With Eq. (24), we can verify $\partial\pi_z^{\mathbf{I}}/\partial\lambda_z^{\mathbf{I}} > 0$ given that $B_z^{\mathbf{I}} > k_a$. Therefore, given that $\lambda_z^{\mathbf{I}} > \lambda$, we have

$$\begin{aligned} \pi_z - \pi_z^{\mathbf{I}} &= \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[B_z^* - k_a - \frac{c_a}{\lambda} \right] - \frac{\theta\lambda_z^{\mathbf{I}}}{1 - (1 - \theta\lambda_z^{\mathbf{I}})\beta} \left[B_z^{\mathbf{I}} - k_a - \frac{c_a}{\lambda_z^{\mathbf{I}}} \right] \\ &< \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[B_z^* - k_a - \frac{c_a}{\lambda} \right] - \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} \left[B_z^{\mathbf{I}} - k_a - \frac{c_a}{\lambda} \right] \\ &= \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} (B_z^* - B_z^{\mathbf{I}}) \\ &= \frac{\theta\lambda}{1 - (1 - \theta\lambda)\beta} (\beta(W_z^{\mathbf{I}} - W_z) + (u^* - u_z^{\mathbf{I}})z) \\ &< W_z^{\mathbf{I}} - W_z, \end{aligned}$$

where the fourth line uses Eq. (20) and the final inequality follows from (22). ■

4.2 Counterfactual Regime II

We now consider the counterfactual Regime II, in which a buyer agent charges c_a per house showing to the buyer and k_a per home purchase to the seller.¹² Again, the seller agent commission remains at the same dollar amount $\frac{zS}{1-S-B}$ as before. We show Regime II would improve market outcome even more than Regime I.

In Regime II, the seller would set the house price

$$p_z^{\mathbf{II}} = z + \frac{zS}{1 - S - B} + k_a. \quad (25)$$

¹²Alternatively, we could consider that a buyer agent charges both c_a and k_a to the buyer in Regime II, and the results would not change. However, in the policy discussions, we will propose to let buyers pay their agents c_a and k_a directly to address the steering problem which is not explicitly modeled in our framework.

Accordingly, the buyer decides on the purchasing threshold $u^{\mathbf{II}}$ (see Appendix A for a general proof):

$$(1 + u_z^{\mathbf{II}})z - \frac{z(1 - B)}{1 - S - B} - k_a = \frac{\beta\theta}{1 - \beta} \left(\int_{u^{\mathbf{II}}}^{\bar{u}} [(u' - u_z^{\mathbf{II}})z] dF(u') - c_b z - c_a \right). \quad (26)$$

Comparing with Eq. (14), the right-hand side of Eq. (26) shifts down while the left hand shifts up, so it is straightforward to obtain $u_z^{\mathbf{II}} < u_z^{\mathbf{I}}$. Accordingly, we can prove the following proposition.

Proposition 6 *Comparing with Regime I, Regime II yields (i) lower home prices, (ii) shorter buyer searching time, (iii) smaller agent service costs if time discounting is sufficiently small (i.e., β is sufficiently close to 1), and (iv) higher consumer welfare and social surplus.*

Proof. (i)-(iii) The proofs are similar to those in Proposition 5, so we do not repeat.

(iv) Given that $u_z^{\mathbf{II}} < u_z^{\mathbf{I}}$, we now prove consumer welfare is higher in Regime II than in Regime I (i.e., $W_z^{\mathbf{II}} > W_z^{\mathbf{I}}$). Note that because buyer agents earn zero profit in both regimes, the comparison of consumer welfare is equivalent to the comparison of social surplus. Recall that in Regime I, we have

$$(1 + u_z^{\mathbf{I}})z - p_z^{\mathbf{I}} = \beta W_z^{\mathbf{I}}.$$

Similarly, in Regime II, we have

$$(1 + u_z^{\mathbf{II}})z - p_z^{\mathbf{II}} = \beta W_z^{\mathbf{II}}.$$

Subtracting these two, we have

$$\beta(W_z^{\mathbf{II}} - W_z^{\mathbf{I}}) = (u_z^{\mathbf{II}} - u_z^{\mathbf{I}})z + p_z^{\mathbf{I}} - p_z^{\mathbf{II}}. \quad (27)$$

Again, writing out $W_z^{\mathbf{I}}$ and $W_z^{\mathbf{II}}$, we have

$$W_z^{\mathbf{I}} = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} -c_b z - p_z^{\mathbf{I}} \\ + \int_0^{u_z^{\mathbf{I}}} (1 + u_z^{\mathbf{I}})z dF(u') + \int_{u_z^{\mathbf{I}}}^{\bar{u}} (1 + u')z dF(u') \end{array} \right),$$

and

$$W_z^{\mathbf{II}} = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} -c_b z - p_z^{\mathbf{II}} - c_a \\ + \int_0^{u_z^{\mathbf{II}}} (1 + u_z^{\mathbf{II}}) z dF(u') + \int_{u_z^{\mathbf{II}}}^{\bar{u}} (1 + u') z dF(u') \end{array} \right).$$

Subtracting these two yields

$$W_z^{\mathbf{II}} - W_z^{\mathbf{I}} = \frac{\theta}{1 - (1 - \theta)\beta} \left(\begin{array}{c} -c_a + p_z^{\mathbf{I}} - p_z^{\mathbf{II}} \\ + \int_0^{u_z^{\mathbf{II}}} (u_z^{\mathbf{II}} - u_z^{\mathbf{I}}) z dF(u') + \int_{u_z^{\mathbf{II}}}^{u_z^{\mathbf{I}}} (u' - u_z^{\mathbf{I}}) z dF(u') \end{array} \right). \quad (28)$$

Note that the last two terms in Eq. (28) imply that

$$\begin{aligned} \int_0^{u_z^{\mathbf{II}}} (u_z^{\mathbf{II}} - u_z^{\mathbf{I}}) z dF(u') + \int_{u_z^{\mathbf{II}}}^{u_z^{\mathbf{I}}} (u' - u_z^{\mathbf{I}}) z dF(u') &= - \left(\int_0^{u_z^{\mathbf{II}}} (u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z dF(u') + \int_{u_z^{\mathbf{II}}}^{u_z^{\mathbf{I}}} (u_z^{\mathbf{I}} - u') z dF(u') \right) \\ &> - \left(\int_0^{u_z^{\mathbf{II}}} (u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z dF(u') + \int_{u_z^{\mathbf{II}}}^{u_z^{\mathbf{I}}} (u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z dF(u') \right) \\ &= - \left(\int_0^{u_z^{\mathbf{I}}} (u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z dF(u') \right) = -(u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z F(u_z^{\mathbf{I}}). \end{aligned}$$

Inserting the inequality into Eq. (28), we have

$$\begin{aligned} W_z^{\mathbf{II}} - W_z^{\mathbf{I}} &> \frac{\theta}{1 - (1 - \theta)\beta} (-c_a + p_z^{\mathbf{I}} - p_z^{\mathbf{II}} - (u_z^{\mathbf{I}} - u_z^{\mathbf{II}}) z F(u_z^{\mathbf{I}})) \\ &= \frac{\theta}{1 - (1 - \theta)\beta} (-c_a + p_z^{\mathbf{I}} - p_z^{\mathbf{II}} + F(u_z^{\mathbf{I}}) (\beta(W_z^{\mathbf{II}} - W_z^{\mathbf{I}}) - (p_z^{\mathbf{I}} - p_z^{\mathbf{II}}))) \\ &= \frac{\theta}{1 - (1 - \theta)\beta} \left(-c_a + \frac{c_a}{1 - F(u_z^{\mathbf{I}})} + F(u_z^{\mathbf{I}}) \left(\beta(W_z^{\mathbf{II}} - W_z^{\mathbf{I}}) - \frac{c_a}{1 - F(u_z^{\mathbf{I}})} \right) \right) \\ &= \frac{\theta}{1 - (1 - \theta)\beta} F(u_z^{\mathbf{I}}) \beta (W_z^{\mathbf{II}} - W_z^{\mathbf{I}}), \end{aligned}$$

where the second line uses Eq. (27).

This yields that

$$(W_z^{\mathbf{II}} - W_z^{\mathbf{I}}) \left(1 - \frac{\theta F(u_z^{\mathbf{I}}) \beta}{1 - (1 - \theta)\beta} \right) > 0. \quad (29)$$

Because

$$1 - \frac{\theta F(u_z^{\mathbf{I}}) \beta}{1 - (1 - \theta)\beta} = \frac{1 - \beta + \theta\beta(1 - F(u_z^{\mathbf{I}}))}{1 - (1 - \theta)\beta} > 0,$$

inequality (29) implies that $W_z^{\mathbf{II}} - W_z^{\mathbf{I}} > 0$. ■

4.3 Policy implications

By comparing the market equilibrium with Regimes I and II, we identify two pricing distortions in the current buyer agent commission system. One is the agents' extra profits, which pushes up buyers' transaction costs of purchasing a home. With a lower buyer agent commission, buyers would be less picky in their home search, which would allow the buyer agent commission to go down further since agents need to show fewer homes to buyers. Another distortion is the free house showings offered by buyer agents. Even in the case where buyer agents make zero profit, loading the agent commission on the purchase value while lowering the cost of house showings induces homebuyers to search too much.

The findings of our analysis suggest that a cost-based commission system would improve market performance and social welfare. However, this does not necessarily mean policymakers should regulate the level of commission fee directly.¹³ Rather, we propose that policymakers may consider shifting to an a la carte model to achieve the outcome discussed in our Regime II. Under this a la carte model, sellers and buyers should each pay their agents directly, which would mitigate the threat of steering by buyer agents. The steering problem, while not explicitly modeled in our analysis, is a key reason why the current buyer agent commission is maintained above cost. Also, buyers should be able to pay their agents for each task separately, independent of the final price of the purchased home. This would allow buyers to shop for each service they need and bargain for the price. As a result, competition among agents would likely align agent compensation with cost, and buyers would not overuse agent services as if they were free.

An a la carte commission system may also provide additional benefits. Given that commission does not increase with the house price, helping the buyer locate and negotiate the lowest possible home price would no longer conflict with buyer agents' self interest. Also, economic efficiency is often improved when products are unbundled because, with separate prices for smaller pieces of products or services, the market mechanism can better match providers' costs to consumers' marginal willingness to pay. Further, with a la carte pricing, there would be no need for a buyer to work with a single agent throughout a search process. Clearly, some agents are better at what they do than others, and the risk

¹³Direct price control would require the regulator to keep track of cost changes in the industry and may cause unintended consequences. A recent example is that the U.S. debit card interchange fee regulation has negatively affected small-ticket transactions (Wang, 2016).

of getting contractually tied to a less productive agent looms large for homebuyers.

5 Quantitative analysis

In this section, we take our model a step further to conduct the quantitative analysis. We first calibrate the model for the market equilibrium, and then we compare that with counterfactual Regimes I and II. We also use the calibrated model to evaluate alternative commission cap regulations.

5.1 Model calibration: Market equilibrium

We first calibrate our model for the market equilibrium. The parameter values we choose are shown in Table 1.

Table 1. Model Parameterization

\bar{u}	β	θ	c_b	S	B	k_a	c_a
0.2	0.999	0.5	$\frac{1}{365*6}$	3%	3%	2,000	100

We assume that u follows a uniform distribution over the domain $[0, \bar{u}]$, where $\bar{u} = 0.2$. This implies that a homebuyer, on average, enjoys 10% utility gains in finding a new home $E(u)z = 0.1z$. We assume that buyers consider home searches each week and $\theta = 0.5$, so a buyer, on average, visits a house every other week. We assume the weekly discount rate is $\beta = 0.999$, which equals an annual discount rate of 0.95. Assuming a buyer searches for a home worth 3 times his annual income and each house visit takes a half day, we set $c_b = \frac{1}{365*6}$.¹⁴ We take agent commission rates $S = B = 3\%$ as they are in reality. We assume buyer agents incur a closing cost $k_a = \$2,000$ per home purchase corresponding to a few days of work for closing the deal, and $c_a = \$100$ per house showing corresponding to a few hours of tour for showing the property. These parameter values are chosen intuitively, and we will then conduct robustness checks.

¹⁴This is a conservative assumption. Consumer finance experts typically recommend that for most people and families, the total house value should be no more than 3 to 5 times their total annual household income.

With the model parameter values in Table 1, we first use condition (10) to solve the lower bound $\underline{z} = \$100,229$, above which buyer agents make a positive profit. For any house type $z \geq \underline{z}$, our model calibration yields the following quantitative findings:

- Using Eq. (6), we solve $u^* = 0.1834$, which implies that $\lambda = 1 - F(u^*) = 8.3\%$. This suggests that a home buyer, on average, takes a house tour every other week (cf. $\theta = 0.5$) and expects to purchase a home in $E(T) = 1/(\theta\lambda) = 24$ weeks.
- Using Eq. (9), we solve buyer agent's expected costs for serving a customer $\Omega = \$3,127$. Also we verify that $\beta = 0.999 > \frac{1}{1+(c_a/k_a)\theta} = 0.976$ so that $\partial\Omega/\partial\lambda < 0$ (cf. condition (17)).
- Using Eq. (8), we verify $\partial\pi_z/\partial B > 0$ for the relevant range of B . This is consistent with the observation that real estate agents are against reducing B . As Figure 3(A) shows, buyer agent profit is an increasing function of commission rate B unless B gets so large that the fall of purchasing probability λ eventually drives down profit. Note that B has an upper limit 0.27. As B approaches 0.27, u^* goes to the upper limit $\bar{u} = 0.2$.
- With $B = 3\%$, we solve expected consumer welfare W and buyer agent profit π using Eqs. (18) and (8), respectively. Both are increasing functions of house type z , as shown in Figure 3(B).

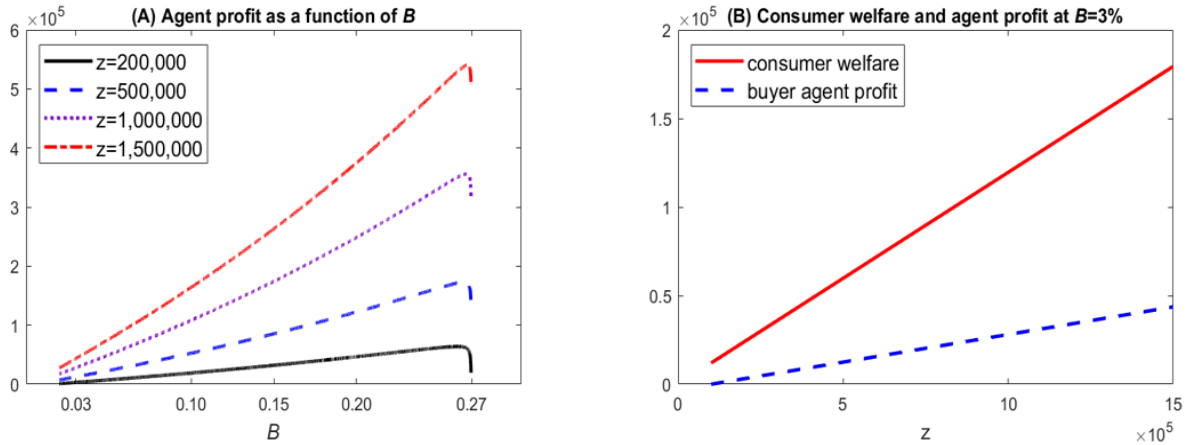


FIG 3. MODEL CALIBRATION FOR MARKET EQUILIBRIUM

5.2 Comparing market equilibrium with Regimes I and II

Figures 4 and 5 present the quantitative results of comparing the market equilibrium with Regimes I and II. Because switching from the market equilibrium to Regime I lowers agent commission, homebuyers become less picky in buying houses. Figure 4 shows this reduces homebuyers' search time, from no effect for low-end houses (i.e., $z = \$100,229$), to a week less for high-end houses (i.e., $z = 1,500,000$). As a result, agent service costs are reduced due to fewer house showings, and the savings range from \$0 for low-end houses to \$43.37 for high-end houses. In comparison, switching to Regime II has bigger impact. Because house showings are no longer free, homebuyers visit fewer houses, and the effects are stronger for low-value houses. Figure 4 shows that by switching from market equilibrium to Regime II, homebuyers' search time is reduced by more than 8 weeks for low-end houses and by about 2 weeks for high-end houses. Accordingly, agent service costs are reduced, from \$398.83 savings for low-end houses to \$87.29 for high-end houses.

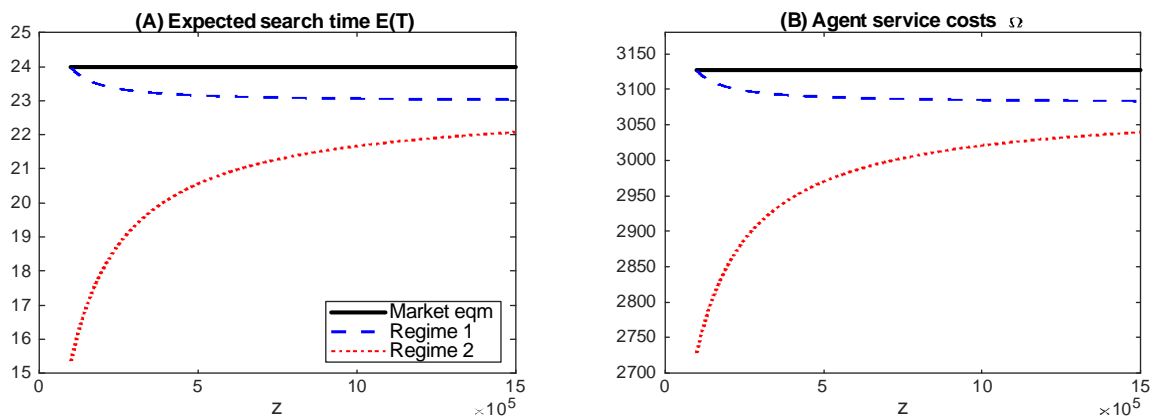


FIG. 4. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON

Figure 5 compares consumer welfare as well as social surplus across different regimes. Figure 5(A) shows that switching from market equilibrium to Regime I increases consumer welfare, ranging from \$0 for low-end houses to \$43,713 for high-end houses. As shown in Figure 5(C), most of the consumer welfare gains are redistribution from agents' profits, and the gain of social surplus is in dozens of dollars. Figure 5(B) shows switching from Regime I to II increases consumer welfare further, especially for low-value houses. The additional consumer welfare gains range from \$258.55 for low-end houses to \$23.89 for high-end houses. Altogether, Figure 5(D) shows that switching from market equilibrium

to Regime II may increase social surplus in hundreds of dollars, ranging from \$258.55 for low-end houses to \$90.72 for high-end houses.

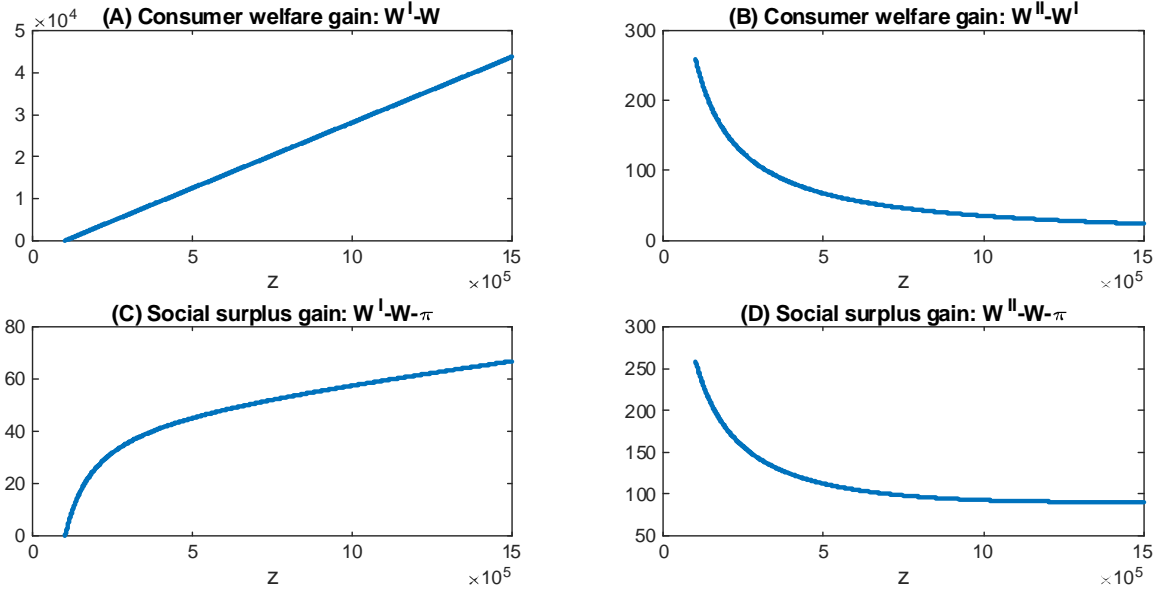


FIG. 5. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON

Combining our welfare comparison results with the home sale price distribution in the Houston metropolitan area in 2019, we sum up the overall effects in Houston. According to the CoreLogic dataset, 89,051 houses were sold in the Houston market in 2019 with the sale price ranging from \$7,000 to \$4,550,000. Our quantitative results imply that switching from the current buyer agent commission system to Regime II would increase consumer welfare by \$529.58 million that year. Most consumer welfare gains would come from buyer agents' profits. Net of the redistribution, social surplus would increase \$13.64 million.

One could project the effects of Houston to the total U.S. housing market. According to the NAR/Haver data, home sales in 2019 totaled 5.344 million in the United States, about 60 times the sales in Houston. This suggests that in that year, switching to Regime II would increase consumer welfare by \$31.78 billion and would increase social surplus by \$818.75 million.

It is worth noting that our estimated social surplus gain is likely a lower bound. In a broader context, the transfer of agent profits to consumers is not merely a redistribution,

but also has major social welfare impact. The literature (e.g., Hsieh and Moretti 2003, Barwick and Pathak 2015) has shown that the U.S. housing brokerage industry suffers excess entry of agents and firms and misallocation of talent and resources. Despite remarkable technology progress driving down home search and matching costs over time, labor productivity of this industry has continued to decline: the number of real estate transactions during the 2010s has been moderately higher than during the 1990s, but the number of agents and firms has nearly doubled. Compared with the United Kingdom where real estate commissions are much lower, the United States has around six times more housing transactions annually, but requires twenty-six times more agents. The key contributing factor of this low labor productivity is high commissions bundled with low entry barriers. Because real estate commission is proportional to house prices, being a real estate agent becomes more lucrative as housing price rises, which attracts more agents to enter to compete for the same number of housing transactions. This leads to a decline in labor productivity and a loss of social surplus. If agent productivity had remained the same as the 1990s, the United States would have a surplus of nearly one million individuals working in other more productive sectors (Barwick and Wong, 2019).

5.3 Buyer heterogeneity and robustness checks

Our quantitative findings are robust with alternative parameter values. In the baseline analysis, we assume $\theta = 0.5$ so homebuyers tend to visit houses every other week. It is possible some homebuyers are more active. Considering that, we reran the quantitative analysis by assuming $\theta = 1$, in which case homebuyers visit houses every week. While this results in shorter home search time, the welfare comparison results are quantitatively similar to our baseline case. The results are shown in Appendix B1.

In recent years, discount brokers such as Redfin have expanded into many housing markets. Sellers who use Redfin often pay 1% for seller agent commission, but they still have to pay the prevailing commission rate to buyer agents. To apply our model to those cases, we reran the quantitative analysis by assuming seller agent commission rate S is 1% instead of 3%. Again, the welfare comparison results are very similar to our baseline case, as shown in Appendix B2.

We made a conservative assumption that a buyer searches for a home worth 3 times his annual income, which is a typical recommendation from consumer finance experts.

However, due to rising home prices, consumers in many places often have to bear a higher home price to income ratio. The data show that in the past twenty years, the average house price in the United States has been around 5 times the annual household income, and during the housing bubble of 2006 and most recently in 2020s, this ratio exceeded 7. Our model predicts that the higher the home price to income ratio, the longer the home search (cf. $\partial u^*/\partial c_b < 0$ in Proposition 2), and therefore, one would expect higher social surplus gains from shifting to a cost-based commission system. To see that, we reran the quantitative analysis by adjusting $c_b = \frac{1}{365*12}$, which means a buyer searches for a home worth 6 times his annual income. The results, reported in Appendix B3, confirm the theoretical prediction and show substantially higher social surplus gains by shifting to Regimes I and II.

We also reran the quantitative exercise by adjusting the value $\bar{u} = 0.3$. This implies that a homebuyer, on average, expects 15% utility gain in finding a new home: $E(u)z = 0.15z$, which is a 50% increase compared with our baseline case. The welfare comparison results are not very different from the baseline, as shown in Appendix B4.

In the baseline calibration, we assume that $k_a = \$2,000$ and $c_a = \$100$. What if agents incur higher costs? In Appendix B5 and B6, we adjust these cost parameters by doubling the values of k_a and c_a , respectively. The results show that a higher k_a makes the shift from the market equilibrium to Regime II less socially beneficial compared with the baseline, but a higher c_a makes it more beneficial. This is because with a higher k_a , the distortion due to agents' extra profits is smaller in the market equilibrium, but with a higher c_a , the distortion due to free house showings is bigger. Therefore, the changes of k_a and c_a show opposite effects.

6 Commission cap regulation

Regime II removes the pricing distortions faced by homebuyers, and hence achieves higher consumer welfare and social surplus. An alternative approach, which would change the industry practice less drastically, is to cap buyer agent commission in the current system. Our model can be applied to evaluating such an approach. We again assume seller agents maintain the same commission compensation in fixed dollar amount as in the baseline model, (i.e., $\frac{zS}{1-S-B}$, where $S = B = 3\%$).

Under the buyer agent commission cap, $B^{\text{cap}} < B = 3\%$. Accordingly, house price p_z^{cap} would be given by

$$p_z^{\text{cap}} = z + \frac{zS}{1 - S - B} + B^{\text{cap}}p_z^{\text{cap}},$$

which yields

$$p_z^{\text{cap}} = \frac{z(1 - B)}{(1 - S - B)(1 - B^{\text{cap}})}. \quad (30)$$

Homebuyers would choose the threshold value u^{cap} that satisfies the following equation (see Appendix A for a general proof):

$$(1 + u^{\text{cap}})z - \frac{z(1 - B)}{(1 - S - B)(1 - B^{\text{cap}})} = \frac{\beta\theta}{1 - \beta} \left(\int_{u^*}^{\bar{u}} [(u' - u^{\text{cap}})z] dF(u') - c_b z \right). \quad (31)$$

Accordingly, buyers' probability of purchasing a house they visited is given by $\lambda^{\text{cap}} = 1 - F(u^{\text{cap}})$, and buyers' expected search time is $E(T^{\text{cap}}) = \frac{1}{\theta\lambda^{\text{cap}}}$. Comparing Eqs. (30) and (1), it is straightforward to see $p_z^{\text{cap}} < p_z$ given $B^{\text{cap}} < B$. As a result, the left-hand side of Eq. (31) is an upward shift compared with that of Eq. (6), so we have $u^{\text{cap}} < u^*$, $\lambda^{\text{cap}} > \lambda$ and $E(T^{\text{cap}}) < E(T)$.

Also, for buyer agents not to incur a loss, it is required that

$$B^{\text{cap}}p_z^{\text{cap}} - k_a - \frac{c_a}{\lambda^{\text{cap}}} \geq 0,$$

which implies

$$z \geq \left(k_a + \frac{c_a}{\lambda^{\text{cap}}} \right) \frac{(1 - S - B)(1 - B^{\text{cap}})}{B^{\text{cap}}(1 - B)}. \quad (32)$$

For any z satisfying condition (32), the buyer agent profit is given by

$$\pi_z^{\text{cap}} = \frac{\theta\lambda^{\text{cap}}}{1 - (1 - \theta\lambda^{\text{cap}})\beta} \left[\frac{z(1 - B)B^{\text{cap}}}{(1 - S - B)(1 - B^{\text{cap}})} - k_a - \frac{c_a}{\lambda^{\text{cap}}} \right], \quad (33)$$

and homebuyers' expected welfare W^{Cap} is given by

$$\beta W^{\text{Cap}} = (1 + u^{\text{cap}})z - \frac{z(1 - B)}{(1 - S - B)(1 - B^{\text{cap}})}. \quad (34)$$

Figure 6 plots model simulations for $B^{\text{cap}} = 1\%$ and $B^{\text{cap}} = 2\%$, respectively. Comparing with the market equilibrium where $B = 3\%$, the cap regulation reduces buyers'

search time and agent profits, and increases consumer welfare and social surplus. The lower the cap, the higher the consumer welfare and social surplus, especially for buying high-value houses.

However, Figure 6 also reveals a limitation of the cap regulation on buyers of low-value houses. When the commission cap is set at 2%, the lower-bound value of z that allows buyer agents to earn a nonnegative profit is $\underline{z} = \$151,045$, which corresponds to home price $p_{\underline{z}} = \underline{z}/(1 - 0.06) = \$160,686$ in the current system. When the cap is set at 1%, $\underline{z} = 303,563$, and $p_{\underline{z}} = \$322,939$. This implies that without additional policy accommodation, the cap regulation alone would force buyer agents not to serve houses below the lower bound, which can be a big part of the market. In fact, the home sale price distribution in Houston shows that 15.64% of houses sold in 2019 were below \$160,000, and 70.54% were below \$320,000. Therefore, a commission floor should be provided to support low-value house transactions if a commission cap is imposed.

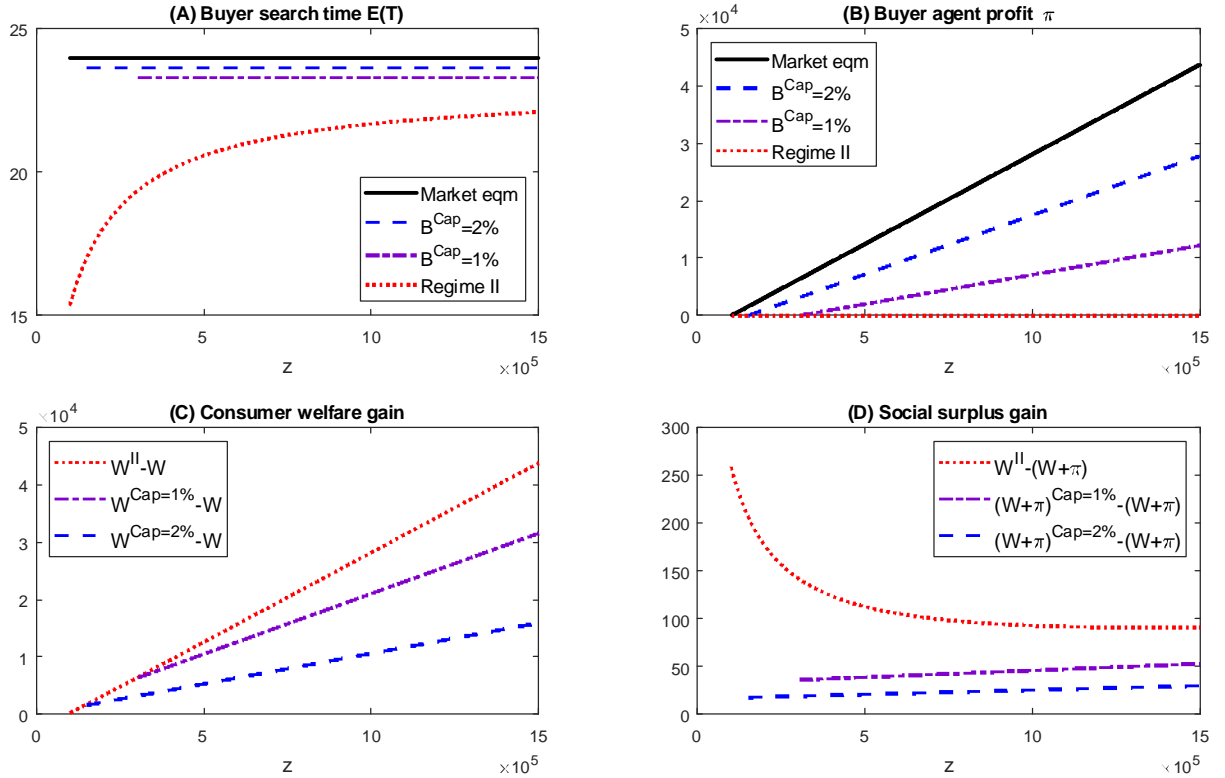


FIG. 6. COMMISSION CAP REGULATION

Compared with this uniform cap regulation, a more refined idea would be to use a nonuniform cap regulation, where B^{cap} would vary with z . This would mitigate the no-service problem, and it could eventually converge to our Regime I. However, as discussed above, direct price control may impose too much information and implementation burden on the regulator. In comparison, the a la carte commission model we proposed would not require commission caps and may deliver even higher consumer welfare and social surplus, as shown in our Regime II.

7 Conclusion

In this paper, we construct a model of home search and buying to evaluate the real estate commission in the U.S. residential housing market. In the model, as in reality, homebuyers enjoy free house showings without having to pay their agents out of pocket. Buyers' agents receive a commission equal to 3% of the house price only after a home is purchased. We show such a compensation structure for buyers' agents deviates from cost basis and may lead to elevated home prices, overused agent services, and prolonged home searches.

Based on the model, we conduct the quantitative analysis, and the results suggest that switching to a cost-based commission model for buyer agents could increase annual consumer welfare by more than \$30 billion and increase annual social surplus by about \$800 million plus a significant improvement in the allocation of agent talent and resources. We also apply the model to an alternative policy option that caps buyer agent commission in the current system. We find a commission cap would also increase consumer welfare, but at the same time, a commission floor would be needed to support low-value housing transactions.

To address the agent commission problem, we propose that policymakers may consider reforming the market structure and shifting to an a la carte model. Such a model would require that sellers and buyers each pay their agents directly, and buyers should be able to pay their agents for each task separately, independent of the final price of the purchased home. This would remove price distortions in the current system and hence improve home search efficiency and social welfare.

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Appendix A. A general proof for Proposition 1 and other cases

We provide a general proof here for uniquely solving for the threshold value of u in the baseline model, as well as in Regimes I, II, and under the commission cap regulation.

We start with a generalized model environment that incorporates our baseline model and all other cases studied in this paper. Buyers who are interested in type z houses search sequentially, and there is no recall. Each period, a buyer has an exogenous probability θ to search. The buyer then incurs a cost x_z to visit a house. During the visit, the buyer learns a buyer-home match quality u specific to the home visited. Given a match quality realization u , the buyer's total lifetime expected utility from the housing services generated by the home is $(1 + u)z$. We assume that u is an i.i.d. random variable draw from the cumulative distribution function $F(u)$ over the domain $[0, \bar{u}]$. We assume the search cost is not prohibitive:

$$E[u]z > x_z. \quad (35)$$

Let X_z denote buyer's cost-to-close, i.e., the home purchase price inclusive of any commissions the buyer pays to purchase a property of type z . We assume

$$0 \leq X_z - z < \bar{u}z. \quad (36)$$

The first inequality follows from assuming that the seller's reservation price is z , which means the buyer must pay at least that amount even in the absence of any agent commissions or fees. The second inequality says that the match quality can potentially be high enough to make the buyer's search worthwhile, given the total purchase cost of X_z .

Once matched with a home of type z and with match quality u , the buyer either buys it or rejects it and stays in the market. He thus solves the following problem:

$$V_z(u) = \max \{(1 + u)z - X_z, \beta W_z\}, \quad (37)$$

where

$$W_z = \theta \left(\int_0^{\bar{u}} V_z(u') dF(u') - x_z \right) + (1 - \theta)\beta W_z. \quad (38)$$

Here $V_z(u)$ is the value with the realized match quality u , W_z is the value of searching prior to finding a match, and β is the buyer's time discount factors.

—**Buyer's decision.** In the buyer's decision in Eq. (37), the first option, i.e., the value of purchasing the home matched with in the current period, is strictly increasing in u , while the second option, i.e., the value of continuing to search, is independent of u . The buyer's optimal decision rule, thus, is a threshold rule: for some u^* , all $u > u^*$ are accepted, and all $u < u^*$ are rejected. At u^* , the buyer is indifferent:

$$(1 + u^*)z - X_z = \beta W_z. \quad (39)$$

The following theorem summarizes the solution of the buyer's sequential search problem.

Theorem 1 *Under conditions (35) and (36), the buyer's acceptance threshold u^* is interior and uniquely determined as a solution to*

$$(1 + u^*)z - X_z = \frac{\beta\theta}{1 - \beta} \left(\int_{u^*}^{\bar{u}} (u' - u^*)z dF(u') - x_z \right). \quad (40)$$

All else equal, u^ decreases in buyer's per-visit cost x_z and increases in the purchase cost X_z .*

Proof. First, we show that u^* satisfies Eq. (40). Using the threshold rule, we have

$$V_z(u) = \begin{cases} \beta W_z = (1 + u^*)z - X_z & \text{if } u \leq u^*, \\ (1 + u)z - X_z & \text{if } u > u^*. \end{cases} \quad (41)$$

Solving Eq. (38) for W_z , we obtain

$$\begin{aligned} W_z &= \frac{\theta}{1 - (1 - \theta)\beta} \left(\int_0^{\bar{u}} V_z(u') dF(u') - x_z \right) \\ &= \frac{\theta}{1 - (1 - \theta)\beta} \left(\int_0^{u^*} [(1 + u^*)z - X_z] dF(u') \right. \\ &\quad \left. + \int_{u^*}^{\bar{u}} [(1 + u')z - X_z] dF(u') - x_z \right), \end{aligned} \quad (42)$$

where the second line uses (41).

The indifference condition (39) can therefore be written as

$$(1 + u^*)z - X_z = \frac{\beta\theta}{1 - (1 - \theta)\beta} \left(\int_0^{u^*} [(1 + u^*)z - X_z] dF(u') \right. \\ \left. + \int_{u^*}^{\bar{u}} [(1 + u')z - X_z] dF(u') - x_z \right)$$

and simplified as follows:

$$\begin{aligned} & \int_0^{u^*} [(1+u^*)z - X_z] dF(u') + \int_{u^*}^{\bar{u}} [(1+u^*)z - X_z] dF(u') \\ &= \frac{\beta\theta}{1 - (1-\theta)\beta} \left(\int_0^{u^*} [(1+u^*)z - X_z] dF(u') \right. \\ & \quad \left. + \int_{u^*}^{\bar{u}} [(1+u')z - X_z] dF(u') - x_z \right) \end{aligned}$$

\implies

$$\begin{aligned} & \left(1 - \frac{\beta\theta}{1 - (1-\theta)\beta} \right) \int_0^{u^*} [(1+u^*)z - X_z] dF(u') \\ &= \frac{\beta\theta}{1 - (1-\theta)\beta} \int_{u^*}^{\bar{u}} [(1+u')z - X_z] dF(u') - \int_{u^*}^{\bar{u}} [(1+u^*)z - X_z] dF(u') - \frac{\beta\theta}{1 - (1-\theta)\beta} x_z \end{aligned}$$

\implies

$$\begin{aligned} & (1-\beta) \int_0^{u^*} [(1+u^*)z - X_z] dF(u') \\ &= \beta\theta \int_{u^*}^{\bar{u}} [(1+u')z - X_z] dF(u') - (1-\beta+\theta\beta) \int_{u^*}^{\bar{u}} [(1+u^*)z - X_z] dF(u') - \beta\theta x_z \end{aligned}$$

\implies Eq. (40).

Second, we show that u^* exists as a unique interior solution to (40). Denote the left-hand side of (40) by $L(u^*)$ and its right-hand side by $R(u^*)$. We have $L(0) = -(X_z - z) \leq 0$, where the inequality follows from (36), and $R(0) = \frac{\beta\theta}{1-\beta} (E[u']z - x_z) > 0$, where the inequality follows from (35), which means $L(0) < R(0)$. Also, $L(\bar{u}) = \bar{u}z - (X_z - z) > 0$, where the inequality follows from (36), and $R(\bar{u}) = -\frac{\beta\theta}{1-\beta} x_z < 0$, which means $L(\bar{u}) > R(\bar{u})$. Continuity now implies the existence of u^* that satisfies (40).

To show uniqueness, it is enough to verify that L is strictly increasing and R strictly decreasing. Indeed, L is linear with slope $z > 0$, and $R'(u^*) = -\frac{\beta\theta}{1-\beta} z(1 - F(u^*)) < 0$. Thus, u^* is interior and unique. Finally, to show how u^* depends on X_z and x_z , we can differentiate (40) and obtain

$$\frac{du^*}{dX_z} = \frac{1}{z \left[1 + \frac{\beta\theta}{1-\beta} (1 - F(u^*)) \right]} > 0 \quad \text{and} \quad \frac{du^*}{dx_z} = \frac{-\frac{\beta\theta}{1-\beta}}{z \left[1 + \frac{\beta\theta}{1-\beta} (1 - F(u^*)) \right]} < 0. \quad (43)$$

■

Equations (43) suggest that the buyer becomes pickier in his home search if X_z increases or x_z decreases. Also, Eqs. (43) imply that

$$\frac{d[(1+u^*)z - X_z]}{dX_z} = \frac{1}{1 + \frac{\beta\theta}{1-\beta}(1 - F(u^*))} - 1 < 0,$$

and

$$\frac{d[(1+u^*)z - X_z]}{dx_z} = \frac{-\frac{\beta\theta}{1-\beta}}{\left[1 + \frac{\beta\theta}{1-\beta}(1 - F(u^*))\right]} < 0.$$

Given Eq. (39), this implies that

$$\frac{dW_z}{dX_z} < 0 \quad \text{and} \quad \frac{dW_z}{dx_z} < 0.$$

Therefore, the buyer's expected welfare decreases in both X_z and x_z .

—**Application to each case in the paper.** The above Theorem 1 for the generalized model can be applied to each of the cases we study in the paper:

Baseline model:

$$X_z = \frac{z}{1 - S - B}, \quad x_z = c_b z.$$

Regime I:

$$X_z = z + \frac{zS}{1 - S - B} + \Phi_z, \quad x_z = c_b z.$$

Regime II:

$$X_z = z + \frac{zS}{1 - S - B} + k_a, \quad x_z = c_b z + c_a.$$

Commission cap regulation:

$$X_z = \frac{z(1 - B)}{(1 - S - B)(1 - B^{\text{cap}})}, \quad x_z = c_b z.$$

Appendix B. Buyer heterogeneity and robustness checks

B1. Alternative value of θ

For robustness checks, we reran the quantitative exercises by assuming $\theta = 1$, in which case homebuyers visit houses every week. While the expected home search time is shorter compared with our baseline case, the welfare comparison results are very similar.

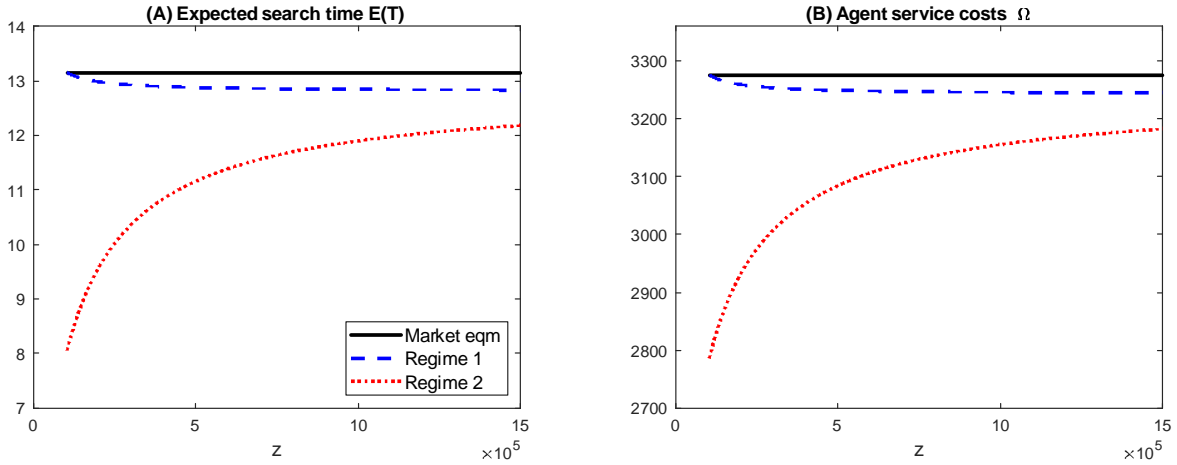


FIG. A1. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($\theta=1$)

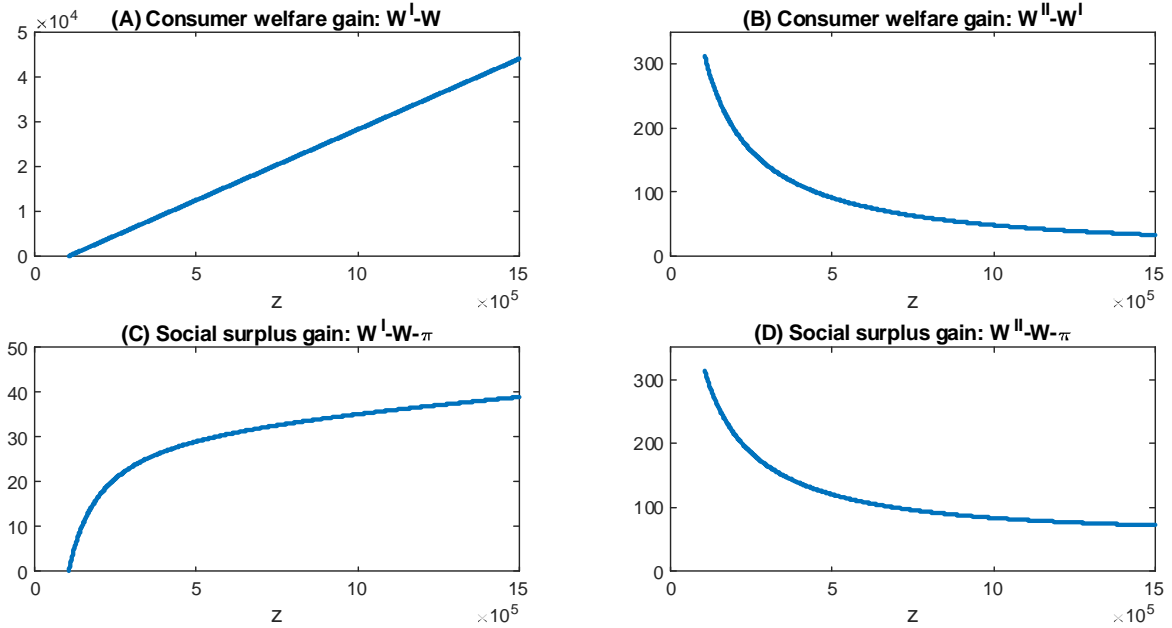


FIG. A2. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($\theta = 1$)

B2. Alternative value of S

For robustness checks, we also reran the quantitative analysis by assuming $S = 1\%$ instead of $S = 3\%$. This covers the cases in which home sellers use discounted brokers. The welfare comparison results are similar to our baseline case.

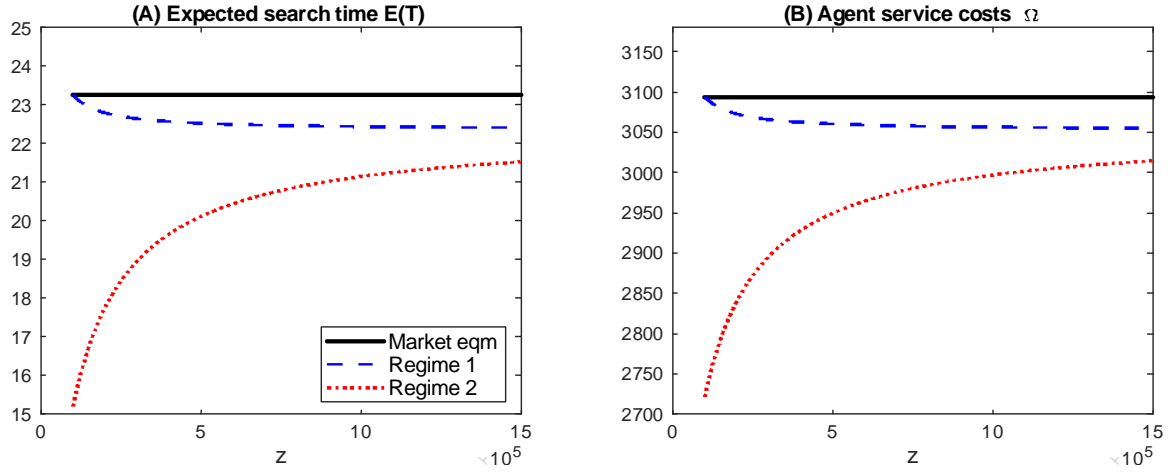


FIG. A3. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($S = 1\%$)

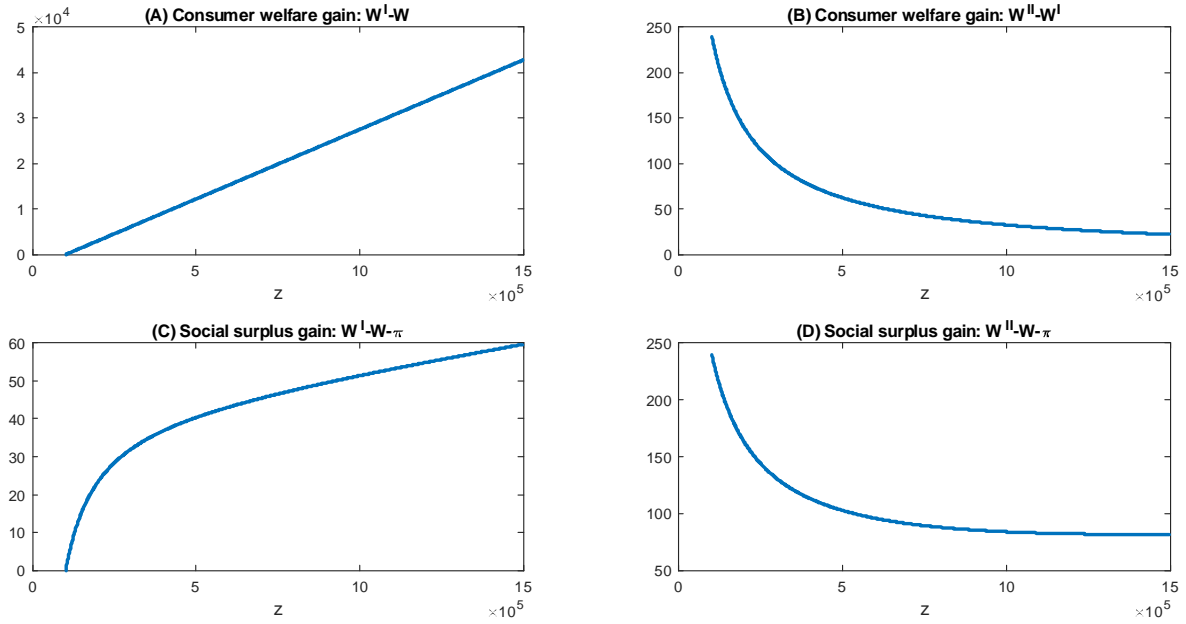


FIG. A4. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($S = 1\%$)

B3. Alternative value of c_b

For robustness checks, we reran the quantitative analysis by adjusting $c_b = \frac{1}{365 \times 12}$, which means a buyer searches for a home worth 6 times his annual income. The results show a longer buyer search time, and higher social surplus gains by shifting to Regimes I and II compared with the baseline.

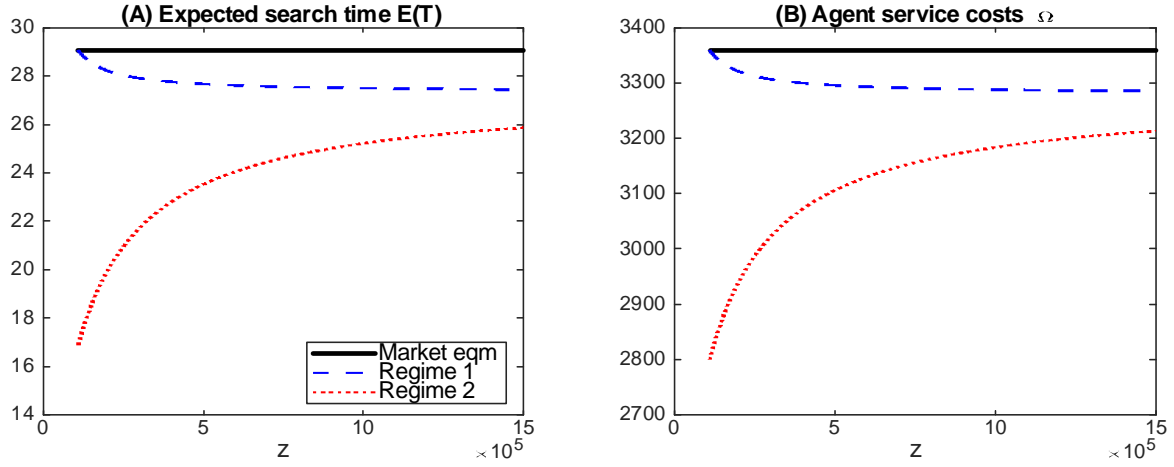


FIG. A5. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($c_b = \frac{1}{365 \times 12}$)

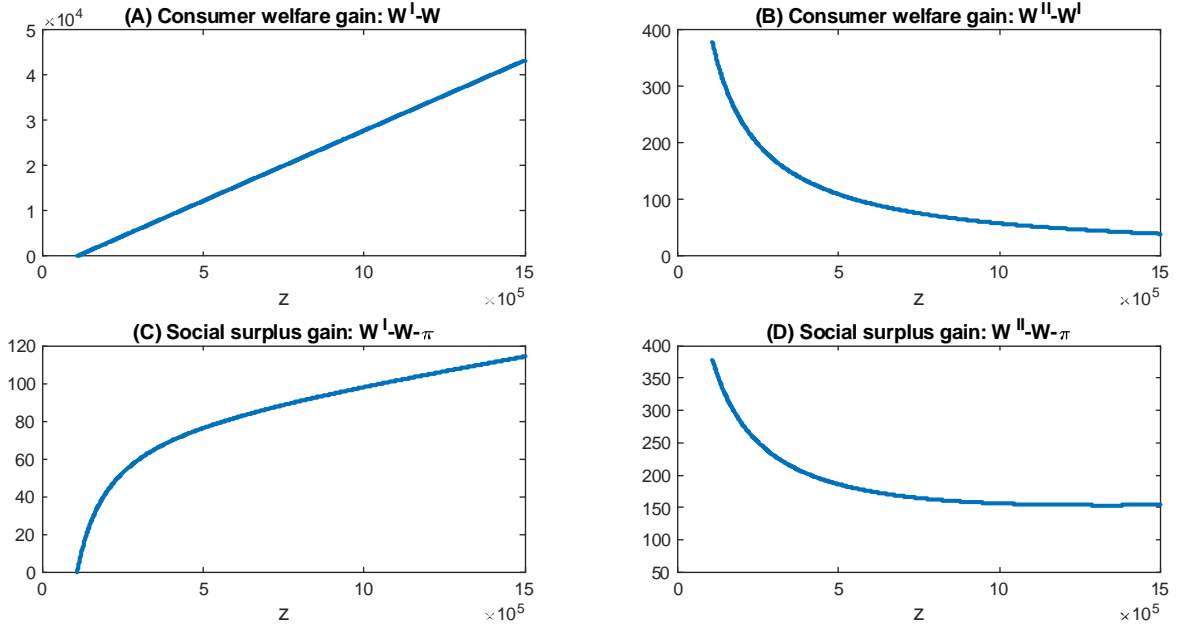


FIG. A6. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($c_b = \frac{1}{365 \times 12}$)

B4. Alternative value of \bar{u}

For robustness checks, we also reran the quantitative exercise by adjusting $\bar{u} = 0.3$. This implies that a buyer, on average, expects 15% utility gains in finding a new home (i.e., $E(u)z = 0.15z$), which is a 50% increase compared with the baseline case. The welfare comparison results are quantitatively similar to the baseline case.

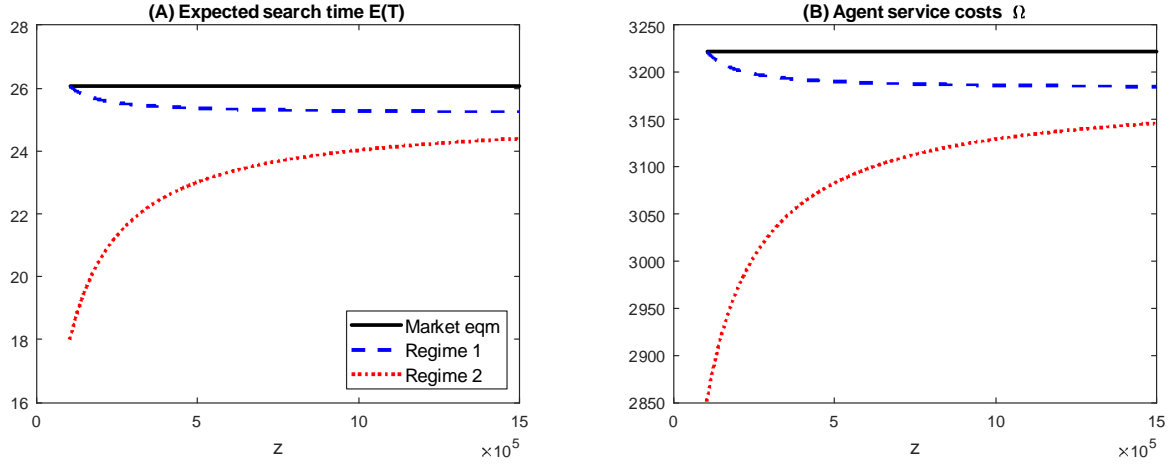


FIG. A7. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($\bar{u} = 0.3$)

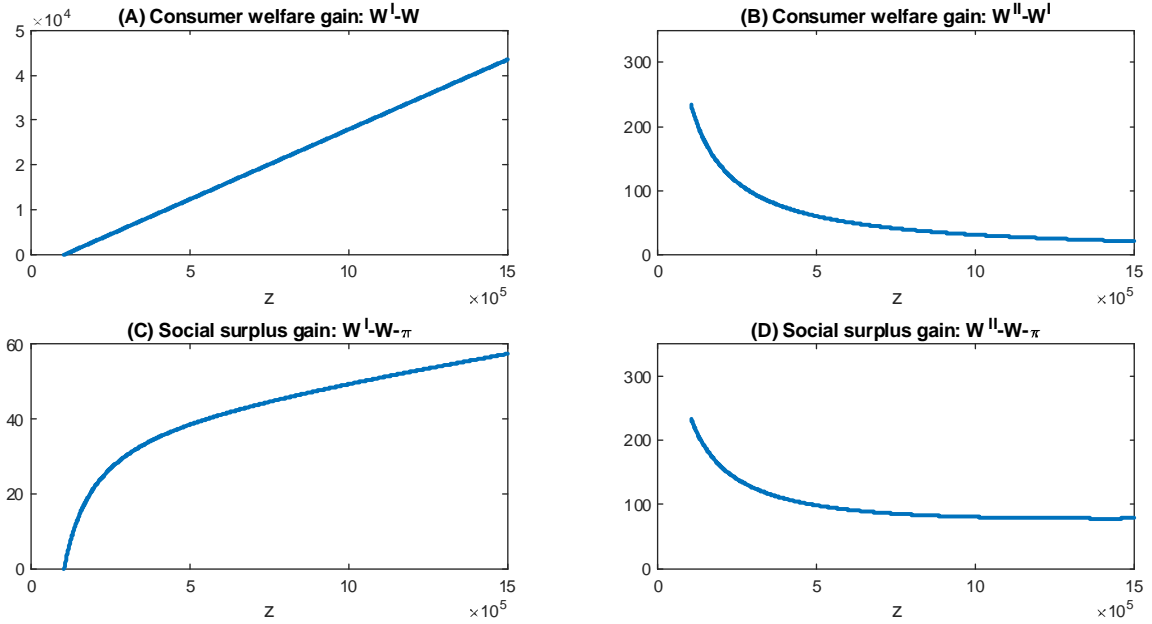


FIG. A8. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($\bar{u} = 0.3$)

B5. Alternative value of k_a

For robustness checks, we reran the quantitative exercise by assuming $k_a = 4000$, doubling buyer agents' closing cost in the baseline calibration. This raises the lower bound of z so that $z = 162,896$. The results show lower gains of consumer welfare and social surplus by shifting to Regimes I and II compared with the baseline case, and more so for low-value house transactions.

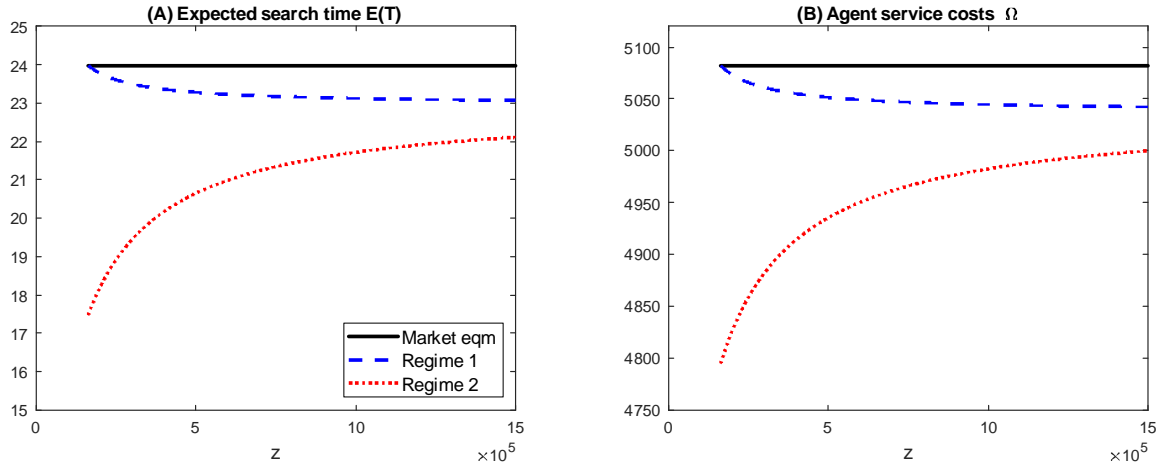


FIG. A9. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($k_a = 4,000$)

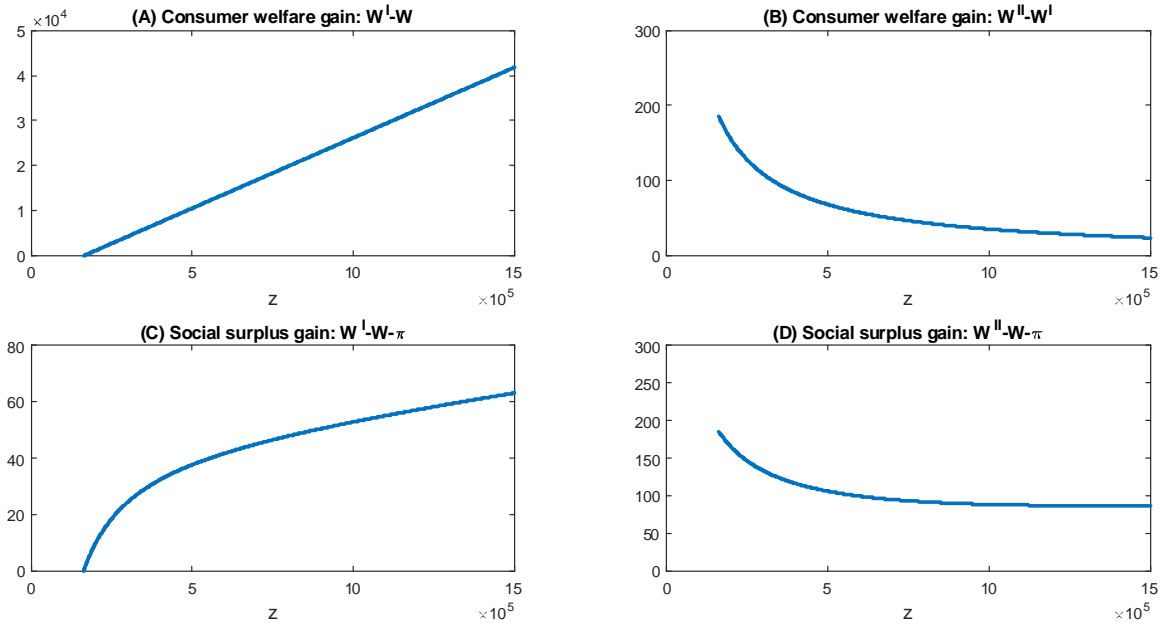


FIG. A10. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($k_a = 4,000$)

B6. Alternative value of c_a

For robustness checks, we reran the quantitative exercise by assuming $c_a = 200$, doubling buyer agents' cost of per house showing in the baseline calibration. This raises the lower bound of z so that $\underline{z} = 137,792$. The results show higher gains of consumer welfare and social surplus by shifting to Regimes I and II compared with the baseline case, and more so for low-value house transactions.

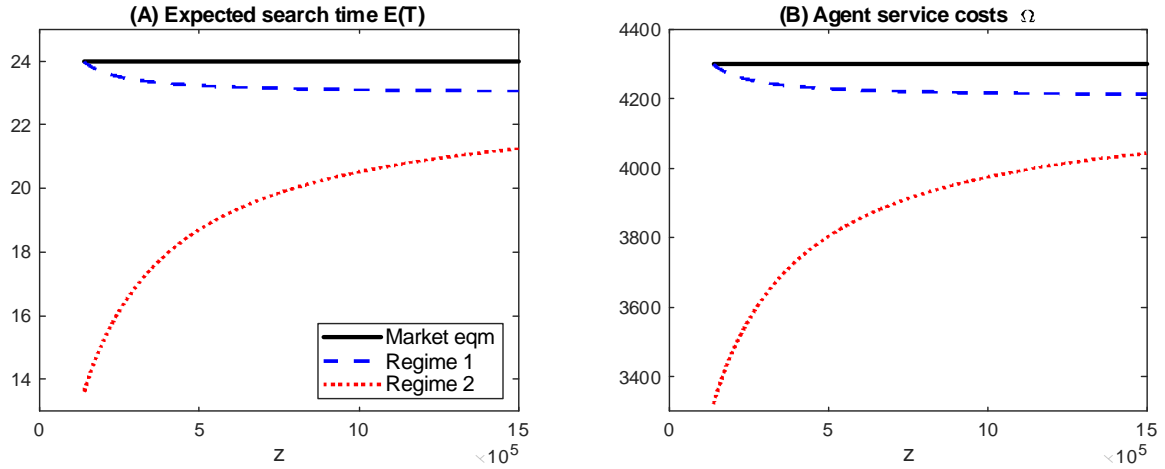


FIG. A11. SEARCH TIME AND AGENT SERVICE COSTS COMPARISON ($c_a = 200$)

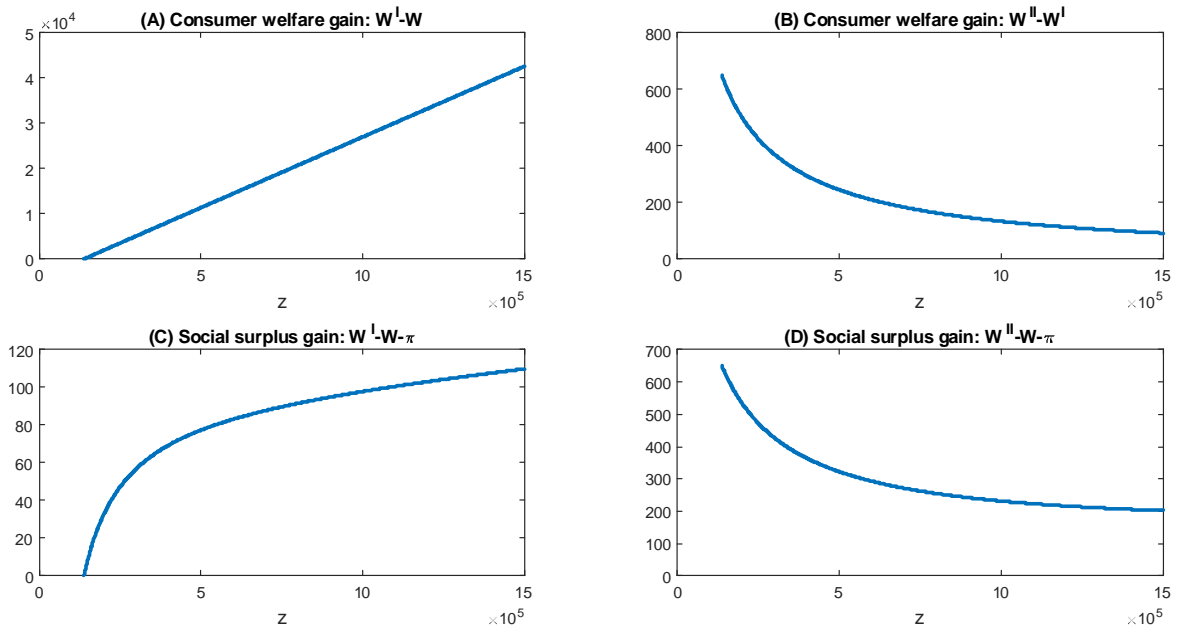


FIG. A12. CONSUMER WELFARE AND SOCIAL SURPLUS COMPARISON ($c_a = 200$)