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Real Estate Commissions and Homebuying

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Abstract

We study home search and buying in the U.S. housing market, focusing on the structure and level of buyer agent commissions. In our model, as in practice, homebuyers receive free house showings while buyers' agents earn a 3% commission from the seller upon a home purchase. We show this structure deviates from a cost-based model, resulting in excessive agent profits and inefficient searches. Adopting a cost-based commission system could raise social welfare by nearly $40 billion annually through improved home search efficiency and reduced rent-seeking by agents. We discuss policy implications of our findings, including for the recent NAR settlement.

Keywords: Real estate commissions, Real estate agents, Housing market, Search and matching

JEL Classification: D4, L1, L8, R3

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1 Introduction

Real estate commissions have long been a controversial issue in the U.S. residential housing market. Despite significant technological advances that have lowered home search and matching costs over the past 30 years, real estate agents continue to command high commission rates. In a typical housing transaction, the seller pays her agent a 6% commission, half of which is passed to the buyer's agent. Until very recently, sellers were required to post the commission offered to the buyer's agent when listing their homes on the Multiple Listing Service (MLS). Using MLS data, Figure 1 plots the distributions of listed house prices and the buyer agent commissions (BAC) offered in the Houston metropolitan area from 1997 to 2019.[1] In the total sample of 2.58 million houses listed for sale, 96.5% offered to pay exactly 3% of the home's sale price to the buyer's agent. The buyer agent commission rate is strikingly uniform across time as well as across the home price distribution.[2]

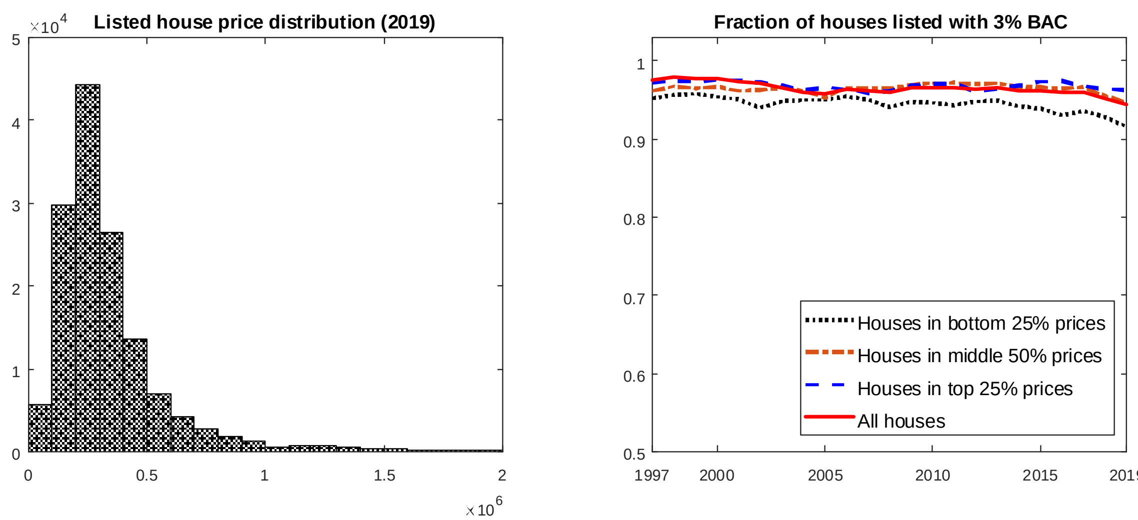

Fig. 1. House Prices and Buyer Agent Commissions in Houston

[1] Data source: CoreLogic.

[2] The uniformity of commission rates in U.S. residential housing market has been a well established fact. See, e.g., Hsieh and Moretti (2003) and Barry et al. (2024). In reality, some buyers may negotiate with their agents to receive a portion of the agent's compensation as a rebate. If so, buyer agent commissions could be less uniform than they appear. However, such rebates are uncommon. Fewer than 6% of agents surveyed reported that they offer cash rebates, and a number of states even ban such rebates entirely (Barry et al., 2024).

This level and structure of commission make the U.S. an anomaly compared with many other developed countries, where the commission rate paid by sellers is much lower and buyers commonly pay their agents' services directly.[3] Comparing across industries, the persistently high real estate commission is also puzzling. In the past few decades, the internet has squeezed margins and employment levels in many sales and advisory professions.[4] In the housing market, however, according to a recent survey conducted by the National Association of Realtors (NAR), although more than half of buyers now find their homes independently online, 89% of them still retain an agent, and the commissions rates have barely budged.[5] Meanwhile, the NAR membership has reached over 1.5 million in the 2020s, doubling its size from the 1990s.

Policymakers and industry observers have been concerned that real estate commissions deviate from underlying costs.[6] With commissions based solely on the price of the home purchased, the buyer agent's compensation is not determined by the quantity or quality of the service rendered by the agent. There is no evidence that buyer agents incur higher service costs assisting buyers shopping for higher-priced homes. Also, with buyer agents paid by sellers, some buyers may be misled into believing and acting as if they receive free services. In October 2023, a Missouri court found the NAR and two brokerage firms were liable for $1.8 billion in damages for conspiring to keep commissions artificially high. Subsequently, the NAR agreed to a historical settlement that amended the rules on buyer agent commissions.[7]

In this paper, we study theoretically and quantitatively the distortion that the prevailing commission level and structure impose on the home search and buying process in the U.S. In the model, as in practice, homebuyers receive free house showings without

[3] 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, 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).

[4] E.g., travel agent employment has shrunk from 100,000 in 2000 to 52,000 in 2019, while financial advisors, who used to charge *ad valorem* fees, have been shifting to fee-for-service models.

[5] *2024 Home Buyers and Sellers Generational Trends Report*, National Association of Realtors.

[6] E.g., see *Competition in the Real Estate Brokerage Industry*, the Federal Trade Commission and the U.S. Department of Justice, April 2007.

[7] As the result of the settlement, the NAR has banned posting commissions offered to buyers' agents on the MLS, effective August 2024. See Section 6 for more discussions on the NAR settlement.

having to pay their agents. Buyers' agents earn a commission equal to 3% of the house price from the seller once a home is purchased. We show that this buyer agent compensation structure deviates from cost basis and affects home search efficiency in two ways. One is the agents' extra profits, which push up buyers' cost of purchasing a home and make buyers more selective in their home search. The other distortion comes from the free-of-charge house showings offered by buyer agents, which lower buyers' marginal cost of home search and induce homebuyers to search more. Together, the two distortions lead to prolonged home searches, overused agent services, and elevated home prices.

We then use our model to evaluate the magnitude of these distortions. The results show that switching to a cost-based commission system, in which buyer agents do not earn extra profits and buyers pay for house showings, can increase consumer welfare by $38.52 billion a year. Most of the consumer welfare gains come from the redistribution of buyer agents' profits. Net of redistribution, social surplus increases by $479.84 million a year due to improved home search and buying efficiency. Moreover, the transfer of agent profits to consumers also increases social surplus by reducing industry rents and agent excessive entry documented in the literature. Taking this into account, the $38.52 billion annual increase in consumer welfare can be regarded as a reasonable estimate of broad social surplus gains that incorporates both effects.

Using the model framework, we explore policy options for improving the efficiency of the U.S. housing market. We argue that banning seller payments to buyer agents can be an effective measure to foster competition among buyer agents and achieve a cost-based à la carte commission system. Under this system, both sellers and buyers pay their agents directly, and buyers can pay their agents for each task separately, independent of the home's purchase price. By removing price distortions, the à la carte system helps achieve efficiency in both the homebuyers' search decisions and agents' market entry. Our policy discussion also provides insight into the motivations and limitations of the recent NAR settlement.

In our analysis, we assume a permanent "buyer's market," in which buyers have all the bargaining power over sellers. As a result, any cut in agent commissions is fully captured by the buyers through lower home prices. Because sellers retain no welfare gains, lowering agent commissions does not increase resale values of houses, so home prices fall in our model regardless of the buyers' future possibility of reselling. We should note, however, that the level of home prices is not a direct measure of consumer welfare. Buchak et al. (2024) study the impact of lowering agent commissions under the assumption of a permanent "seller's market." They find that reducing agent commissions can lead to higher home prices, as lower future transaction costs increase the resale value of houses, which benefits the sellers. While each model captures a different market scenario, both predict that lowering agent commissions enhances consumer welfare. The differing home price responses reflect how welfare gains are distributed between buyers and sellers.

Our paper adds to the growing literature on 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), Buchak et al. (2024), Gilbukh and Goldsmith-Pinkham (2024), Barry et al. (2025), and Hatfield et al. (2025). Our paper complements the existing studies by being the first one to quantify pricing distortions in the buyer agent commission system using a structural model.

Our study also connects to the literature on many other network markets that feature two-sidedness (e.g., Rochet and Tirole, 2003, 2006). For example, in the payment card markets, the interchange fee, paid by merchant acquirers to card issuers, is comparable to the buyer agent commission in our analysis. In both cases, 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). These fees allow the networks to profit and grow, which is arguably necessary for a network at its nascent stage. But as a network reaches maturity, the extra profits have become increasingly less justifiable.

The rest of the paper is organized as follows. Section 2 lays out the model, and Section 3 solves the market outcome under the existing commission regime. Section 4 provides welfare analysis, comparing the market outcome with counterfactual regimes where pricing distortions are removed. Section 5 calibrates the model to quantify the welfare findings. Section 6 discusses policy implications, and Section 7 concludes. The Appendix contains model proofs, robustness checks of the quantitative analysis, and a model extension for evaluating a uniform commission cap regulation.

2 Model setup

To study how real estate commissions affect home search and buying, we adapt a standard sequential search model to the housing market context.[8]

In a given local housing market, we define a home type by its seller's reservation value, z, based on the characteristics of the home (e.g., size and quality).[9] We assume that buyers are segmented by z, i.e., each buyer has a unique home type segment in which he searches. We denote the range of home type segments in a given local housing market by $[\underline{z}, \bar{z}]$.

To complete a sale, a seller needs to pay a commission fee proportional to the final sale price to both the seller agent and the buyer agent. We denote these commission rates by S and B, respectively.

We assume the so-called "buyers' market," meaning, when a buyer and a seller meet, the buyer makes a take-it-or-leave-it offer to the seller. The buyer offers the seller's reservation value and the seller accepts. The house is sold at a final price, inclusive of commission fees, p_z, such that $p_z = z + Sp_z + Bp_z$, which means

$$p_z = \frac{z}{1 - S - B}. \tag{1}$$

A buyer who looks for a type-z house searches sequentially with no recall. Each period, the buyer has an exogenous probability θ of viewing a type-z home for sale.[10] The buyer incurs a cost $c_b z$ to view the house, which captures the buyer's opportunity cost of time.[11]

In a viewing, 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 $(1 + u)z$.[12] We assume that u is

[8] See e.g., Rogerson et al. (2005) for a review of the standard sequential search model.

[9] The value z can be interpreted as the present value of the rental income that a seller would earn from renting out the house.

[10] In a buyer's market, 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.

[11] The time cost can be measured by the buyer's forgone income, which is positively related to the value of house that the buyer searches for. Therefore, we assume the house viewing cost is proportional to the visited house's value.

[12] Under the permanent buyer's market assumption, any future sales of the home by the buyer do not add value because the gains from trade will be captured by prospective buyers.

an i.i.d. draw from a cumulative distribution function $F(u)$ over the domain $[0, \bar{u}]$. We assume

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

meaning the search cost is not prohibitive and the match quality is potentially high enough to make the buyer's search worthwhile.

Once matched to a home with match quality u, the buyer either buys it or rejects it and stays in the market.[13] The buyer, thus, solves the following problem

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

where

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

Here, $V_z(u)$ is the buyer's 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 large number 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. Buyer agents incur a cost c_a per house showing and a cost k_a at closing of the home purchase transaction. Buyer agents do not charge commissions equal to their costs. Rather, they are paid a percentage commission rate B by the sellers. We take $B = 0.03$, as it is in the data.[14]

3 Buyer's search decision and agent's profit

In this baseline market environment, we now solve for a buyer's optimal search decision rule and for the buyer agent's resulting profit.

—**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

[13] In the model, we do not formally include the option to stop searching and leave the market altogether. In the quantitative analysis, we verify $W_z > 0$ so that this option is never "in the money" for the buyer.

[14] In this paper, we do not explain why this rate prevails. It is possible that 3% is a focal point established historically by collusion among real estate agents, or it is the constrained profit-maximizing rate above which sellers and buyers would switch to an alternative home search venue. Our analysis is consistent with either explanation.

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:

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

The following proposition pins down the buyer's optimal acceptance threshold, u^*.

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

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

Everything else being equal, u^* increases with the buyer agent commission rate B, decreases with the buyer's own per-visit cost c_b, but does not vary with the house type z. The buyer's expected welfare W_z decreases in both B and c_b.

Proof. See Appendix A1. ■

Condition (6) has the standard sequential search interpretation. It states that the buyer is indifferent between buying the house and continuing the search at the threshold value u^*. What distinguishes our model is the addition of the home price p_z and the buyer's own search cost $c_b z$ to the threshold condition.

Comparative statics are easily obtained by examining the impact of a parameter change on the left-hand side of (6), which increases in u^*, and the right-hand side of (6), which decreases in u^*. Note that an increase in the buyer agent commission rate B raises p_z and shifts the left-hand side of (6) downward with no impact on the right-hand side, resulting in a higher threshold u^*. An increase of c_b, in contrast, shifts down the right-hand side of (6) without affecting the left-hand side, which leads to a lower value of u^*. Any change of z is offset on both sides of (6), so the value of u^* remains unchanged.

Furthermore, the indifference condition (5) implies comparative statics for the buyer's ex ante value of search, W_z. For example, a cut in B increases W_z because the direct impact of B on p_z is always stronger than the indirect impact of B on u^*.

—**Buyers' search time.** The buyer's search problem implies that in each period a buyer has the probability $\theta\lambda$ of buying 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. We have $\Pr\{T = j\} = \theta\lambda(1-\theta\lambda)^{j-1}$, and, thus, the average search time for a buyer in the market is given by

$$E[T] = \sum_{j=1}^{\infty} j \Pr\{T = j\} = \sum_{j=1}^{\infty} j\theta\lambda(1-\theta\lambda)^{j-1} = \frac{1}{\theta\lambda},$$

which means $E[T]$ increases with u^*. Using Proposition 1, it is straightforward to show that a homebuyer's average search time $E[T]$ increases with the buyer agent commission rate B, decreases with the buyer's per-visit cost c_b, but, because $\lambda = 1 - F(u^*)$ is independent of z, it does not vary with house type z.

—**Real estate agent profits.** In the model, we assume seller agents do not earn extra profits, and we focus on buyer agents. In each period, with probability θ, a buyer agent incurs a cost c_a to show a house. Following a house showing, the buyer purchases the home with probability λ at price p_z, in which case the buyer agent incurs a cost of k_a to assist with the transaction and earns a commission $p_z B = \frac{zB}{1-S-B}$. With probability $1 - \theta\lambda$, however, the buyer does not purchase a home. 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

$$\pi_z = \frac{\theta\lambda}{1-(1-\theta\lambda)\beta}\left(\frac{zB}{1-S-B} - k_a - \frac{c_a}{\lambda}\right). \tag{7}$$

Recall from Proposition 1 that λ is independent of z in the baseline model. The agent's expected profit, thus, increases in z and decreases in the agent's cost to show, c_a, and in the cost to close, k_a. Proposition 1 also implies that λ increases in the buyers search cost c_b, which means π_z increases in c_b.

As above, the agent's total expected service cost, denoted by Ω, can be derived as

$$\Omega = \frac{\theta\lambda}{1-(1-\theta\lambda)\beta}\left(k_a + \frac{c_a}{\lambda}\right). \tag{8}$$

In the baseline model, the buyer agent's expected service cost does not vary with z.

For a given value of commission rate B, nonnegative buyer agent profit, $\pi_z \geq 0$, is implied by

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

or, equivalently, by

$$z \geq \left(k_a + \frac{c_a}{1-F(u^*)}\right)\frac{1-S-B}{B}. \tag{9}$$

Define $\underline{z} = \left(k_a + \frac{c_a}{1-F(u^*)}\right)\frac{1-S-B}{B}$. In our analysis, we assume that $z \geq \underline{z}$ always holds, i.e., we focus on the housing segments where buyer agents earn nonnegative profits at the prevailing commission rate of $B = 0.03$.[15]

4 Welfare analysis

In our baseline model, as in reality, the buyer agent's commission deviates from cost basis in two ways: the above-cost charge at closing and the below-cost (namely, zero) charge per showing. To evaluate the effects of these deviations, we remove them one at a time. Specifically, we compare the market baseline with two counterfactual pricing regimes. In Regime I, we assume that buyer agents continue to offer free house showings but charge a decreased commission at closing that just allows them to break even. In Regime II, buyer agents simply pass their costs to the buyers, charging c_a per house showing and k_a per home purchase. The seller agent commissions in both counterfactuals are at the same dollar amount, $\frac{zS}{1-S-B}$, as in the market baseline, which covers seller agents' service costs.

Our analysis shows that the two deviations from cost basis embedded in the existing commission system distort buyers' decisions, leading to prolonged home searches, overused agent services, and elevated home prices. Due to these deviations, consumer welfare and social surplus (i.e., the sum of consumer welfare and agent profits) are both lower.

[15] We take $B = 0.03$ as exogenously given, which does not have to be the maximizer of π_z given by Eq. (7). In reality, agents may face additional pricing constraints not specified in our model that caps $B = 0.03$. In a related paper (Grochulski and Wang, 2025), we explore the issue more explicitly.

4.1 Counterfactual Regime I: a zero-profit cap

In Regime I, buyer agents continue to offer free house showings and collect a commission, in the amount Φ_z, from sellers, when a home is purchased. The commission Φ_z is set by a planner at a level lower than the market baseline:

$$\Phi_z < \frac{zB}{1-S-B}, \tag{10}$$

for any house type $z \geq \underline{z}$. The planner ensures Φ_z is just high enough to allow the buyer agent to break even, essentially a zero-profit cap. The seller agent receives the same dollar amount of commission as in the market baseline, $\frac{zS}{1-S-B}$. The transaction price for a house of type z, therefore, is

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

Buyers maximize their expected value of search by solving (3)-(4), but with the transaction price $p_z^{\mathbf{I}}$ given in (11). As before, a buyer's optimal purchase decision takes a threshold form with an acceptance threshold, $u_z^{\mathbf{I}}$, determined by[16]

$$(1+u_z^{\mathbf{I}})z - p_z^{\mathbf{I}} = \frac{\beta\theta}{1-\beta}\left(\int_{u_z^{\mathbf{I}}}^{\bar{u}} \left[(u' - u_z^{\mathbf{I}})z\right] \, dF(u') - c_b z\right). \tag{12}$$

Comparing (12) against (6), we obtain that the buyer's acceptance threshold is lower in Regime I than in the baseline: $u_z^{\mathbf{I}} < u^*$.[17]

Taking into account the buyers' optimal search behavior, the planner's problem is choosing Φ_z ex ante to reduce the level of commission relative to the market baseline, as in (10), and to ensure buyer-agent zero profit, $\pi_z = 0$, in each home type segment z.

Proposition 2 *In Regime I, a unique solution to the planner's problem exists for each $z \geq \underline{z}$:*

$$\Phi_z = k_a + \frac{c_a}{1-F(u_z^{\mathbf{I}})}. \tag{13}$$

Compared with the market baseline, Regime I yields (i) shorter buyer search time, (ii) lower agent service costs if time discounting is sufficiently small, (iii) lower home prices,

[16] See Appendix A1 for a general proof.

[17] Indeed, with $p_z^{\mathbf{I}} < p_z$, the left-hand side of (12) is an upward shift of the left-hand side of (6), while their right-hand sides are the same.

and (iv) higher consumer welfare and social surplus.

Proof. See Appendix A2. ■

Using Regime I as a theoretical paradigm, we isolate the distortion caused by agents' extra profits. Compared with the market baseline, Regime I increases consumer welfare by lowering agent commissions. Moreover, it improves social surplus defined as the sum of consumer welfare and agent profits. In the market baseline, homebuyers respond to high commissions by prolonging their search process and creates deadweight loss. Lower commissions in Regime I reduce this deadweight loss by reducing the delay in buyers' acceptance decision.

While Regime I improves market performance, it does not achieve full efficiency. In this regime, homebuyers' agents are paid by sellers, so homebuyers do not directly face the marginal cost of home visits even though their agents make zero profit. This leaves another pricing distortion, as we discuss in the following counterfactual Regime II.

4.2 Counterfactual Regime II: cost-based pricing

We now consider a counterfactual Regime II, in which buyer agents directly pass their costs (i.e., c_a per showing and k_a at closing) to the buyers.[18] The seller agent commission remains at the same dollar amount as in the baseline, $\frac{zS}{1-S-B}$. We show that Regime II not only improves the market outcome over Regime I, but also it achieves social optimum.

In Regime II, the transaction price for a house of type z is

$$p_z^{\mathbf{II}} = z + \frac{zS}{1-S-B}. \tag{14}$$

The buyer's acceptance threshold, denoted by $u^{\mathbf{II}}$, is determined by [19]

$$(1+u_z^{\mathbf{II}})z - p_z^{\mathbf{II}} - k_a = \frac{\beta\theta}{1-\beta}\left(\int_{u_z^{\mathbf{II}}}^{\bar{u}} \left[(u' - u_z^{\mathbf{II}})z\right]\, dF(u') - c_b z - c_a\right). \tag{15}$$

At closing of the transaction, in addition to the transaction price inclusive of the seller's

[18] Alternatively, we could assume in Regime II, buyer agents charge c_a per showing to the buyer and charge k_a to the seller. In this case, home price $p_z^{\mathbf{II}} = z + \frac{zS}{1-S-B} + k_a$ and all the analysis remains intact.

[19] See Appendix A1 for a general proof.

agent commission, the buyer covers his own agent's cost, k_a, which enters the left-hand side of (15). During the search process, the buyer also pays his agent c_a for each house showing, which enters the right-hand side of (15).

Comparing condition (15) against (12), we obtain that the buyer's acceptance threshold in Regime II is lower than in Regime I: $u_z^{\mathbf{II}} < u_z^{\mathbf{I}}$.[20]

Proposition 3 *Compared with Regime I, Regime II yields (i) shorter buyer search time, (ii) smaller agent service costs if time discounting is sufficiently small, (iii) lower home prices, and (iv) higher consumer welfare and social surplus.*

Proof. See Appendix A3. ■

Relative to Regime I, Regime II does not affect the buyer agents' profits, as these are already zero in Regime I. Regime II, however, further improves the efficiency of the buyer search process by removing the incentive to overuse buyer agent services that, both in the market baseline and in Regime I, is caused by the absence of a fee for home showings. In fact, with the fees matching the agent's cost of service, the buyer's optimal search behavior is fully efficient.[21]

Proposition 4 *Regime II maximizes consumer welfare and social surplus.*

Proof. See Appendix A4. ■

5 Quantitative analysis

In this section, we use our model to quantify the magnitude of the distortions embedded in the current commission system. We first calibrate the baseline model and then compare it with counterfactual Regimes I and II. Our findings show that switching to a cost-based commission system, in which buyer agents do not earn extra profits and do not provide free house showings, could increase consumer welfare by \$38.52 billion a year. Because

[20] Indeed, relative to (12), the right-hand side of (15) shifts down while the left-hand side shifts up.

[21] Note that cost-based pricing of Regime II is not a unique fee structure that induces efficient buyer search behavior. Specifically, if the closing fee, in dollar terms, is B_z and the showing fee is b_z, then search remains efficient if $(1-\beta)(B_z - k_a) = \theta\beta(b_z - c_a)$. This condition is never met if the agent does not charge a showing fee, as is the case in the baseline regime and in Regime I.

agents' profits are rents, this annual increase in consumer welfare can be regarded as a reasonable estimate of broad social surplus gains.

5.1 Model calibration

We calibrate the model to U.S. homebuying data before the COVID pandemic. The unit of time is one week and five model parameter values are chosen based on a priori information, as shown in Table 1.

Table 1. Model parameters based on a priori information

Discount factor	Home search probability	Buyer search cost	Seller agent commission	Buyer agent commission
β	θ	c_b	S	B
0.999	0.9	$\frac{0.5}{260\times2.75\times0.94}$	3%	3%

We take agent commission rates $S = B = 3\%$, as they are in practice.[22] We set a weekly discount rate $\beta = 0.999$, which corresponds to an annual discount rate of 0.95. According to a survey conducted by the NAR, in 2019, homebuyers searched on average for 10 weeks and viewed 9 houses before making a purchase.[23] Based on this information, we set $\theta = 0.9$, i.e., a buyer gets a viewing with 90% probability each week. The NAR survey also shows that the ratio of median home price to median homebuyer household income was 2.75 in 2019. Denoting household income by i, we have $p_z = \frac{z}{1-S-B} = 2.75i$, so $z = 0.94 \times 2.75i$. We use this ratio to calibrate the buyer's search cost, c_b. We assume the buyer's opportunity cost of visiting a home for sale and deliberating the purchase decision is a half workday. With 260 workdays in a year, we thus have $c_b z = 0.5i/260$. Solving these two equations for c_b, we obtain $c_b = \frac{0.5}{260\times2.75\times0.94}$.

For the buyer-home match quality u, we assume a uniform distribution over $[0, \bar{u}]$. With the five parameter values chosen above, we calibrate $\bar{u}$ so that the model solution matches the data moment $E[T] = 10$ from the NAR survey. From $E[T] = 1/(\theta\lambda) = 1/(0.9\lambda) = 10$, we obtain $\lambda = 1 - F(u^*) = 1 - u^*/\bar{u} = 1/9$. Using this restriction in Eq. (6), we solve for $\bar{u} = 0.1298$ and the acceptance threshold of $u^* = 0.1154$.

[22] A 3% commission for buyer agent is the most commonly applied rate in our sample from both the Houston and U.S. national markets (see Section 5.3 for more discussions).

[23] *2020 Home Buyers and Sellers Generational Trends Report*, NAR, March 2020.

To calibrate buyer-agent service costs, we use agent salary data from Redfin.[24] According to Ziprecruiter.com, the nationwide average wage for a Redfin real estate agent is \$41 per hour. We assume a buyer agent spends on average 2.5 hours to prepare, show, and follow up with a client per home showing, and 40 hours assisting a successful home purchase transaction (writing an offer, facilitating home inspection, a mortgage, and closing services). This gives us $c_a = \$41 \times 2.5$ and $k_a = \$41 \times 40$. We provide robustness checks for the model parameter values in Appendix B.

With the calibrated parameters, using Eq. (8), we compute the buyer agent's expected cost to serve a customer: $\Omega = \$2,540$. Using condition (9), we then compute the lower bound above which buyer agents make positive profit: $\underline{z} = \$80,291$. Finally, using Eqs. (5) and (7), we confirm that for each $z \geq \underline{z}$ our calibrated model yields $W_z > 0$, meaning homebuyers prefer searching to dropping out of the market, and $\partial W_z/\partial B < 0$ and $\partial \pi_z/\partial B > 0$ for any $B \leq 0.03$, meaning a commission cut would benefit buyers and lower buyer agents' profits.

5.2 Comparing market baseline with Regimes I and II

Figure 2 presents quantitative results of our model comparing the market baseline with Regimes I and II. Figure 2(A) shows that shifting from the baseline system to the cost-based Regime II increases consumer welfare significantly and more so for buyers of higher-valued houses. For buyers of a middle-tier home $z = \$300,000$, the welfare gain is \$7,042, or 2.21% of the home's price.[25] For buyers of a high-end home $z = \$1,000,000$, the welfare gain is \$29,137, or 2.74% of the home's price. Most consumer welfare gains come from the redistribution of buyer agent profits, as Regime I provides the bulk of the consumer welfare gains produced by Regime II.[26]

Figure 2(B) shows social surplus gains, i.e., the gain in the sum of buyer welfare and buyer agent's profit. For most home types, the social surplus gain from switching to the cost-based Regime II is between \$50 and \$200 per transaction. Figure 2(B) also shows

[24] Redfin is a large broker that, as an exception from the industry standard, compensates agents with a salary rather than commission. See https://www.redfin.com/guides/agent-resources/working-at-redfin.

[25] For context, the median U.S. home sale price was $\$257,500$ and the mean price was $\$350,915$ in 2019 (see Section 5.3 for the U.S. home sale price distribution).

[26] Indeed, the consumer welfare gains from shifting to Regime I and II appear nearly overlapped in Figure 3(A).

that it is not the level of commissions but the adjusted commission structure that produces significant social surplus gains, especially for lower-valued homes. The social surplus gain from Regime II over and above Regime I is \$77.73 for a middle-tier home $z = \$300,000$, and \$214.58 for a low-end home $\underline{z} = \$80,291$.

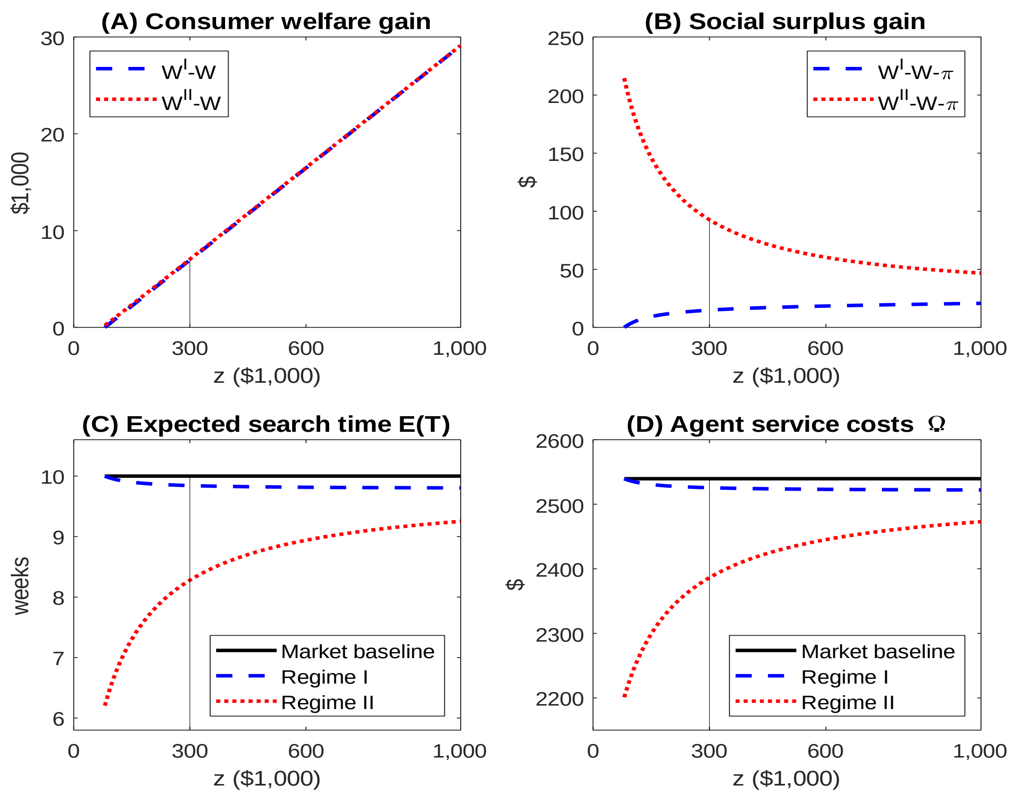

FIG. 2. COMPARING MARKET OUTCOME WITH REGIMES I AND II

Figures 2(C)-2(D) plot the impact on home search behavior. As we show is Section 4, a reduction in commissions obtained by shifting to Regime I speeds up the home search process. Quantitatively, however, this effect is weak at the weekly search frequency in our model, as it works through the discounting channel: the lower the commission, the smaller the benefit from prolonging the home search to postpone paying the commission. Figure 2(C) shows that Regime I reduces the search time for buying a middle-tier home ($z = \$300,000$), from 10 weeks down to 9.84 weeks, a 1.6% reduction. This saves both the buyer's search cost and the agent's service cost. Correspondingly, Figure 2(D) shows that agent service cost is reduced by \$13.98.

Switching to Regime II, however, has a much stronger impact on home search behavior. Because house showings are no longer free, homebuyers visit fewer houses, especially so for buyers of lower-valued houses. Figure 2(C) shows that the average search time for a middle-tier home ($z = \$300,000$) is down to 8.28 weeks, a 17.2% reduction compared with the baseline system. For a low-end home ($\underline{z} = \$80,291$), it is down to 6.21 weeks, a 37.9% reduction. Correspondingly, Figure 2(D) shows that the agent service costs are reduced by \$153.27 and \$338.65, respectively.

5.3 Aggregate welfare gains

With the calibrated model, we can compute aggregate consumer welfare and social surplus gains from the buyer agent commission (BAC) reform for local housing markets and for the nation as a whole. In this section, we first conduct a quantitative assessment for the Houston metro area market and then expand the analysis to the national market. To do so, we compile comprehensive home sales data from CoreLogic.[27] Figure 3 shows the home sale price distributions in Houston and in the U.S.

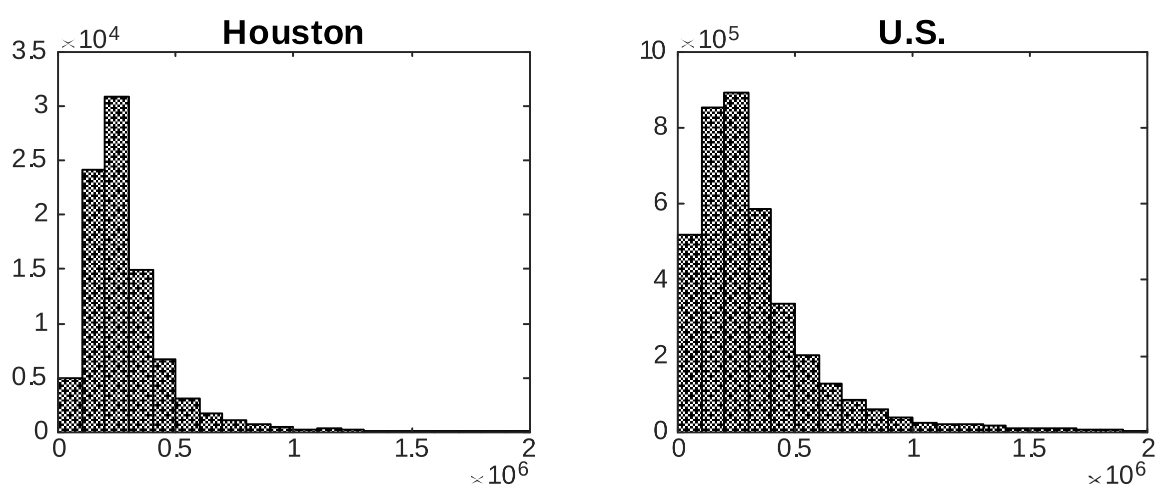

FIG. 3. HOME SALE PRICE DISTRIBUTION IN 2019: HOUSTON VS. U.S.

[27] The CoreLogic Real Estate Database contains property-level data and sale listings for properties across the U.S. It obtains Multiple Listing Service (MLS) data directly from regional boards of realtors. In our analysis, we focus on homes sold in 2019, and we exclude bank REO, foreclosures, short sales as well as homes under construction and corporate owned.

Houston. According to the CoreLogic data, 90,458 houses were sold in the Houston metro market in 2019, with the median price \$243,000 and the mean price \$303,124. Among all the sales, 88,720 (or 98%) homes were sold for no more than \$1 million, and 1,721 (or 1.9%) homes were sold between \$1-5 million. We ignore 17 (or 0.02%) homes sold above \$5 million to avoid overly expensive outliers, and we also remove 3,971 (or 4.39%) homes below $p_{\underline{z}} = \$85,416$ (i.e., $\underline{z} = p_{\underline{z}} \times (1-B-S) = \$80,291$). We then use our model to compute the welfare gains for each \$1,000 price bin and aggregate over all transactions in the sample.[28] We find that switching from the existing buyer agent commission system to the cost-based Regime II would increase consumer welfare by \$595.32 million in Houston in 2019. Net of the redistribution, social surplus would increase \$9.50 million.

U.S. The U.S. home sales in 2019 totaled 5.344 million[29], approximately 59 times the number of sales in Houston. A direct projection based on our Houston results would suggest that the BAC reform could increase consumer welfare by \$35.17 billion and social surplus by \$561.39 million across the U.S. in 2019. However, a more accurate estimate can account for the differences between Houston and the national market—particularly in terms of home price distribution and buyer agent commission rates.

To address these differences, we compile all U.S. housing transactions from CoreLogic. Our sample has 3.86 million transactions in 2019, which covers 72.2% of the entire home sales in the U.S. for that year. As shown in Figure 3, the national home price distribution is more right-skewed compared to Houston, with a higher median sale price of \$257,500 and a higher mean price of \$350,915. Without adjusting for this difference, the simple projection from Houston to the national level underestimates the consumer welfare gains but overestimates the social efficiency gains from the BAC reform. When we account for the difference in the distribution of home prices and apply our calibrated model with a 3% buyer agent commission rate, we find that shifting to the cost-based Regime II would increase consumer welfare by \$42.31 billion and social surplus by \$494.82 million in the U.S. in 2019.[30]

[28] Our result is robust to the choice of the price bin size.

[29] Data source: NAR.

[30] Our calculation takes into account that our sample covers 72.2% of the entire home sales in the U.S. in 2019.

Furthermore, the national data show some variation in the BAC, which is not present in Houston. Most U.S. home sales offered buyer agent commissions between 2.5% and 3%, with 3% being the most common (used in 50.7% of sales), followed by 2.5% (30.7%). The prevalence of these rates also varies with home prices. Among homes sold for no more than $1 million, 51.8% used a 3% rate and 29.5% used a 2.5% rate. For homes sold above $1 million, however, only 25.8% used a 3% rate, while 55.9% used a 2.5% rate. Incorporating this heterogeneity into our quantitative model moderates the estimated effects of the BAC reform. Under the refined calibration, switching to the cost-based Regime II would increase consumer welfare by $38.52 billion and social surplus by $479.84 million in 2019.

Although our quantitative analysis abstracts from some potentially important factors such as housing cycles and local market specifics, it offers a national-data-based estimate of consumer welfare and social surplus losses due to the inefficient agent commission system, and shows that the scale of these losses is enormous. In fact, with 5.344 million home sales and $350,915 average sale price in 2019, the total U.S. home purchase value reached $1.88 trillion. Under a 3% commission rate, buyer agents would have earned $56.26 billion. Our analysis shows that a major portion of that could be saved for consumers under a cost-based commission system, plus additional gains from improved home search and buying efficiency. We conduct a series of robustness checks with alternative model assumptions and the results are quantitatively similar (see Appendix B).

5.4 Agent rent seeking, excessive entry, and misallocation

In our social welfare analysis, we treat agents' profit on par with buyers' welfare. This approach, however, ignores the problem of agent rent seeking, excessive entry, and the resulting resource misallocation. As shown in Hsieh and Moretti (2003) and Barwich and Pathak (2015), fixed agent commissions and the associated excessive agent profits, combined with relatively unobstructed entry into the industry, have led to excessive entry of agents, and, consequently, to a very low average agent utilization rate. An average agent spends a lot of time searching for clients instead of serving clients, which is socially wasteful.

Indeed, despite remarkable progress in technology, labor productivity in the brokerage industry has declined over the last 30 years: 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 employs twenty-six times more agents.

Taking this misallocation into account, redistribution of agent profits into consumer welfare is not social-welfare neutral, as we treat it in our model, but rather it enhances social welfare by limiting the misallocation of agent labor and resource use. As shown in Posner (1975), with free entry, the amount of resources wasted on competition for rents can be as high as the rents themselves. In our calibration, switching to cost-based pricing implies a transfer of about \$38.04 billion per year (\$38.52 billion less \$479.84 million) from agents' profits to consumers. This amount can therefore be regarded as an upper-bound estimate on annual social surplus gains from removing rent seeking.

In fact, results obtained in Barwick and Wong (2019) indicate our estimate may be a tight upper bound on the welfare gains from removing rent seeking. Barwick and Wong (2019) report that if real estate agent productivity remained the same as it was in the 1990s, the number of agents working in real estate would be nearly one million fewer than what it is now. This one million workers would be available to work in other, more productive sectors. Assuming half of these individuals work now as buyer agents, our estimate of buyer agent extra profits, \$38.04 billion a year, implies that each of these agents foregoes $\$76,080$ a year they could make working in another industry, which matches closely the current salary levels of salespeople in other industries.

In sum, taking into account the reduction in rent-seeking behavior, the estimate of consumer welfare gains from our model—\$38.52 billion per year—can be regarded as a reasonable estimate of social surplus gains from both the improvement in home search efficiency and the reduction in rent-seeking-induced misallocation of resources.

6 Policy discussion

In this section, we discuss policy interventions through which an efficient, cost-based commission system could be implemented in practice. We first discuss interventions regulating the level of buyer agent commissions without fundamentally changing their structure. We then discuss implementing an efficient commission system via structural reforms. We conclude with some remarks on the recent NAR settlement.

In the current commission system, homebuyers do not directly compensate their agents. Instead, sellers attach an offer of buyer agent compensation to their home's listing and gross up the home's price to recover this amount. Buyers end up compensating their agent through a circular system, where money goes from the buyer to the seller to the buyer's agent.

This circular compensation system stifles competition and preserves the pricing distortions identified in our analysis (i.e., excess agent profits and unpriced buyer services) via the following mechanism. First, buyer agents offer free services to capture potential buyers so that sellers are willing to work with them to reach buyers. Second, sellers are forced to offer excessive commissions in their listings as they are concerned that buyer agents would steer clients away from their properties unless they offer the prevailing commission rate.[31] Finally, buyers pay for the excessive commissions through higher house prices, and they do not have easy means to negotiate for lower commissions because they are offered ex ante by the sellers.

Without reforming this circular compensation structure, policy options to remedy the pricing distortions are limited and less effective. Our Regime I characterizes a theoretical paradigm where zero-profit caps are used to eliminate excess agent profits in all home value segments z. However, these caps depend on agent service costs as well as on buyers' search behavior, and are not uniform across z, so the implementation does not appear practical. In Appendix C, we discuss introducing a uniform percentage cap in the existing commission system. A uniform cap is practically implementable, but it would not fully remove excess agent profits in high-z house segments, and like Regime I, it does not address the problem of free house showings.

We are then led to believe that a fundamental change of the circular compensation structure for buyer agents is needed to achieve market efficiency. In theory, policymakers can cap the payment from sellers to buyer agents at k_a or below. This amount would

[31] Empirical studies (e.g., Barwick et al., 2017 and Barry et al., 2024) provide strong evidence that steering helps substain high commission fees.

be insufficient for buyer agents to break even, so they would need to turn to buyers to negotiate for additional service fees and charge for house showings. However, such a regulation can still be difficult to implement if it requires assessing agent costs in the industry at an ongoing basis.

In contrast, an outright ban on all payments from sellers to buyer agents can be a practical and effective solution. This simple policy does not require price controls but ensures that buyer agents bargain with buyers and compete against one another for commissions. It eliminates the buyer agents' ability of steering and enables buyers to bargain for both the price and the scope of the services to be provided by buyer agents.

With sufficient competition among buyer agents, this policy would then align the buyer agents' commissions with their service costs. Further, because buyers' welfare is higher in Regime II than in Regime I, our model shows that strong enough competition between buyer agents should also lead to an unbundling of buyer agent services: the contract that offers a per-showing fee and a separate fee for the agent's help with closing wins over the bundled contract that only has one, higher, fee at closing. As the result, the buyer agent compensation system should evolve into the so-called à la carte pricing system, where buyers face separate fees for each service provided, and competition aligns the level of these fees with the agents' cost of service.

The ban on seller payments, however, can be insufficient in the cases where competition among buyer agents is limited. For example, entry of agents may not be completely free, and local market power of large brokerage firms may be considerable. In those cases, additional policy interventions, such as banning anti-competitive bundling, can be implemented to further agent competition to help achieve the à la carte pricing system.

Switching to a cost-based commission system can raise a concern about a potential disadvantage for liquidity-constrained buyers, as the current model allows the buyer agent's commission to be included in the home price and partially financed through a mortgage. However, in practice, this concern can be readily addressed. Buyers can simply request that the seller covers their agent's commission as part of the purchase offer. When drafting an offer, both the buyer and the buyer's agent are aware of the commission owed, and they can incorporate it into the offer price. This way, the commission continues to be rolled into the mortgage, just as it is under the current system.

The recent NAR settlement helps raise the consumers' awareness of the excessive commission rates, and it bans posting commissions offered to buyers' agents on the MLS. However, the settlement does not go as far in reforming the system as our analysis suggests. Specifically, because the settlement does not ban payments from sellers to buyer agents outright, buyer agents can still receive commission offers from sellers through off-MLS channels. As a result, the settlement could still preserve the circular structure of buyer agent compensation. Moreover, with buyer agents learning their compensation offer privately, the removal of this information from the MLS may reintroduce the asymmetry of information between buyers and buyer agents that the Department of Justice fought to remove as recently in 2020.[32] While the full impact of the settlement remains to be seen, these limitations could hinder the effectiveness of the reform.[33]

7 Conclusion

In this paper, we construct a model of home search and buying to evaluate real estate commissions prevalent in the U.S. residential housing market. In the model, as in practice, homebuyers receive free house showings without having to pay their agents. A buyer's agent earns a 3% commission from the seller upon the home purchase. We show this compensation structure deviates from cost basis, leading to excessive agent profits and inefficient home searches.

Based on the model, we conduct quantitative analyses. The results show that switching to a cost-based commission system for buyer agents could increase consumer welfare by nearly $40 billion a year. This annual increase in consumer welfare can also be regarded

[32] In 2020, the U.S. Department of Justice settled with the NAR for anticompetitive violations including the NAR's Commission Concealment Rules that prohibit an MLS from disclosing to prospective buyers the amount of commission that the buyer broker will earn if the buyer purchases a home listed on the MLS.

[33] A recent New York Times article reports that "One year after the National Association of Realtors agreed, as part of a legal settlement, to change a key rule on real estate commissions, little has changed...Though average commissions appear to be slipping, industry watchdogs say that Realtors and their brokerages have used workarounds and pressure on sellers to subvert the settlement...Average commissions dropped from 5.64 percent to 4.96 percent in the months that followed, according to a survey of 1,300 agents conducted by RISMedia, a real estate media company...Two other studies, conducted by the online brokerage Redfin and the cloud-based real estate accounting firm AccountTech, found commissions have not changed." — See "Home Sellers and Buyers Accuse Realtors of Blocking Lower Fees," *New York Times*, March 15, 2025.

as a reasonable estimate of broad social surplus gains from both the improvement in home search efficiency and the reduction in rent-seeking-induced misallocation of resources.

In terms of policy implications, we discuss implementing a cost-based à la carte commission system. Such a system requires that sellers and buyers each pay their agents directly, and buyers can pay their agents for each task separately, independent of the home's price. By fostering competition among agents and removing pricing distortions, the à la carte system can help achieve efficiency in the critically important U.S. housing market.

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Appendix A. Proofs

A1. A general proof for Proposition 1 and other cases

We provide a general proof for uniquely solving for the threshold value of u in the baseline model, as well as in Regimes I, II, and under a uniform 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:

$$E[u]z > x_z. \tag{16}$$

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

$$0 \leq X_z - z < \bar{u}z. \tag{17}$$

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. 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:

$$V_z(u) = \max\left\{(1+u)z - X_z, \beta W_z\right\}, \tag{18}$$

where

$$W_z = \theta\left(\int_0^{\bar{u}} V_z(u')dF(u') - x_z\right) + (1-\theta)\beta W_z. \tag{19}$$

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 factor.

—**Buyer's decision.** In the buyer's decision in Eq. (18), 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:

$$(1 + u^*)z - X_z = \beta W_z. \tag{20}$$

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

Theorem 1 *Under conditions (16) and (17), the buyer's acceptance threshold u^* is interior and uniquely determined as a solution to*

$$(1 + u^*)z - X_z = \frac{\beta\theta}{1-\beta}\left(\int_{u^*}^{\bar{u}} (u' - u^*)z dF(u') - x_z\right). \tag{21}$$

Everything else being equal, u^* increases in the purchase cost X_z and decreases in the buyer's per-visit cost x_z, and the buyer's expected welfare W_z decreases in both X_z and x_z.

Proof. First, we show that u^* satisfies (21). Using the threshold rule, we have

$$V_z(u) = \begin{cases} \beta W_z = (1+u^*)z - X_z & \text{if} \quad u \leq u^*, \\ (1+u)z - X_z & \text{if} \quad u > u^*. \end{cases} \tag{22}$$

Solving (19) for W_z, we obtain

$$\begin{aligned} W_z &= \frac{\theta}{1-(1-\theta)\beta}\left(\int_0^{\bar{u}} V_z(u')dF(u') - x_z\right) \\ &= \frac{\theta}{1-(1-\theta)\beta}\left(\begin{array}{c} \int_0^{u^*} \left[(1+u^*)z - X_z\right] dF(u') \\ + \int_{u^*}^{\bar{u}} \left[(1+u')z - X_z\right]\ dF(u') - x_z \end{array}\right), \end{aligned} \tag{23}$$

where the second line uses (22).

The indifference condition (20) can therefore be written as

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

and simplified as follows:

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

$\Longrightarrow$

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

$\Longrightarrow$

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

which simplifies to (21).

Second, we show that u^* exists as a unique interior solution to (21). Denote the left-hand side (LHS) of (21) by $L(u^*)$ and its right-hand side (RHS) by $R(u^*)$. We have $L(0) = -(X_z - z) \leq 0$, where the inequality follows from (17), and $R(0) = \frac{\beta\theta}{1-\beta}\left(E[u']z - x_z\right) > 0$, where the inequality follows from (16), which means $L(0) < R(0)$. Also, $L(\bar{u}) = \bar{u}z - (X_z - z) > 0$, where the inequality follows from (17), 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 (21).

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. Figure A1 helps visualize how u^* is determined.

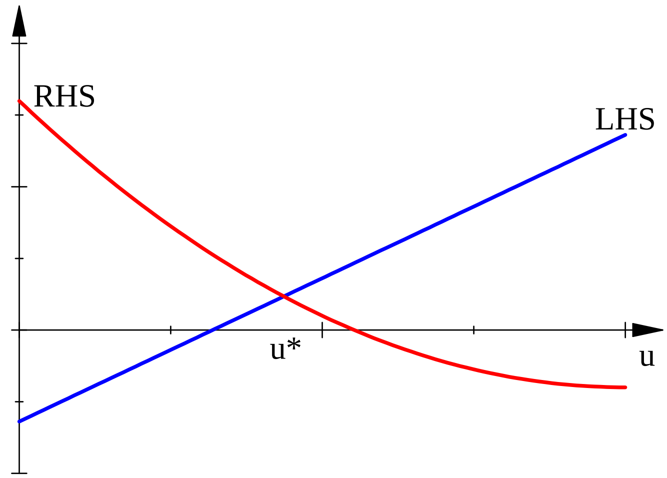

FIG. A1. DETERMINING THE THRESHOLD VALUE u^*

To show how u^* depends on X_z and x_z, we differentiate (21) and obtain

$$\frac{du^*}{dX_z} = \frac{1}{z\left[1 + \frac{\beta\theta}{1-\beta}(1 - F(u^*))\right]} > 0 \quad \text{and} \quad \frac{du^*}{dx_z} = \frac{-\frac{\beta\theta}{1-\beta}}{z\left[1 + \frac{\beta\theta}{1-\beta}(1 - F(u^*))\right]} < 0. \quad (24)$$

Figure A1 illustrates the findings of (24) intuitively: An increase in X_z shifts down the LHS, resulting in a higher value of u^*, while an increase in x_z shifts down the RHS, resulting in a lower value of u^*. From (24) we also obtain

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

and

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

which, with W_z given in (20), implies

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

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

—**Application to each case in the paper.** The above Theorem 1 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:

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

A uniform commission cap regulation in Appendix C:

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

A2. Proof of Proposition 2

In Regime I, with commission Φ_z, the buyer's agent profit is

$$\pi_z^{\mathbf{I}} = \frac{\theta \lambda_z^{\mathbf{I}}}{1 - (1 - \theta \lambda_z^{\mathbf{I}})\beta} \left[\Phi_z - k_a - \frac{c_a}{\lambda_z^{\mathbf{I}}}\right],$$

where $\lambda_z^{\mathbf{I}} = 1 - F(u_z^{\mathbf{I}})$. Setting $\pi_z^{\mathbf{I}} = 0$ and solving for Φ_z gives us $\Phi_z = k_a + \frac{c_a}{1 - F(u_z^{\mathbf{I}})}$. To show that this commission is a solution of the planner's problem, we need to verify $\Phi_z < \frac{zB}{1-S-B}$ for each $z \geq \underline{z}$. Indeed, using the definition of $\underline{z}$ and $u_z^{\mathbf{I}} < u^*$, we obtain

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

(i) The buyer's average search time is shorter in Regime I because

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

(ii) In both the baseline and Regime I, the buyer agent's expected service cost is given by

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

Differentiation yields

$$\frac{\partial\Omega}{\partial\lambda} < 0 \quad \text{iff} \quad \beta > \frac{1}{1+(c_a/k_a)\theta}, \tag{25}$$

i.e., the expected service cost decreases in λ for β high enough. With $\lambda_z^{\mathbf{I}} = 1 - F(u_z^{\mathbf{I}}) > 1 - F(u^*) = \lambda$ for any $z \geq \underline{z}$, the service cost is smaller in Regime I for β high enough.

(iii) Home prices are lower in Regime I because

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

(iv) Given that $u_z^{\mathbf{I}} < u^*$, we prove that, relative to the baseline model, Regime I yields higher consumer welfare, $W_z^{\mathbf{I}} > W_z$, and higher social surplus, $W_z^{\mathbf{I}} + \pi_z^{\mathbf{I}} > W_z + \pi_z$.

— *Consumer welfare comparison.* We first prove consumer welfare, which is equal to the buyers' surplus in our model, is higher in Regime I than in the baseline. By Theorem 1, $\frac{dW_z}{dX_z} < 0$, where X_z is the total cost to the buyer at close. $W_z^{\mathbf{I}} > W_z$ now follows from $p_z^{\mathbf{I}} < p_z$ shown in part (iii).

— *Social surplus comparison.* We now prove social surplus is higher in Regime I: $W_z^{\mathbf{I}} + \pi_z^{\mathbf{I}} > W_z + \pi_z$ or, equivalently, $W_z^{\mathbf{I}} - W_z > \pi_z - \pi_z^{\mathbf{I}}$.

Recall that in the baseline model we have

$$(1+u^*)z - p_z = \beta W_z,$$

and in Regime I we have

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

Subtracting these two, we obtain

$$p_z - p_z^{\mathbf{I}} = \beta(W_z^{\mathbf{I}} - W_z) + (u^* - u_z^{\mathbf{I}})z. \tag{26}$$

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

$$W_z = \frac{\theta}{1-(1-\theta)\beta}\begin{pmatrix} -c_b z - p_z \\ +\int_0^{u^*}(1+u^*)zdF(u') + \int_{u^*}^{\bar{u}}(1+u')zdF(u') \end{pmatrix}$$

and

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

Subtracting these two, we obtain

$$W_z^{\mathbf{I}} - W_z = \frac{\theta}{1-(1-\theta)\beta}\begin{pmatrix} p_z - p_z^{\mathbf{I}} \\ +\int_0^{u_z^{\mathbf{I}}}(u_z^{\mathbf{I}}-u^*)zdF(u') + \int_{u_z^{\mathbf{I}}}^{u^*}(u'-u^*)zdF(u') \end{pmatrix}. \tag{27}$$

The last two terms in (27) imply that

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

Using this inequality in (27), we obtain

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

where the second line uses (26). Simplifying, we get

$$(1-\beta)(W_z^{\mathbf{I}}-W_z) > \theta(u^*-u_z^{\mathbf{I}})z\left(1-F(u^*)\right) > 0. \tag{28}$$

Denote by B_z^* the dollar amount of buyer agent commission in the baseline model, i.e.,

$B_z^* = \frac{zB}{1-S-B}$. We have $p_z - p_z^{\mathbf{I}} = B_z^* - \Phi_z$. It then follows from (26) that

$$B_z^* - \Phi_z = \beta(W_z^{\mathbf{I}} - W_z) + (u^* - u_z^{\mathbf{I}})z. \tag{29}$$

Recall that the buyer agent profit in the baseline is

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

Similarly, the buyer agent profit in Regime I is

$$\pi_z^{\mathbf{I}} = \frac{\theta\lambda_z^{\mathbf{I}}}{1-(1-\theta\lambda_z^{\mathbf{I}})\beta}\left[\Phi_z - k_a - \frac{c_a}{\lambda_z^{\mathbf{I}}}\right]. \tag{30}$$

In (30), given that $\Phi_z > k_a$, we can verify that $\partial\pi_z^{\mathbf{I}}/\partial\lambda_z^{\mathbf{I}} > 0$. Therefore, with $\lambda_z^{\mathbf{I}} > \lambda$, we have

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

where the fourth line uses (29) and the final inequality follows from (28).

A3. Proof of Proposition 3

(i) The buyer's expected search time is shorter in Regime II because

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

(ii) Using (25), $\Omega_z^{\mathbf{II}} < \Omega_z^{\mathbf{I}}$ for all $z \geq \underline{z}$ follows from $\lambda_z^{\mathbf{II}} = 1 - F(u_z^{\mathbf{II}}) > 1 - F(u_z^{\mathbf{I}}) = \lambda_z^{\mathbf{I}}$

as long as $\beta > \frac{1}{1+(c_a/k_a)\theta}$ holds.

(iii) Home prices are lower in Regime II because

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

(iv) With $u_z^{\mathbf{II}} < u_z^{\mathbf{I}}$, 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 obtain

$$\beta(W_z^{\mathbf{II}} - W_z^{\mathbf{I}}) = (u_z^{\mathbf{II}} - u_z^{\mathbf{I}})z + p_z^{\mathbf{I}} - p_z^{\mathbf{II}}. \tag{31}$$

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

$$W_z^{\mathbf{II}} - W_z^{\mathbf{I}} = \frac{\theta}{1-(1-\theta)\beta}\left(\begin{array}{c} -c_a + p_z^{\mathbf{I}} - p_z^{\mathbf{II}} \\ +\int_0^{u_z^{\mathbf{II}}}(u_z^{\mathbf{II}} - u_z^{\mathbf{I}})z dF(u') + \int_{u_z^{\mathbf{II}}}^{u_z^{\mathbf{I}}}(u' - u_z^{\mathbf{I}})z dF(u') \end{array}\right). \tag{32}$$

Note that the last two terms in (32) imply that

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

Applying this inequality to (32), we have

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

where the second line uses (31). Factoring this inequality, we obtain

$$
\left(W_z^{\mathbf{II}}-W_z^{\mathbf{I}}\right)\left(1-\frac{\theta F(u_z^{\mathbf{I}})\beta}{1-(1-\theta)\beta}\right)>0, \tag{33}
$$

which implies $W_z^{\mathbf{II}}-W_z^{\mathbf{I}}>0$ because

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

A4. Proof of Proposition 4

Consider the problem of maximizing total social surplus $\Delta_z = W_z + \pi_z$, where the sum of the buyer's welfare and the agent's profit matters but not their distribution. Suppose a social planner chooses the commission fees, with the buyer paying his agent q_z per showing and Q_z at closing, and the buyer's acceptance threshold, which we denote by $u_z^{\mathbf{soc}}$ subject to buyer incentive compatibility. We prove that a solution to this problem coincides with Regime II.

In the planner's problem, with fees q_z, Q_z and the acceptance threshold $u_z^{\mathbf{soc}}$, the buyer's welfare is given by

$$\begin{aligned} W_z &= \theta\left(\int_{u_z^{\mathbf{soc}}}^{\bar{u}}\left((1+u')z-\left(z+\frac{zS}{1-S-B}+Q_z\right)\right)dF(u')-(c_bz+q_z)\right) \\ &\quad +\beta\left(1-\theta\int_{u_z^{\mathbf{soc}}}^{\bar{u}}dF(u')\right)W_z, \end{aligned} \tag{34}$$

and the buyer agent profit is

$$\pi_z=\theta\left(\int_{u_z^{\mathbf{soc}}}^{\bar{u}}(Q_z-k_a)\,dF(u')+(q_z-c_a)\right)+\beta\left(1-\theta\int_{u_z^{\mathbf{soc}}}^{\bar{u}}dF(u')\right)\pi_z. \tag{35}$$

Adding Eqs. (34) and (35), we obtain

$$\begin{aligned} \Delta_z &= \theta\left(\int_{u_z^{\mathbf{soc}}}^{\bar{u}}\left((1+u')z-\left(z+\frac{zS}{1-S-B}+k_a\right)\right)dF(u')-(c_bz+c_a)\right) \\ &\quad +\beta\left(1-\theta\int_{u_z^{\mathbf{soc}}}^{\bar{u}}dF(u')\right)\Delta_z. \end{aligned} \tag{36}$$

As we see, Q_z and q_z drop out, i.e., total social surplus depends only on the acceptance threshold $u_z^{\mathbf{soc}}$, and not on the fees Q_z, q_z.

Rearranging terms in (36), we have

$$\begin{aligned} \Delta_z &= \frac{\theta}{1-\beta\left(1-\theta\int_{u_z^{\mathbf{soc}}}^{\bar{u}}dF(u')\right)} \\ &\quad \left(\int_{u_z^{\mathbf{soc}}}^{\bar{u}}\left[(1+u')z-\left(z+\frac{zS}{1-S-B}+k_a\right)\right]dF(u')-(c_bz+c_a)\right). \end{aligned} \tag{37}$$

To maximize Δ_z, we take the first-order condition $d\Delta_z/du_z^{\mathbf{soc}}=0$, which with some algebra can be reduced to

$$(1+u_z^{\mathbf{soc}})z-\left(z+\frac{zS}{1-S-B}+k_a\right)=\frac{\beta\theta}{1-\beta}\left(\int_{u_z^{\mathbf{soc}}}^{\bar{u}}\left[(u'-u_z^{\mathbf{soc}})\,z\right]dF(u')-(c_bz+c_a)\right).$$

This is the same condition as that determines the threshold $u_z^{\mathbf{II}}$ in Regime II. We also verify that the second-order condition $d^2\Delta_z/(du_z^{\mathbf{soc}})^2 < 0$ holds at this $u_z^{\mathbf{soc}}$. Hence, $u_z^{\mathbf{II}} = u_z^{\mathbf{soc}}$, which means that the pricing of buyer agent services in Regime II induces homebuyers to use an efficient, i.e., surplus-maximizing, acceptance threshold. This confirms search is efficient under Regime II. Because buyer agents earn zero profit in Regime II, this also implies that Regime II maximizes consumer welfare.

Appendix B. Quantitative analysis: Robustness checks

Our quantitative findings are robust under alternative model assumptions. In the baseline exercise, we assume $\theta = 0.9$ so homebuyers take house tours almost every week. Alternatively, we could consider a slower market with $\theta = 0.45$, so homebuyers visit houses about every other week. Everything else equal, this yields that buyers' expected home search time $E(T) = 19.33$ weeks, almost doubling that in the baseline. Nevertheless, the welfare comparison results for each housing segment z, shown in Appendix B1, are very similar to the baseline. The aggregate effects are also similar. Assuming $\theta = 0.45$ for the entire national housing market and incorporating the heterogeneity of B in the data, we find that shifting to Regime II would increase U.S. annual consumer welfare by \$38.19 billion and annual social surplus by \$482.16 million.

In the baseline analysis, we assume seller agent commission rate $S = 3\%$. 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. For robustness checks, we reran the quantitative analysis by assuming $S = 1\%$ while $B = 3\%$. The welfare comparison results are very similar to our baseline case for each housing segment z, as shown in Appendix B2. The aggregate effects are also similar. Assuming $S = 1\%$ for the entire national housing market and incorporating the heterogeneity of B in the data, we find that switching to Regime II would increase U.S. annual consumer welfare by \$38.40 billion and annual social surplus by \$464.97 million.

We assume that in the baseline analysis, buyers search for homes 2.75 times their annual household income. In some scenarios, consumers could bear a higher home price to income ratio. 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 1), and therefore, the higher social surplus gains from shifting to a cost-based commission system. To see that, we reran the quantitative analysis by adjusting $c_b = \frac{0.5}{260 \times 5.5 \times 0.94}$, which means a buyer searches for a home worth 5.5 times his annual household income. The welfare results for each housing segment z, shown in Appendix B3, confirm the theoretical prediction and show substantially higher social surplus gains by shifting to Regimes I and II. In terms of the aggregate effect, we find that shifting to Regime II would increase U.S. annual consumer welfare by \$37.25 billion and annual social surplus by \$981.75 million.

In the baseline calibration, we assume that $k_a = \$41 \times 40$ and $c_a = \$41 \times 2.5$. What if agents incur higher costs? In Appendix B4 and B5, we continue to assume $B = S = 3\%$ and we adjust the 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 existing commission system 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 existing commission system, but with a higher c_a, the distortion due to free house showings is larger. Therefore, the changes of k_a and c_a have opposite effects. In terms of aggregate effects, we find that if the value of k_a is doubled (i.e., $k_a = \$41 \times 80$), switching from the existing commission system to Regime II (taking into account the heterogeneity of B in the data) would increase annual consumer welfare by \$31.11 billion and annual social surplus by \$367.62 million. In comparison, if the value of c_a is doubled (i.e., $c_a = \$41 \times 5$), switching to Regime II would increase annual consumer welfare by \$35.11 billion and annual social surplus by \$1.35 billion.

B1. Alternative value of θ

To check robustness, we adjust the value $\theta = 0.45$ (instead of $\theta = 0.9$) so that buyers' expected search time $E(T) = 19.33$ weeks, almost doubling what in the baseline model. This captures a slower housing market. The welfare comparison results are similar to our baseline case.

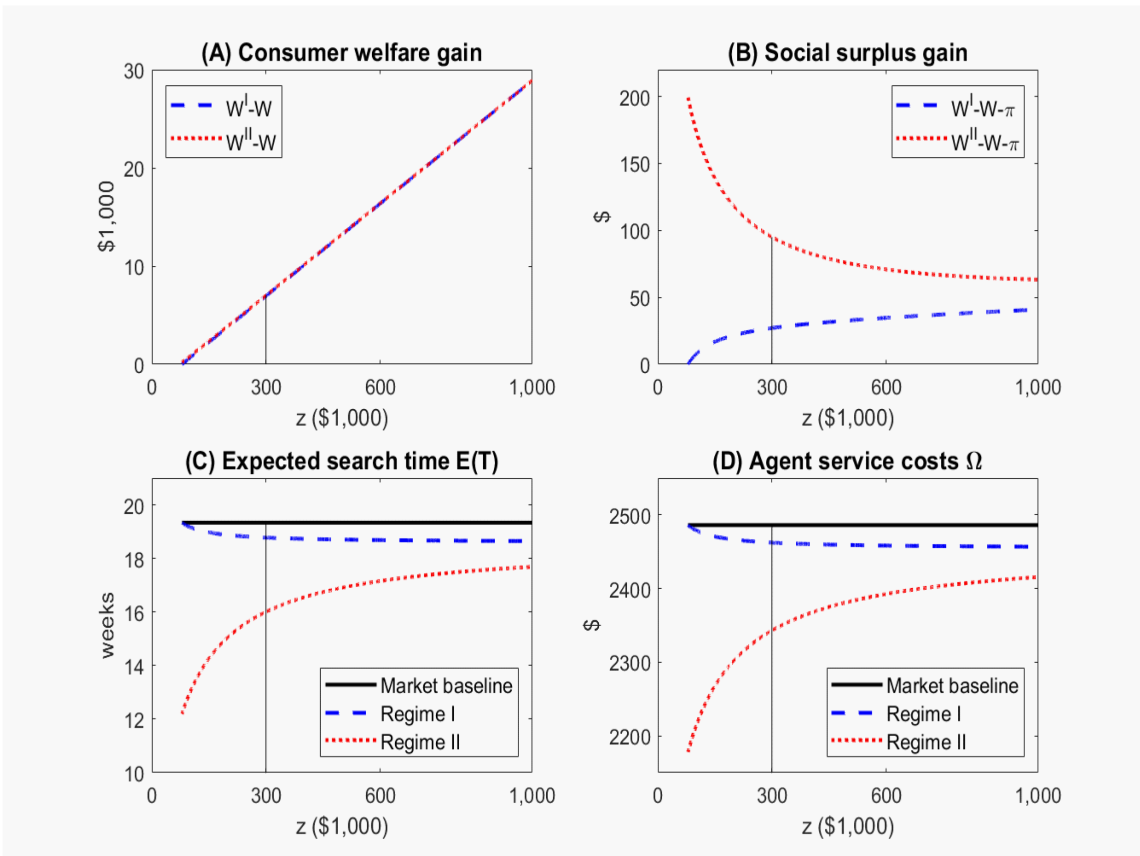

Fig. B1. Comparing Market Baseline with Regimes I and II ($\theta = 0.45$)

B2. Alternative value of S

To check robustness, we adjust sellers' commission rate $S = 1\%$ (instead of $S = 3\%$) while $B = 3\%$. This covers the cases in which home sellers use discounted brokers. The welfare comparison results are similar to our baseline case.

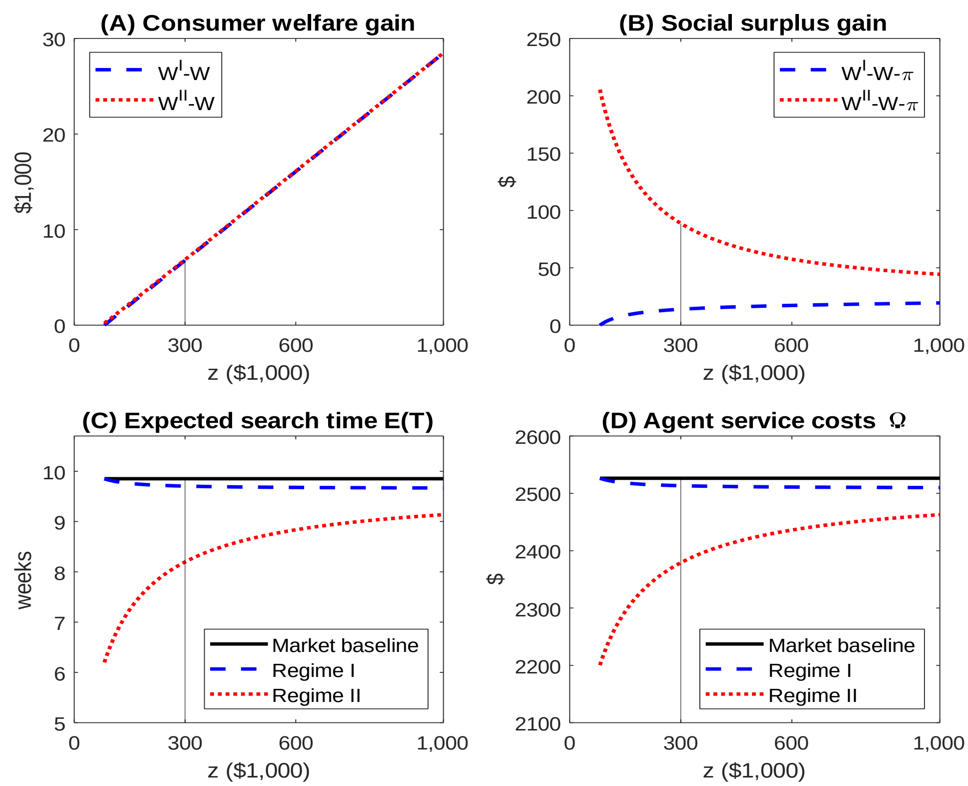

Fig. B2. Comparing Market Baseline with Regimes I and II ($S = 1\%$)

B3. Alternative value of c_b

To check robustness, we adjust $c_b = \frac{0.5}{260\times5.5\times0.94}$, which means a buyer searches for a home worth 5.5 times his annual household income. The results show longer buyer search time compared with the baseline, and higher social surplus gains by shifting to Regimes I and II.

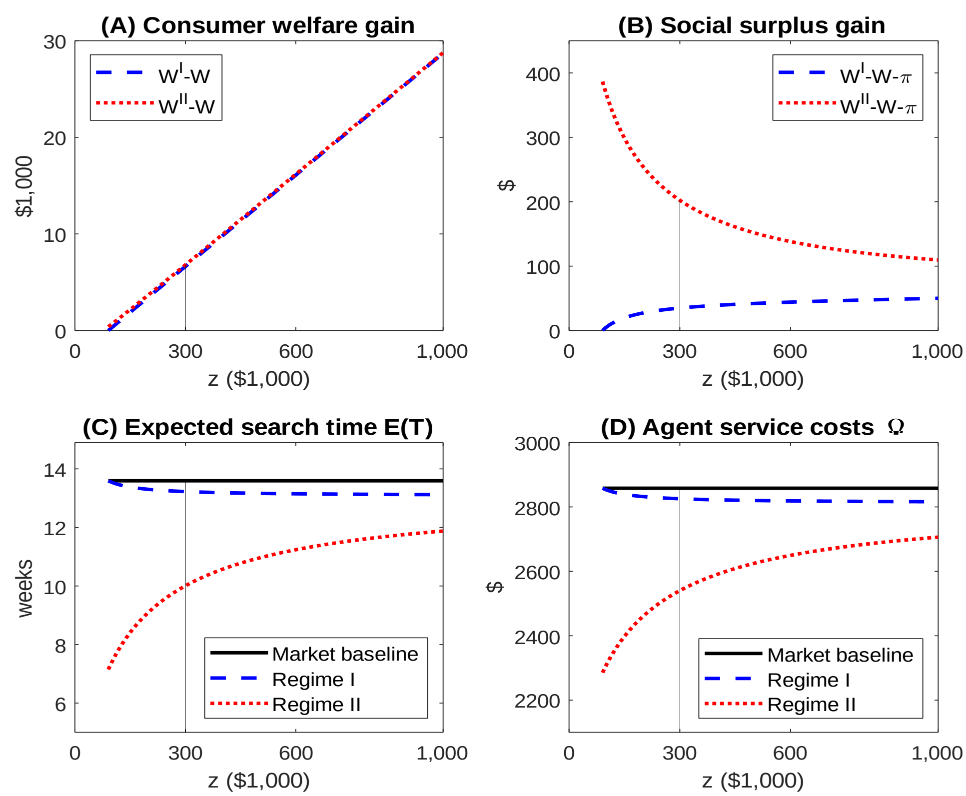

FIG. B3. COMPARING MARKET BASELINE WITH REGIMES I AND II

$(c_b = \frac{0.5}{260\times5.5\times0.94})$

B4. Alternative value of k_a

To check robustness, we reran the quantitative exercise by assuming $k_a = \$41 \times 80$, doubling buyer agents' cost at closing in the baseline. This raises the lower bound of z so that $\underline{z} = \$131,678$. The results show lower gains of consumer welfare and social surplus by shifting to Regimes I and II compared with the baseline, and more so for low-value house transactions.

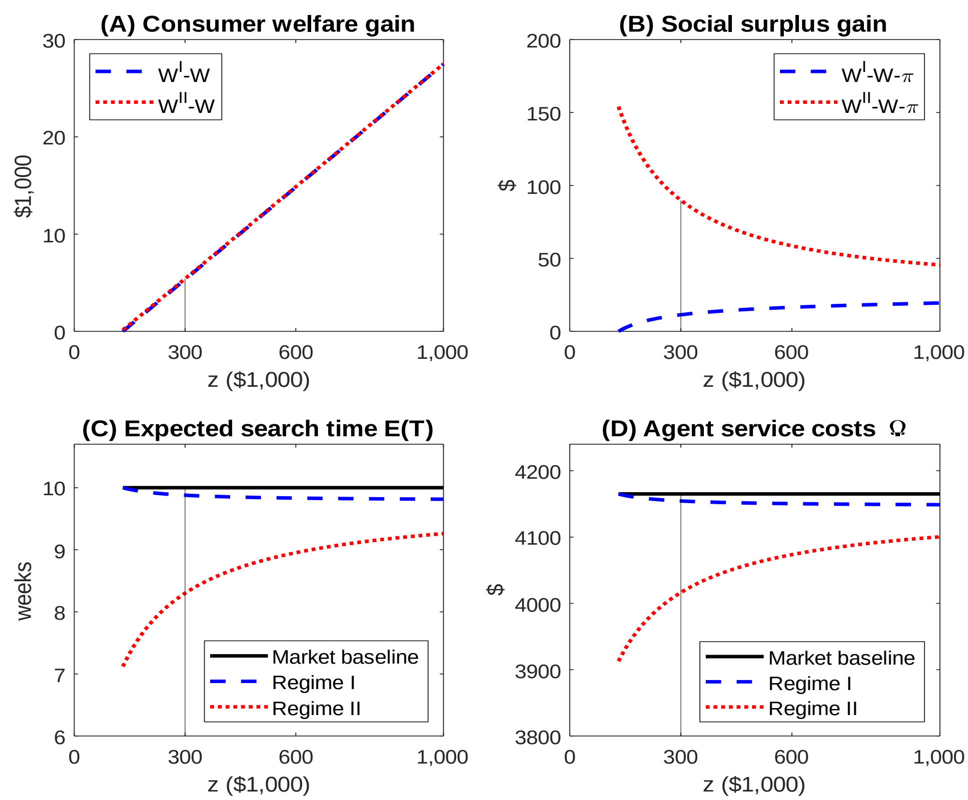

Fig. B4. Comparing Market Baseline with Regimes I and II ($k_a = \$41 \times 80$)

B5. Alternative value of c_a

To check robustness, we reran the quantitative exercise by assuming $c_a = \$41 \times 5$, doubling buyer agents' cost of per house showing in the baseline calibration. This raises the lower bound of z so that $\underline{z} = \$109,195$. The results show smaller consumer welfare gains but higher social surplus gains by shifting to Regimes I and II compared with the baseline case, and more so for low-value house transactions.

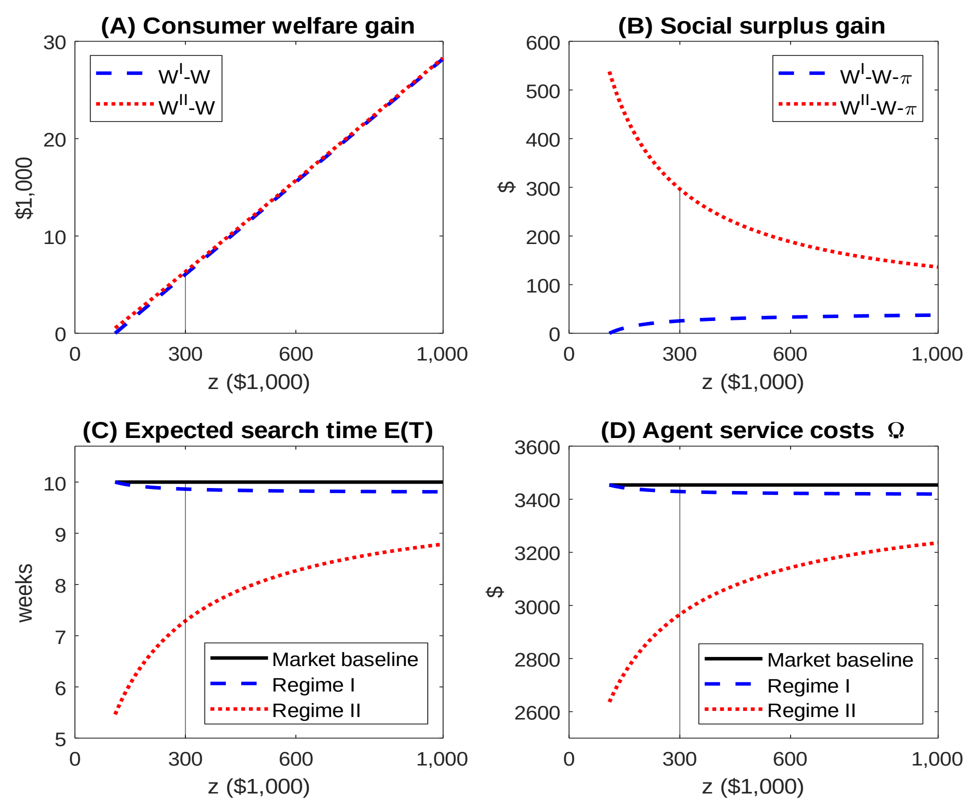

FIG. B5. COMPARING MARKET BASELINE WITH REGIMES I AND II ($c_a = \$41 \times 5$)

Appendix C. A uniform commission cap regulation

In the paper, we show that Regime II achieves the socially efficient outcome and we discuss its implementation via an à la carte system. For comparison, we extend the model to evaluate a regulation that imposes a simple uniform percentage cap on the buyer agent commission $B^{\mathbf{cap}}(< B = 3\%)$ in the existing system.

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 $S = B = 3\%$). Accordingly, house price $p_z^{\mathbf{cap}}$ is given by

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

which yields

$$p_z^{\mathbf{cap}} = \frac{z(1-B)}{(1-S-B)\left(1-B^{\mathbf{cap}}\right)}. \tag{38}$$

Homebuyers choose the threshold value $u^{\mathbf{cap}}$ that satisfies the following equation (see Appendix A1 for a general proof):

$$(1+u^{\mathbf{cap}})z - \frac{z(1-B)}{(1-S-B)\left(1-B^{\mathbf{cap}}\right)} = \frac{\beta\theta}{1-\beta}\left(\int_{u^{\mathbf{cap}}}^{\bar{u}} \left[(u' - u^{\mathbf{cap}})z\right]\, dF(u') - c_b z\right). \tag{39}$$

Accordingly, buyers' probability of purchasing a house they visited is given by $\lambda^{\mathbf{cap}} = 1 - F(u^{\mathbf{cap}})$, and buyers' expected search time is $E(T^{\mathbf{cap}}) = \frac{1}{\theta\lambda^{\mathbf{cap}}}$.

Recall that in the baseline commission regime, the house price p_z is given by

$$p_z = \frac{z}{1-S-B}, \tag{40}$$

and the buyer's threshold value u^* is determined by

$$(1+u^*)z - \frac{z}{1-S-B} = \frac{\beta\theta}{1-\beta}\left(\int_{u^*}^{\bar{u}} (u' - u^*)z dF(u') - c_b z\right). \tag{41}$$

Comparing Eqs. (38) and (40) yields $p_z^{\mathbf{cap}} < p_z$ given $B^{\mathbf{cap}} < B$. As a result, the left-hand side of Eq. (39) is an upward shift compared with that of Eq. (41), so we have $u^{\mathbf{cap}} < u^*$, $\lambda^{\mathbf{cap}} > \lambda$, and $E(T^{\mathbf{cap}}) < E(T)$.

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

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

which implies

$$z \geq \left(k_a + \frac{c_a}{\lambda^{\mathbf{cap}}}\right) \frac{(1-S-B)\,(1-B^{\mathbf{cap}})}{B^{\mathbf{cap}}(1-B)}. \tag{42}$$

For any z satisfying condition (42), the buyer agent profit is given by

$$\pi_z^{\mathbf{cap}} = \frac{\theta\lambda^{\mathbf{cap}}}{1-(1-\theta\lambda^{\mathbf{cap}})\beta}\left[\frac{z(1-B)B^{\mathbf{cap}}}{(1-S-B)\,(1-B^{\mathbf{cap}})} - k_a - \frac{c_a}{\lambda^{\mathbf{cap}}}\right], \tag{43}$$

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

$$\beta W^{\mathbf{Cap}} = (1+u^{\mathbf{cap}})z - \frac{z(1-B)}{(1-S-B)\,(1-B^{\mathbf{cap}})}. \tag{44}$$

Figure C1 plots the model simulations for $B^{\mathbf{cap}} = 1\%$ and $B^{\mathbf{cap}} = 2\%$, respectively.

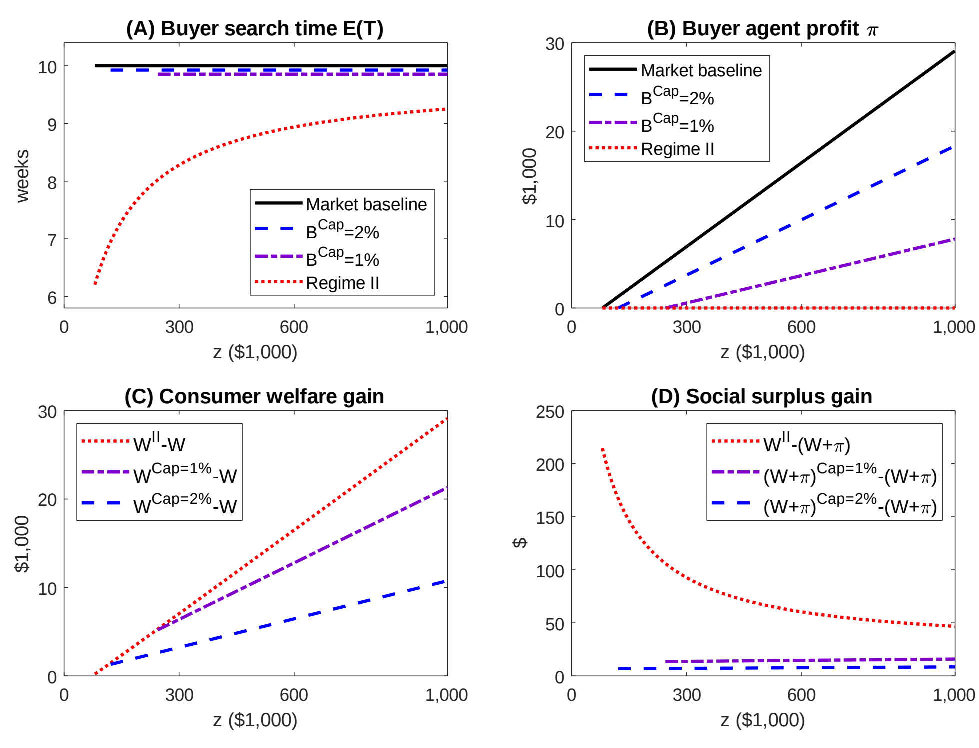

Fig. C1. Uniform Commission Cap Regulation

Comparing with the market baseline where $B = 3\%$, the cap regulation reduces buyers' search time and agent profits, and increases consumer welfare and social surplus, especially for buying high-value houses. However, comparing with Regime II, the uniform cap does not fully address the excessive agent profits in high-z house segments as well as the issue of free house showings.

Keeping the existing commission structure unchanged, Figure C1 shows a side effect of the cap regulation on buyers of low-value houses. When the commission cap is set at 2%, the lower-bound home price that allows buyer agents to earn a nonnegative profit is $p_{\underline{z}} = \$129,101$. When the cap is set at 1%, $p_{\underline{z}} = \$260,171$. This implies that under the existing commission structure, the cap regulation would force buyer agents to stop serving the low-value housing segments. However, it is possible that the cap may change the commission structure endogenously for buying low-value houses and force buyer agents to turn to buyers to negotiate for compensation, which may improve the market outcome.