Underpricing Regimes in Housing Markets

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Abstract

I study a staggered policy change intended to reduce bidding wars for homes by increasing their list price and eliminating underpricing. Using a novel and large micro data set and a difference-in-difference methodology, I find that increasing the list price reduces the buyer arrival rates in all stages of the search process – online, at the open houses, and during bidding – and increases the probability of a failed sale. I find a strong null effect on the sales price which can be bounded to a tight interval around zero. I find no effect on the sales effort exerted by real estate agents, nor on time-on-market. To explain these findings, I develop a search model where a non-committing list price is set optimally by real estate agents and where the list price directs buyers' search. The model is consistent with my empirical findings, and can explain why the policy did not last in the long run.

JEL classification: R21, R30, R38, C57, D83, C78

Keywords: Real estate prices, list prices, bidding wars, auctions.

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1 Introduction

An underpricing regime means that the majority of homes sells above their list price, in contrast to a market price regime or an overpricing regime. Underpricing occurs world-wide[1] and particularly in hot housing markets (Han and Strange, 2014). Underpricing, it has been argued, is bad for buyers for many reasons.[2] It may increase the noise about the market value contained in the list price, and it may lead buyers to waste time screening for homes they eventually cannot afford. Time constrained buyers may visit the wrong homes, if they are unaware of the degree of underpricing. Moreover, there may be a miss-match of buyers and sellers that is bad also for the sellers. I study Sweden's two largest housing markets, Stockholm and Gothenburg, where severe underpricing has been considered a problem since the early 2000's. Using a survey, Gunnelin and Lind (2008) find that real estate agents (REAs) in Stockholm deliberately underpriced on average by 30 percent in 2007, despite it being illegal and known to hurt their reputation.

Although concerns have been raised regarding the damaging effects of underpricing regimes, it is hard to estimate such effects empirically. The most challenging task of the empirical list price literature is to find a credible way of dealing with the endogeneity of the list price. Previous work attempts to deal with this in a variety of ways. For example, Björklund et al. (2006), Kang and Gardner (1989) and Belkin et al. (1976), run hedonic pricing regressions with the list price as an additional control variable. Yavas and Yang (1995) and Guren (2016) instruments for the "true" market value of a home using time-on-market and estimated price appreciation since purchase, respectively. Papers studying "charm pricing" compare homes listed just below a nominal threshold to those listed just above, see e.g. Beracha and Seiler (2014), Cardella and Seiler (2016) and Allen and Dare (2004).

In contrast to previous studies, I analyze a reform that shifted entire markets from being underpricing regimes to market price regimes. Before the reform home could be severely underpriced. After the reform homes are listed using an *accepted price*. The accepted price is supposed to be in line with the REAs' valuation of the home, but not below the sellers' ex ante reservation price. The reform was upheld for about a year and a half, before REAs started to underprice again.

Except for randomized field experiments (which is unheard of in the list price literature),

[1]Some recent U.S. headlines are "In San Francisco's Bidding Wars, Home Prices Go Ballistic" (Wall Street Journal, August 27, 2015), "Lowered prices create bidding wars in hot housing market" (Boston Globe, March 31 2015), 'Toronto real estate gimmickry hits the limit of our patience" (The Toronto Star, May 22 2016).In New South Wales, Australia, the problem of underpricing lead the government to impose tighter underpricing regulations (link) on January 1st 2016. Prior to the new regulations, the news were filled with headlines like "25pc underquoting by real estate agents the new norm" (The Australian Financial Review, Nov 7 2014).

[2]Some arguments from the media can be found in the article "Hocking Stuart Richmond fined for underquoting Melbourne properties" (James Hancock, ABC News Australia, October 6, 2016)

the type of reform that I study is the ideal setup for analyzing the causes and consequences of underpricing regimes. This is so for three reasons. First, the reform directly affected only the list price and was coordinated by the largest real estate agent trade association. The timing and construction of the reform was thus as good as random to the individual real estate agents and objects. Second, different regions were reformed at different dates. The reform thus lends itself well to a difference-in-difference analysis of the causal effect of underpricing regimes. The reform occurred in markets with rising, flat, and falling home prices, allowing me to alleviate concerns about the reform being "optimally timed". Third, neither sellers' nor buyers' offers are binding in this market. Hence, the list price does not affect the sales mechanism (i.e., the design of the auction) at all.[3] The effects I find are thus solely the effects of a higher list price.

Another benefit from studying a reform that affects everyone is that it equates to analyzing the effect of a *regime shift*. The existing literature on the role of list prices[4] focus on the effect of *individual* deviations from the expected list price of a particular home. Individual underpricing is a marketing tool sellers can use to compete with other sellers for a given number of buyers. A regime shift studies how the total number of buyers (aggregate demand) respond to the list price. From a policy perspective the latter is more relevant because any new law affecting the way list prices are set would imply a regime shift upon implementation.

Using difference-in-difference regressions and a large, novel, and detailed data set, I find a number of consequences of the reform. First, I find that the take up rate of the reform in the sample was almost full (extensive margin) and it increased the list prices by 15 percent (intensive margin). This is empirical evidence of almost full compliance, which is striking for a voluntary reform. That REAs were able to voluntarily and momentarily reduce their underpricing is empirical evidence that underpricing was deliberate, and not due to their inability to predict sale prices. I argue that because the reform directly affected only the list price, any effects I find will be causal (i.e., due to the increased list price). Second, I find that the reform makes the list price a stronger predictor of the sale price and that this decreases the buyer arrivals. The average standard deviation of the list-sale difference decreases by five percent. This means that after the reform prospective home buyers could extract more information about the value of the home from the list price, requiring them to spend less

[3]The fact that the accepted price is supposed to be above the sellers ex ante reservation price is unlikely to affect the sales mechanism, for two reasons. First, home prices have been growing rapidly in the fifteen years prior to the reform. Any price the seller will be offered is hence likely to be far above the nominal purchase price (and mortgage). We know from Genesove and Mayer (2001) that sellers exhibit nominal loss aversion – but because nominal losses are highly unlikely in this market it is unlikely to affect the results. Second, the seller did not have to and was not incentivized to sell at the accepted price, although he was supposed to be willing to sell at that price.

[4]See e.g. Anglin et al. (2003), Han and Strange (2016), and references in Han and Strange (2015)

time searching for homes. This argument is coherent with my findings on buyer arrivals. The daily number of online views of the advertisement decreases by 55 percent and the number of prospective buyers visiting the open houses decreases by 24 percent. The number of bidders for the home decreases by 23 percent. I estimate the monetary value of the increased search effort to 0.4 percent of the value of the home, which is large considering the list price did not effect the mechanism at all.[5] Third, there is virtually no effect on the transaction itself. A striking null result is that the sale price is not affected by the reform. With very strict clustering of standard errors, the effect on the sale price is within -3 and +2 percent with 95 percent confidence. Nor do I find an effect on time on market in my preferred specification, but the standard errors are large, and it does come out as positive in some specifications. There is a statistically significant but economically insignificant increase in the probability of a transaction being withdrawn without a sale (failed sale). I find no effect on the work effort by REAs, or on the composition of buyers or sellers.

Behavioral theories can explain that an increase in the list price will increase the sale price, or decrease the sale price.[6] The majority of housing search models use the list price as a ceiling where the seller will have to sell, see e.g. Han and Strange (2015) and Guren (2016). Underpricing is impossible in these models. Three recent papers do allow for underpricing. Han and Strange (2016) develop a search model where the home will sell at the list price if there is exactly one "high"-type buyer. In that case the sellers is committed to sell at the list price. If there are more "high" type or "low" type buyers, the home will sell at auction and the seller is not commited to sell at the list price, but can sell above or below. The list price directs search because of the possibility of getting the home for a bargain (at the list price). Buyers visit the home if it is optimal to do so. They find that increasing the list price reduces the buyer arrivals. Merlo et al. (2015) solve the home selling problem theoretically. They find that if the arrivals of buyers are very elastic to the list price, it would be optimal for the seller to underprice. Han and Strange (2016) and Merlo et al. (2015) use the number of bidders as a proxy for buyer arrivals, but do not have data to validate whether it is actually a good proxy. Albrecht et al. (2015) solve a general equilibrium search model where sellers compete for buyers using the list price, and buyers compete against other buyers using bidding. There is asymmetric information and a seller can signal their type, "motivated" or "relaxed", by

[5] Compare to 0.21 found in Anenberg and Bayer (2013)

[6] The anchoring theory by Tversky and Kahneman (1975), argues that a higher list price will increase peoples' perception of the value of the home, and hence the sale price. The basic private value auction models yield that the more bidders, the higher the sale price. If a low list price will lure people into the auction, and bidders are susceptible to *irrational overbidding* – this could push up the price. Malmendier and Lee (2011) finds irrational overbidding occurs in online auctions, although Einav et al. (2015) find that it no longer persists.

using a low or high list price, respectively.[7].

To explain the empirical results, I develop a search model that fit the institutional setting. In the model, the REAs set the list price optimally, trading off commission from the sale for the risk of losing their REA license. The REAs are aware that a lower list price increase buyer arrivals, which will increase the probability of sale. Deliberate underpricing is illegal (unfair marketing) and might inflict the loss of a costly REA license.[8] I assume that the list price directs search online: buyers only view homes online that are listed within their budget. This rule-of-thumb behavior is not fully rational, but is motivated by Piazzesi et al. (2015) who find that about two thirds of prospective home buyers specify a list price range when searching online. After viewing the online advertisement, prospective buyers choose optimally whether to pay a search cost to visit the open house and participate in the auction. A key mechanism of this model is that although the list price directs search, it is fully non-committing: there are no incentives what so ever for the seller to sell at the list price.

The model can replicate the empirical results. As the list price increase the number of visitors online decrease. Above an endogenous threshold level, so does the number of visitors to the open house. As long as the number of visitors is large enough, above fifteen, the average sale price is inelastic to these changes. This is a property of the expected value of the second order statistic of the willingness to pay for the home. The reform can explain why the policy did not last in the long run. The probability of loosing the REA license is too small, compared to the gains of underpricing, for it to be optimal for the REAs to use market pricing.

The rest of the paper is organized as follows. In Section 2 I briefly describe the institutional setting of Swedish residential real estate market, and in Section 3 I discuss the reform. Section 4 describes the data. Section 5 contains the empirical analysis of the causal effect of the list price on the real estate market. The search model is presented in Section 6. In section 7 I discuss the welfare consequences of prolonged search due to the reform, and Section 8 concludes. Most robustness tests, elaborations, and alternative specifications are found in the Online Appendix, along with a further exposé on the effects of individually underpricing the market, and the gains from underpricing under different pricing regimes.

[7]Neither of these three papers discuss whether underpricing can increase buyer arrivals without affecting sale price. In my model the average sale price derived from the auction is not very sensitive to the number of bidders, as long as the number of bidders is large enough. But as soon as the number of bidders is small, the sale price becomes sensitive. That this occurs even at relatively few buyers is due to the the binding budget constraint and the distribution function of the willingness to pay. Although not discussed explicitly, these models might be able to generate similar results, but at higher number of bidders.

[8]Obtaining such a license in Sweden is costly and requires a special two year college degree. This cost can also be thought of as a hurt reputation causing fewer new transactions.

2 The Swedish Residential Real Estate Market

This section outlines the key institutional details of the Swedish residential real estate market. For a longer exposé, see the Online Appendix.

2.1 Legal ownership/governance structure

The paper studies sales of apartments. Apartment ownership in Sweden is organized around cooperative associations (co-ops). A co-op member (a shareholder) does not outright own their apartment in the sense that they possess the legal title to it. Instead they own the right to live in a specific apartment as long as the monthly co-op fee is paid. Most people think of co-ops as owning an apartment, and the right to live in a specific apartment can be sold on the open market. The co-op fee is used to cover building maintenance, heating, and co-op mortgage. The fact that the home is owned by a co-op have two of important consequences. First, the board of the co-op often restrict subletting the apartment to the legal minimum.[9] Thus there are very few, if any, pure investors in this market. Second, co-ops are heavily regulated by law (sv *Bostadsrättslagen*[10]) and there is a minimal amount of due diligence required when purchasing a co-op. This pushes down the time required to transact, and time-on-market is usually less than three weeks. [11]

2.2 Real estate agents (REAs)

Only licensed REAs and lawyers are allowed to broker real estate in Sweden. The license is issued by The Swedish Estate Agents Inspectorate (Fastighetsmäklarinspektionen), a government agency. To be eligible for a license one needs a two year university degree covering Economics, Business, Law, and Real Estate.

A Swedish REA is hired by and paid for by the seller. The REAs are bound by law to safeguard the interests of both the buyer and the seller (Riksdagen, 2011). The payment to the REA is contingent on the property actually being sold. If the seller chooses not to sell, the REA will not receive payment, irrespective of what bids have been placed. Most REAs charge a commission. Either a fixed percentage (1.5 percent of the sale price is common), or a fixed amount and then a percentage above a certain threshold (for example SEK 40,000 +

[9] Essentially that subletting is limited to maximum one year, and only allowed for a few specified reasons reasons such as studying in a different city, or cohabiting with a new partner.

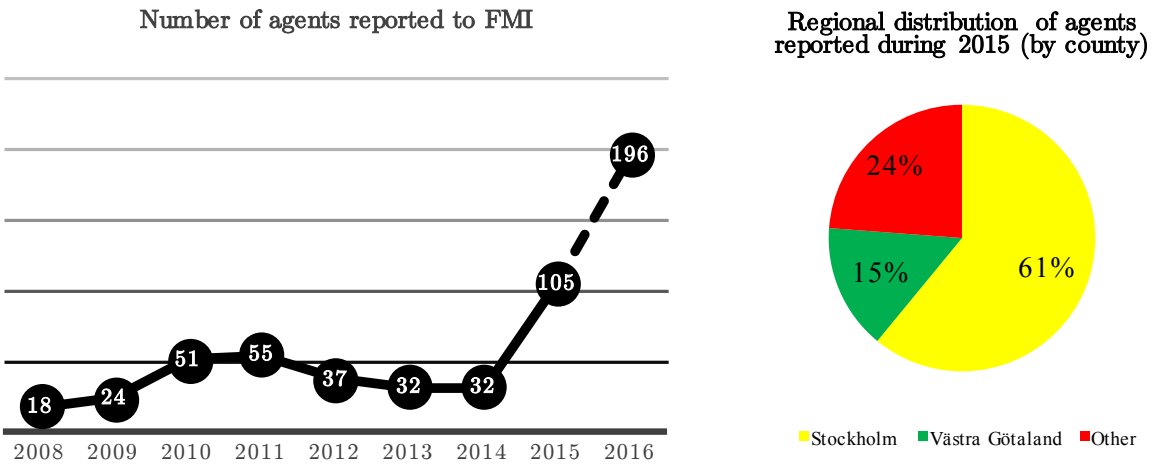
[10] There are still a few, older, co-ops in existence that are subject to other laws (sv *Lagen om Ekonomiska föreningar*). These are often called *Bostadsföreningar* instead of *Bostadsrättsföreningar*. Because of their old age they often have small or no mortgages and are hence secure investments requiring little due-diligence.

[11] See Sodini et al. (2016) for more details on co-ops in general and their creation and real estate purchases in particular.

10 percent above two million). If the REA works for a large REA-company, the latter take three quarters of the commission and leave the individual REA with as little as one quarter.

As part of the REAs' obligation to safe guard the interest of both the buyer and the seller they have to use fair marketing (Riksdagen (2011) and Riksdagen (2008)). Fair marketing implies listing the home at a price that is close to market value of the home, using hedonic pricing models augmented by the REAs' expert knowledge. It is thus illegal for REAs to intentionally underprice. Discontent prospective buyers might report the REAs to the authorities, who in turn can withdraw the REAs' license to broker real estate. Figure 1 displays the frequency of REAs reported to the authorities for issues related to unfair marketing and underpricing. The left panel shows the number of reported REAs, which grew sharply prior to the first reform in 2011. It was stable through 2012-2014 but then grew sharply in 2015. The right panel show that most reported REAs were located in Stockholm County and Västra Götaland (Gothenburg). These are the regions that where underpricing is most extreme, and affected by the reform.

Figure 1: Number of agents reported to the supervisory authority for bad conduct regarding list prices.



Note: Data supplied by Fastighetsmäklarinspektionen. The data is reported on the County level. Stockholm County is the union of Central Stockholm and Outer Stockholm. Gothenburg is a subset of Västra Götaland County. The value for 2016 is based on data through May 2016, and extrapolated using the same rate of growth as during 2015. The total number of licensed real estate agents is about 6,700 (2012)

Most sellers are in no hurry and tend place more weight on the sales price when selling the largest single asset of their portfolio. Because of the flat incentive structure for REAs, they tend to place more weight on closing the deal quickly so they can move on to the next deal.

This means that in general the seller and the agents' incentives are not perfectly aligned. On the other hand, the time on the market for homes in Sweden is very short, the average home sells in less than three weeks.

2.3 The sales process and sales mechanism

Homes for sale are advertised in local newspapers, and on multiple listing services (MLSs) online. The largest MLSs are `Hemnet.se`, `Blocket.se` and `Booli.se`. Homes are usually listed 3-10 days before the first scheduled viewing, which is often on a Sunday afternoon. There are usually one or two additional viewings on the prior Thursday or the following Monday or Tuesday evening. The viewings are open house without a prior sign-up requirement.

The sales mechanism is a sequential ascending auction, often referred to as an English auction (Krishna, 2002). Bids are open, and all potential buyers continuously obtain information about the highest bid and the (anonymized) ID of the highest bidder. Many REAs publish the full bidding history online until the home is sold, see the Online Appendix for two examples. There are five peculiarities that need to be highlighted, compared to the traditional English outcry auction used to sell e.g. second-hand furniture.

First, there is no fixed auction time. Bidding can start at any time and the auction keeps going until the seller accepts a buyer. Bidding is commonly done by sending a text message, email or placing a phone call to the REA. The REA usually does not perform a background check on buyers, so auction participation is "cheap" for buyers visiting the open houses. Second, bids can be placed at any time until the final sales contract has been signed by both bidder the seller. If the seller is not happy with the highest bid, he can wait indefinitely for a higher bid. Third, the bids are not binding for neither buyer nor seller. A bidder can withdraw his bid at any time. The seller might not sell even if there multiple bids far above what was ex ante believed possible. In neither case is there is a pecuniary withdrawal cost until the binding sales contract is signed. As a partial commitment device, most contracts with REAs prohibits the seller to hire another REA within 3 months after the first attempt at selling the home. Fourth, in an attempt to prohibit fraudulent behavior such as decoy bidders hired by the REAs, the REAs are bound by law to reveal the identity behind the anonymous bidder IDs to the winning bidder and to the seller. Fifth, the seller has the exclusive right to choose whom to sell to and at what price, even if is not the highest bidder. In contrast to the North American market for homes, sellers will rarely choose someone else but the highest bidders.[12] The REA will check with the buyers' mortgage lender that funding is in place, so funding is usually not an issue for the buyer. Table 1 presents a typical time

[12] In New York, for example, it often happens that a seller choose a lower full-cash bid instead of a higher bid that need financing.

schedule for selling a home in central Stockholm.

Table 1: Typical sales process for apartment in Central Stockholm

Day	Event
0	Seller contact a few REAs for price quotes (typically around 1.5% or 40,000 kr 10% above market value or similar)
2	Sign a contract with a REA that you're not allowed to hire another REA to sell the same home within 3 months
5	REA sends in a photographer and possibly a stylist. REA collects information about the home, co-op, etc, and writes a description
6	Publish the home online (typically a thursday)
20	Main open house viewing: 0.5-1 hour on a sunday afternoon
22	Supplementary viewing: 0.5-1 hour on a Monday or Tuesday afternoon
23	Bidding starts by text, email and phone calls to REA
26	No bidder is willing to raise the bid further. REA contacts the seller and winning bidder to sign the sales contract

Note: The table is based on averages for Central Stockholm where I have data, and my best guess for the events where I do not data (the first three bullets).

Please note that although it is common that the first bid is at the list price, there is nothing in the sales mechanism that force this behavior into place. Buyers are allowed to and often do bid below the list price. It is also possible to bid below the highest current bid, which is reasonable if the bid has other preferable terms (say a different preferred move-in date).

2.4 Labels for for list prices

In this paper I use the term "list price" to mean the price level at which a home was advertised. Some papers refers to list prices as asking prices or advertised price. For the purpose of this study they all mean the same thing. Importantly, the list price is not the sellers' reservation price or the sales price (transaction price). A reservation price is a price level above which a seller agrees to sell his home; and this does not exist in the Swedish market. The sales price is the price derived from the auction.

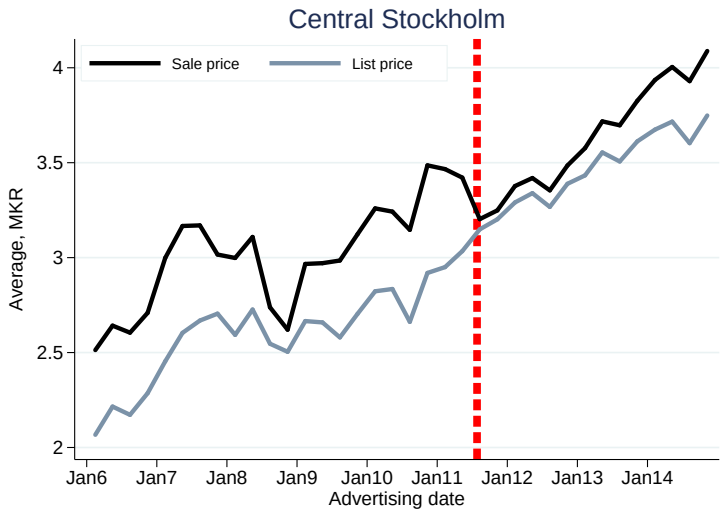
Homes in Sweden are advertised using different labels of the list prices. A few examples are "bid starting point", "starting price", "price", "accepted price", and "accept price". The only difference between these prices is the label in the sense that they do not affect the sales mechanism. Because sellers have neither legal nor pecuniary commitment to sell at the list price, the name of the list price does not affect their incentives, and because the types of list prices are not defined in law they have no other effect on the market mechanism. If

the price level is the same, the only difference between different list prices types is whatever behavioral effect this will have on buyers and sellers. I argue that the list price label does not cause behavioral distortions for three reasons. First, on one of the large MLS's (`blocket.se`) you cannot see the list price type. Buyers on that MLS are thus unaware of the price label. Second, the price label has no legal meaning, and does not affect the sale mechanism. Third, in the regions and time period I study almost all homes are advertised using the same list price type. If labels differed in the same market they would be more likely to matter than if all homes in a given market have the same label.

2.5 Transaction prices and the list-sale spread

Figure 2 shows the average asking and sales prices in Central Stockholm over time. It shows that the average list price is always well below the average sales price. Further, the list-sale spread fell across the board in the heat of the international financial crisis in 2008, as well as during the Euro crisis of late 2010 and early 2011. At the time of the reform in central Stockholm, August 1st 2011, list price increased relative to the sale price. Prices stayed close for about 28 months, until underpricing slowly started to re-appear. The real estate agents claim the re-appearance of underpricing was due to their inability to estimate the market price of homes in a rapidly increasing market.

Figure 2: Average list- and sales prices over time in Central Stockholm



Note: The graph shows quarterly averages (means) of the List price and Sales price in Central Stockholm. The graph look similar if using hedonic- or repeat-sales indexes.

The media commonly refer to the urban markets in Sweden as using *teaser prices*. The fact that list prices are significantly below sales prices has caused a large media debate, and the REAs where often portrayed as being insincere, trying to fool home buyers into purchasing homes above their budget. Following this debate – possibly in fear of regulation – the Swedish Real Estate Agents Trade Association (Mäklarsamfundet) hired two researchers to analyze the occurrence and potential remedies of teaser prices. The researchers (Gunnelin and Lind, 2008) find that Stockholm based REAs set the list price 30-40 percent below the expected market value in anticipation of a bidding war. They further find that the media attention that these teaser prices caused has hurt the reputation of the REAs. In their interviews, none of the REAs could come up with a viable alternative to underpricing.

3 The Reform

To improve the reputation of the REAs one of their trade associations, Mäklarsamfundet, coordinated a policy change. Mäklarsamfundet is the largest of such associations and covers about 80% of all REAs. The reform consisted of listing homes at market value instead of far below. The reform was accomplished by instructing REAs to start listing homes using *accepted price*. The policy change was introduced in three stages. First in central Stockholm, then outer Stockholm[13], and last Gothenburg.

3.1 Definition of "accepted price"

Although the term accepted price existed prior to the reform, it was not defined formally, and it was used differently by different REAs. As part of the reform Mäklarsamfundet defined accepted price as in Figure 3. It means that accepted price is defined as the maximum of the REAs ex ante valuation of the home and the seller's reservation price. As part of the reform the trade association made sure that the new definition was communicated to potential buyers: it was discussed in all big media outlets and in all new listings.

3.2 Reform dates

The reform was rolled out in three steps over 17 months. The first step affected homes listed in central Stockholm on or after August 1st 2011. It was announced to the trade association's members and the media on July 27, so the possible time frame for an "Ashenfelter's dip" is only a matter of days.[14] In total 40 REA companies – comprising more than 80 percent

[13] Outer Stockholm is defined as all of Stockholm County excluding central Stockholm.

[14] See Ashenfelter (1978) for the original paper, a comprehensive survey in Heckman et al. (1999)

Figure 3: Official definition of *Accepted price*

(a) Definition in Swedish. Taken from a Real Estate Listing on Real Estate Agent Notar's website.

Accepted Price

This home is marketed as "Accepted price". This means that the advertised price is at a level which the seller is willing to accept as final sales price. If there are multiple bids, however, bidding might occur and the price might go higher. The seller and the real estate agent will jointly agree on the level of the accepted price which is also within the real estate agent's valuation of the home.

Although an accepted price is advertised the seller has the legal right to review any offers, which means the seller has the right to choose whether to sell the home, to whom and at what price.

(b) Definition in English. (author translation)

of the market – agreed to participate in the Central Stockholm reform. The reform was first introduced in central Stockholm because this was the geographical area where list-sale spreads were most stable, and the REAs did not anticipate any large effects on neither price nor time on market (Gunnelin and Lind, 2008). See the Online Appendix for a list of REAs that agreed to the reform, as well as a map showing the definition of Central Stockholm used in the reform.

In the early winter of 2011 Mäklarsamfundet announced that also homes in the rest of Stockholm County would be listed using Accepted price starting January 1st 2012.[15] On November 26th 2012 Mäklarsamfundet announced that also homes in Gothenburg Municipality, listed on or after December 21st, would be marketed using accepted price. Note that December is a month with very few sales. The potential "Ashenfelter's dip" due to the reform being announced one month before its implementation is thus minimal.

3.3 Compliance

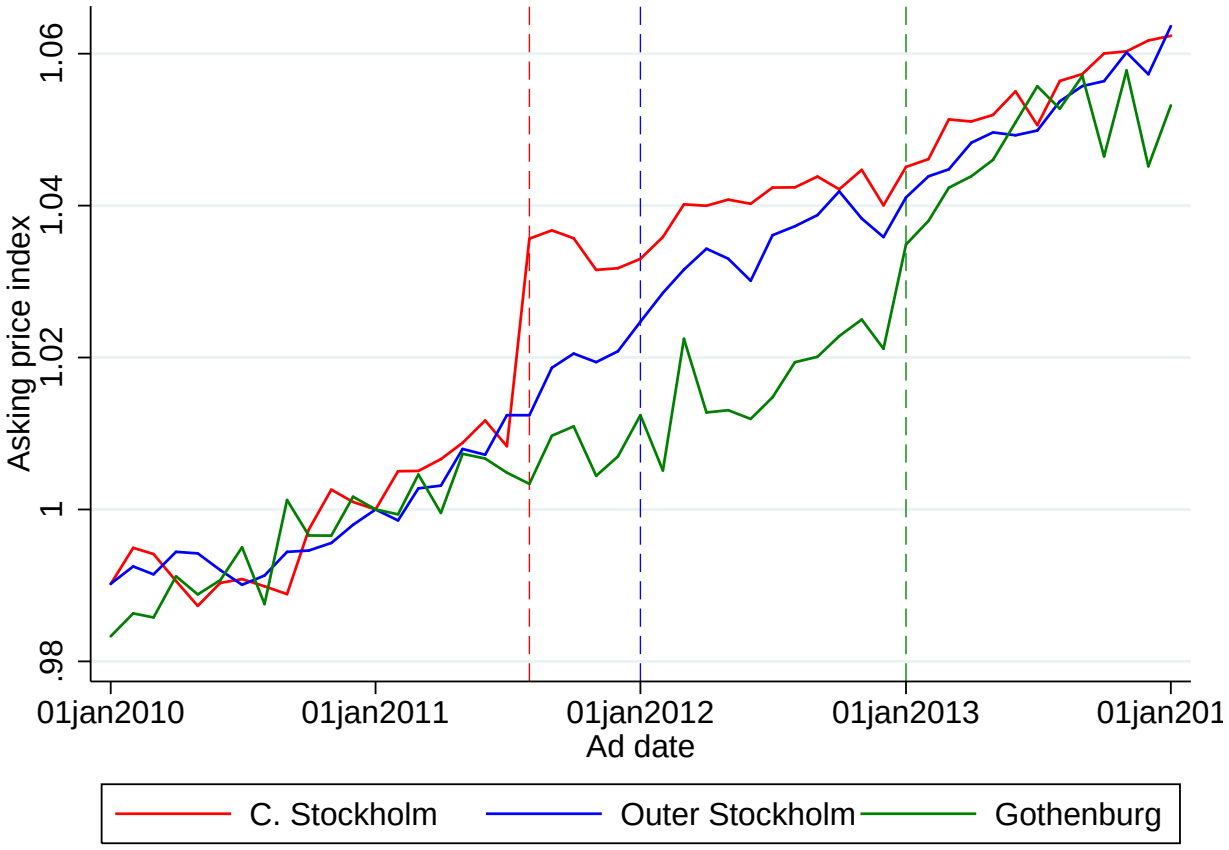
Formally, it was fully voluntary for the real estate agents to participate in the reform.[16] We know that some real estate agents did not comply. In a market where real estate agents claim that they set the list price 30-40 percent below the market value one would expect to see a large upward shift in list prices if they all of a sudden started listing homes at their own ex ante expectation of the final sales price. Figure 4 confirms this. It shows hedonic list price indexes over time (i.e. controlling for observable characteristics of each home). At the time a particular region was reformed the list prices shoot up, but they are otherwise parallel over time. Prior to August 2011 when no region was reformed, all three regions move in parallel. After January 2013, when all regions was reformed, they also move in parallel. During the times when one or two regions was reformed, they move in parallel although at different levels.

For outer Stockholm about half of the reform effect occurs already at the time of central Stockholm's reform, whilst the rest of the effect is at the time of the non-central reform. This endogenous take up rate in outer Stockholm at the time of the central Stockholm reform is probably due to two reasons. First, once a particular REA office was reformed, the agents working in that office also listed homes they sold just outside of central Stockholm using accepted price, although these was not officially reformed yet. Second, accepted price caused a lot of fuss in the media, and some of the outer Stockholm REAs chose to endogenously

[15] In a private email correspondence with Mäklarsamfundet they claim that the outer Stockholm reform was announced just before the reform date, but did not specify a specific date.

[16] I've talked to a lot of smaller agents' who say they was more or less bullied by the Trade association and the larger REAs into complying with the reform.

Figure 4: List prices around the three reforms.



Note: The figure displays the hedonic list price index – i.e controlling for observable characteristics of the homes – for the three reformed regions using the *full sample*. The dashed lines mark the reforms. All three indexes are normalized to 1 on January 1st 2011.

start listing homes using accepted price prior to the official reform. In the empirical analysis, which focus on intention to treat, this endogenous pre-treatment will lead to an downward bias of the results.

3.4 The sales mechanism is unchanged

It is important to highlight that the reform did not change anything in the auction mechanism or in the sales process. In particular; although the seller is supposed to be ex ante willing to sell the apartment at the accepted price, he is not bound to sell at that price. Further, buyers are still able to bid below, at, or above the accepted price, and to withdraw their bids without any cost. In essence, the reform only changed the *label* and the *level* of the initial bid starting point. As illustration Figure 5 shows examples on how the online advertisements might look for the two different list prices. If the accepted price is a stronger signal about the market value of the home than the pre-reform list price, it could have a large effect in reducing information asymmetries on the market. But it did not affect the sales mechanism.

The REAs implemented the reform with the anticipation that it would decrease the difference between the initial list price and the final sales price. In this paper I find that this is indeed the case, but I also find a range of other effects of the reform.

4 Data

I employ transaction level data from two sources. Both sources contain the standard variables used in hedonic regressions in the housing literature. The first source contains more details about the different stages of the transaction, as well as information on buyers, sellers and the REA. To the best of my knowledge, this is the first paper to use such a detailed transaction level data set on residential real estate. This data set is from a number of anonymous REAs. To test for sample selection bias, the second data set contains (almost) the universe of all transactions in Sweden during the sample period. This larger data set contains fewer variables, however, and can thus be used only to study the treatment effect on the main outcome variables. I describe the REA data set in some detail, and mention the comprehensive data set, below. For more details, other minor data sets, and variable transformations I refer to the Online Appendix.

4.1 The REA data set

The main transaction level data used has been supplied by a number of anonymous real estate agents, all who where part of the group that agreed to comply with the reform. I refer

Figure 5: Online apartment advertisements – pre-reform list price vs *accepted price*

Årsta
Rämensvägen 24
Bostadsrättslägenhet
2 ROK, 50 KVM

Pris:

1 695 000

VISAS Söndag 1/6, Måndag 2/6

Årsta
Rämensvägen 24
Bostadsrättslägenhet
2 ROK, 50 KVM

Accepterat pris:

2 095 000 kr

VISAS Söndag 1/6, Måndag 2/6

Note: These are real estate advertisements from the internet, showing the implications of the *bid starting price* (left) and *accepted price* (right). The right ad is a real example, and the left is mock-up I created using an ad from a different (non-reformed) region to exemplify the reform. The only differences due to the reform is the label of the price and the level of the price. The ads include a photograph taken by a professional photographer (often the apartment have been prepared by a professional stylist), the geographical area, the address, the type of home (in this case, coop) the number of rooms and the size in square meters. The ads also include the type of price: accepted price or price, the list price and the date of the viewings. By clicking on the ads the buyer is referred to a more detailed description of the apartment.

Source: `www.svenskfast.se`, retrieved 05/26/2014.

to this data as the REA data set.

The REA data set covers the two largest cities of Sweden; Stockholm and Gothenburg with populations of about 1.4, and 0.55 million respectively. The data set starts in January 2007 and runs through December 2014, and the sample size from 15,000 to 20,000 depending on which variables are being studied (not all variables exist for all transactions).

The REA data set contains standard characteristics of the home: size in square meters and number of rooms, which floor of the building the apartment is located on, the construction year of the building, the monthly fee to the coop, the percent share of the coop, a dummy for elevator, a dummy for balcony, longitude and latitude, street name and number). The REA data set also contains detailed information about the actual transaction: the list price and sales price, the advertisement date, the viewing dates (which gives the total number of viewings organized), the sale date and the move in date, the number of online views[17] , the number of people who came to the open houses, the number of people who participated in the bidding for the home, the date and time of open houses (hence the number of open houses), a numeric ID of the actual – individual – real estate agent who sold the home, as well as an indicator variable about the type of list price used (which I transform into a dummy variable that equals one for homes sold using accepted price, and zero otherwise), and a variable indicating sale status (which I use to find failed, or withdrawn, sales). The REA data set further contains information about the date of birth of all the buyers and sellers (hence the number of buyers and sellers) and the total mortgage loan amount of the seller. Because of the rich number of variables available in this data I am able to say something about the channel through which the list price affects the sale, not only about the actual effect. Because I have details about the buyers and the sellers I can also investigate if the allocations change with the list price.

4.1.1 Summary statistics

Table 2 displays a summary of the data. The top panel shows home details for Gothenburg, Central Stockholm and outer Stockholm. The average home in Stockholm has a little more than two rooms and is just below 56 square meters (603 square feet). The monthly fee to the co-op is SEK 2,583 (USD 300). The building is built in 1930's, and the apartment is just above the second floor. Homes in outer Stockholm are similar in size and cost to those in Gothenburg.

Panel B shows transaction details. The average Central Stockholm home is listed for MSEK 2.4 (about USD 270,000), sold for MSEK 2.8. Hence the average home sell 17 percent

[17]This is the number of views at the REAs website. This is potentially a stronger signal of buyer interest (match quality) than the number of online views on the MLSs'.

Table 2: Summary statistics

Region	Gothenburg		C. Stockholm		NC. Stockholm	
Value	mean	std	mean	std	mean	std
Panel A: Home characteristics						
Size, rooms	2.20	0.92	2.04	0.96	2.40	1.01
Size, sqm	61.30	23.20	56.43	26.53	63.77	24.39
Monthly fee	3303.71	1210.32	2583.39	1258.30	3432.95	1319.00
Floor in building	2.82	1.78	2.19	1.99	2.15	1.99
Construction year	1950.56	29.97	1930.28	33.46	1964.67	32.18
Latitude	57.70	0.02	59.33	0.01	59.33	0.04
Longitude	11.97	0.04	18.05	0.03	18.02	0.07
Panel B: Transaction details (averages)						
Accepted price	0.28	0.45	0.25	0.43	0.30	0.46
List price	1649621.82	837770.98	2363369.89	1384596.07	1700367.76	867560.81
Prospective buyers	19.93	15.52	23.82	18.80	16.42	13.75
Bidders	4.15	3.69	4.48	4.62	3.48	3.11
Sale price	1874585.14	846451.70	2758090.92	1404361.93	1950368.74	892548.96
Days on market	13.45	48.50	11.85	43.61	16.61	58.66
Failed sale	0.04	0.19	0.04	0.20	0.04	0.19
Number of viewings	2.23	0.99	2.66	1.27	2.63	1.42
Panel C : Buyer/seller details						
Number of buyers	1.46	0.59	1.45	0.55	1.44	0.53
Buyer age, oldest	37.64	13.60	37.23	12.61	37.06	12.88
Number of sellers	1.36	0.51	1.35	0.52	1.38	0.51
Sellers mortgage	986999.02	552824.99	1511586.82	932926.52	1143506.20	4500656.31
Sellers LTV	0.54	0.22	0.50	0.22	0.53	1.15
Seller age, oldest	39.10	13.73	39.92	12.88	39.87	13.73
Panel D: Transaction details						
std(List price)	650144.35	351568.29	1136824.90	444822.87	553452.05	366911.17
std(Sale price)	671501.24	345311.23	1176224.49	450814.62	700246.96	311045.75
std(Days on market)	24.93	37.84	21.31	33.98	23.26	38.04
std(Price increase)	0.11	0.04	0.13	0.06	0.17	0.09

Note: Panels A-C shows mean and standard deviation for the most relevant variables in the REA data set. In Panel D I first create a panel data set with the standard deviation within each region and week-of-listing. I then calculate the mean and standard deviation of this. The table is based on data from 2007–2014, i.e., both pre- and post treatment.

above the list price. The homes sell fast on average within 12 days of listing. The number of online views, number of people who came to the viewings and signed up, and the number of bidders can be thought of as representing different stages of the matching process for a home. Homes in Central Stockholm have similar arrival rates to Gothenburg, with about 4,000 online views, 20-23 people at the viewings and four to four and a half people participating in the bidding. Outer Stockholm is more similar to the non-treated areas, with about 3,000 online views, 15 people at the viewings and 3 bidders. About four percent of the sales are withdrawn from the market without a sale.

Panel C displays characteristics of buyers and sellers. The average Central Stockholm seller has a mortgage of SEK 1.5m, while sellers in the rest of Sweden has mortgages closer to one million SEK. In Central Stockholm there are on average more buyers (1.45) than sellers (1.35). The oldest buyer is younger than the oldest seller (40 years). Sellers have a Loan-To-Value ration of about one half.

To calculate Panel D, I create a panel data set. For each listing week and each region, I calculate the standard deviation of the relevant variables. The table contains the time average of these standard deviations, and their standard deviation.

Although a great data set, it has two main drawbacks. First, I have only one observation per transaction. For a given transaction there is no time series of the total number of online views, bidders, etc. Thus I cannot study in detail the bidding strategies of home buyers and how they are affected by the list price. The single observation per transaction is troublesome for certain relationships. The number of online views grows almost mechanically with time on market, but a large number of online views is associated with a higher sales price, whilst a long time on market is associated with a low sales price. Second, a general problem in real estate transaction data is the lack of a reliable *quality* parameter. This is also the case in this data set. The unobserved quality could be a combination of factors like the view from the kitchen (a view of the sea might be preferred to a highway view) as well as the condition of the kitchen/bathrooms/floors, and the floor layout. In the data, a completely renovated apartment may look exactly the same as an apartment in very poor condition, even though the cost of the renovations will potentially be priced in the final sales price. As long as none of these things change with the reform they should not affect the results, except by increasing the standard errors.

4.2 The Comprehensive data set

To verify that selection bias, i.e. that there is a different effect in the REA data set than in the rest of Sweden, I augment the REA data set with a data set covering in excess of 80 percent of the universe of transactions from 2005 through 2014. I call this data set the comprehensive

data set. This data set contains almost the same home characteristics as the REA data set, but much less information about the transaction: only the list price and sales price, and advertised date, sales date and move-in date. It contains about 250,000 transactions with all variables. For more details on the comprehensive data set, see the Online Appendix.

5 Regression Analysis

In this section I study the causal effect of the reform on the real estate market. I do this a difference in difference regression framework. The reform occurs at different dates in different regions. To deal with this I normalize the treatment date to zero in all regions, and then pool the the data across regions.

The main identification for this paper is a difference in difference regression. The identifying assumption is that the introduction of the reform can be used as an exogenous shift in the level of the list price. The reform I study is ideal for this assumption, partly because the individual REAs was unaware that the reform was planned until a few days prior to the reform. Prior to the reform homes was listed at a *price* and after the reform they was listed using an *accepted price*. The reform affected the list price *label*. However, when the list price type changed, the list price level (value in SEK) also changed. Only the price label and the price level changed with the reform – the sales mechanism was unchanged. This allows me to study the effect of a regime shift in list prices levels. The first regime was a underpricing regime where the average list price was far below the sales price. The reformed transferred this into a market price regime where the average list price was closer to market value.

5.1 Verifying parallel trends: a graphical approach

The main assumption required for difference in difference regressions to be valid are parallel pre-trends. If the relevant variables move parallel over time except at the time of the reform, we have a case for a causal effect of the reform on the variables in question. To validate this, I estimate the following regression:

$$\log(Y_{it}) = \alpha + \beta X_{it} + \mu_t + \mu_j + \mu_{rea} + u_{it} \tag{1}$$

where Y_{it} is the outcome variable, and X_{it} is a vector of linear controls for the characteristics of the homes. I use dummy variables to capture average differences across different dimensions using fixed effects (FEs). Specifically, μ_t are listing month FEs relative to January 2010. μ_j are constituency (sv. Valkrets, tiny geographical areas often containing no more than a few blocks in each) FEs capturing geographical variation. μ_{rea} are individual

specific real estate agent fixed effects capturing the different skills between individual real estate agents.

In Figure 6 I plot the regression coefficients on the time fixed effects μ_t relative to January 2010. I estimate the above regression twice, once for each region. I then plot the coefficient of the monthly FEs to see how they vary over time. This is repeated for the six most relevant outcome variables. I omit outer Stockholm from the figure because it makes the figure easier to read. It looks as one would expect from the other two graphs.

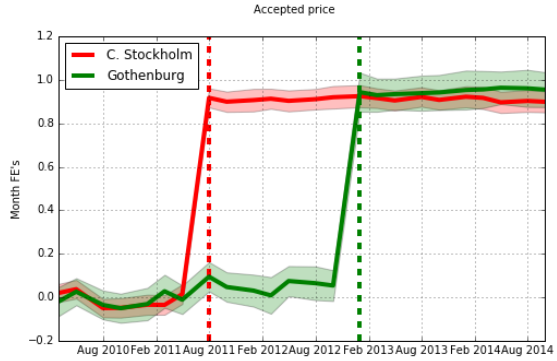
Panel (a) shows share the of homes sold using accepted price over time in Central Stockholm and Gothenburg. The numbers are relative to January 2010. The reform dates are highlighted with dashed lines. There is a sharp increase in the share of homes sold using accepted price at the time of the respective reform, from about 0 to almost 1. This shows that treatment the REA data has almost full reform compliance. The reason why neither region reach full 1.0 after the reform is that they are not 0.0 in January 2010. Recall that REAs could choose to list homes using accepted price prior to the reform. A small fraction, about 5 percent, of homes was endogenously listed using accepted price in January 2010.

Panel (b) shows the (natural logarithm of the) list prices over time. Recall that the reform affected the list price type directly and the list price level directly. The two regions move in tandem except at the time of the respective reforms. At the reforms there is a large sudden increase in the list prices for both regions.

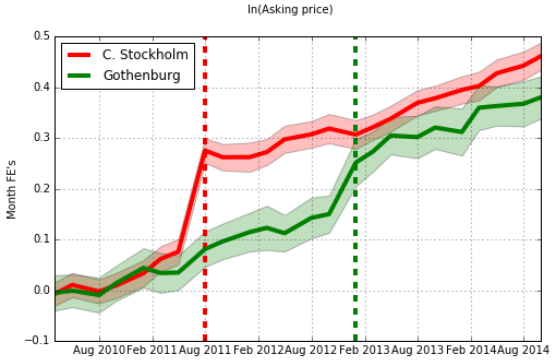
Panel (c) shows the number of online views per day over time. The longer a home is on the market, the more online views it will have. I am interested in the buyer arrivals. If the flow of new buyers interested in this particular home is constant, it is natural to assume that the number of online views grows linear in time all else equal. I cannot test this explicitly in this sample as I do not have a time series of online views. But I do find a strong and positive correlation between online views and the time on market. Further, in the Online Appendix I display the number of online views over time for a random home in outer Stockholm during the fall of 2016. Although just one data point, and a different sample, this figure does lend some support to the idea of linear arrivals of buyers online. Thus, I normalize the number of online views by dividing by the time on market. Prior to the reform in Central Stockholm, the difference between the Central Stockholm and Gothenburg is large (are about a half). Recall that the two lines are different estimations of the same regression but on different regions. That the confidence intervals are partly overlapping prior to the reform does thus not say that they are equal. After central Stockholm is reformed, the lines move closer together (the difference is now about a fifth). After Gothenburg has been reformed the lines spread apart again. They widen more than they was prior to the reforms.

Panel (d) shows the number of prospective buyers – people showing up to the open

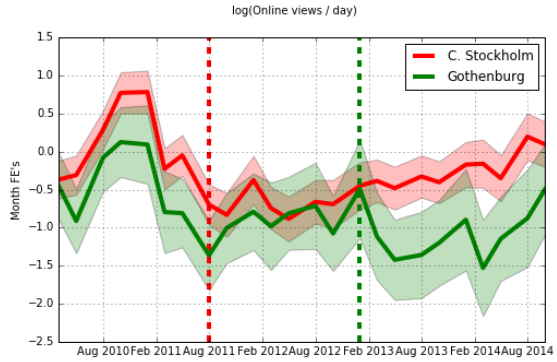
Figure 6: Parallel trends and the reform: comparing Central Stockholm to Gothenburg using REA data.



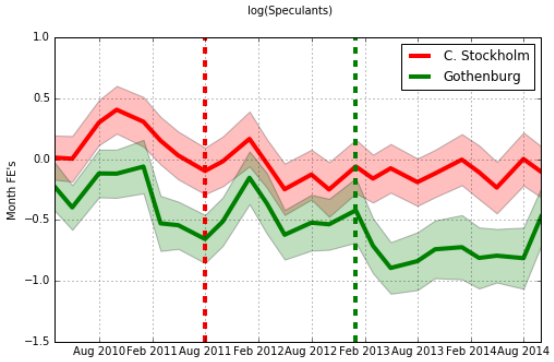
(a) Accepted price



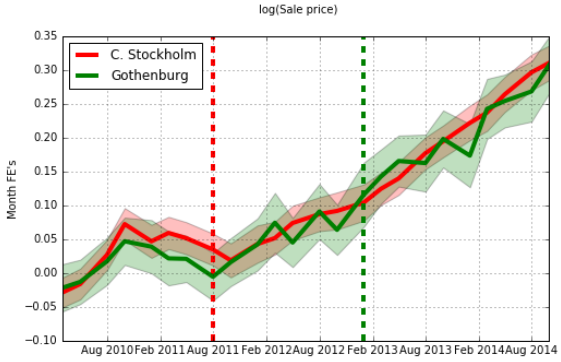
(b) List price



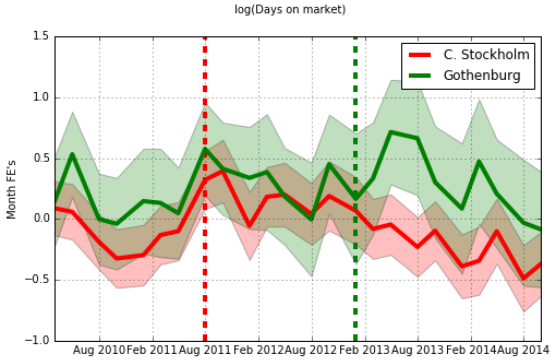
(c) Online views per day



(d) Speculants at open house viewing



(e) Sale price



(f) Time on makrket (days)

Note: In the graph each color represents one geographical region. The plots display the point estimates and 95% confidence intervals for the time fixed effects μ_t from the regression $\log(Y_{it}) = \alpha + \beta X_{it} + \mu_t + \mu_j + \mu_{rea} + u_{it}$. This is a standard hedonic index calculation, but with a large number of fixed effects and applie to different stages of the housing transaction, not just the sale price. See page 19 for variable definitions.

houses – over time. Prior to the reforms, central Stockholm was above Gothenburg. When only Central Stockholm has been reformed they are much closer. They separate again when Gothenburg is also reformed, when both have been reformed. Note that that the number of prospective buyers increased in Gothenburg after the central Stockholm reform. If the reform decreased the number of prospective buyers it would be natural to see a decrease in the number of prospective buyers in Stockholm. The real estate market had been very cool during the spring of 2011, but really took off – with increased demand – during the fall of 2011. Because of the reform in central Stockholm we do not see a large increase in demand (prospective buyers).

Panel (e) shows the sales price. The two lines move in parallel all the time, with some noise. There is no visually convincing effect of the reform. If anything prices seem to go in different directions at the different reforms, but the effect looks small relative to both the confidence intervals and the noise.

Panel (f) shows time on market (in days). The average time on market is very volatile. The confidence intervals are large, because, as noted above, the regression model does a poor job in capturing time on market. If anything, there seems to be a small positive effect of time on market from the reform. The central Stockholm line is above the red line prior to the first and post the last reform. Between the reforms they are closer.

Below I set up a regression framework to formally test the effect of the reform on the relevant variables. I use two main specifications. In the first I pool the data relative to the date of the reform. In the second specification I do not normalize the reform date. The results are similar.

5.2 Difference-in-difference regressions

This model use data normalized to zero relative to the reform dates in the region the transaction is located. This normalization is commonly used in applied econometrics papers. One of the benefits of the normalization is that it will force all regions to be treated for the same length.

The current data set has a weakness in that that it only contains data for reformed regions. There is no untreated control group in the data. I first create a new variable, RD (relative days), that for each transactions contain the number of days since the reform. RD is negative for transactions prior to the reform and positive after the reform.

To select control groups I then proceed as follows. First, for a particular region, I select as a control group that of the other regions that has the most similar pre-trends. Because this control group is also reformed but at a different date, I truncate the sample to include on both sides of the RD at most as many days as the difference between the two reforms.

Thus, this combination of treatment- and control group will only include one reform. This construction will cause some transactions to exist in both a treatment group and a control group but one with positive and one with negative RD[18]. Another problem with this setup is the duration of the sample length. The summer (June and July) and winter (December) months are typically very thin markets. Most homes are sold during the fall and spring. I want to make sure I include a time period long enough that the results are not driven by short-term seasonality effects. I want at least half a year worth of data in the regressions.

I estimate the following regression:

$$\begin{aligned} \log(Y_{it}) &= \alpha + \beta_r X_{it} + \zeta_{1r} RD + \zeta_{2r} RD^2 + \theta_{it} TreatmentGroup \\ &\quad + \gamma_{it} Reformed + \mu_t + \mu_j + \mu_{rea} + u_{it} \end{aligned} \tag{2}$$

where Y_{it} is the relevant variables for the different stages of the sales process. X_{it} is a vector of (the natural logarithm of) linear controls for the characteristics of the homes (size in rooms, sqm, fee, GPS-coordinates, etc.). The subscript r indicates that these are interacted with regional dummies to create region-specific loadings. The ζs pick up region specific linear and quadratic time trends, respectively. $TreatmentGroup$ is a dummy variable equaling one if the transaction i is in the treated region and zero otherwise. $Reformed$ is a dummy equaling one if transaction i is located in a reformed region and was listed online after this region was reformed. I create dummy variables to be able to use fixed effects (FEs) to capture average differences across multiple dimensions. Specifically, μ_t are listing week FEs. μ_j are constituency FEs capturing geographical variation. μ_{rea} are individual real estate agent fixed effects capturing the different skills between individual real estate agents. Standard errors are clustered at the month (30-day RD groups) and reform region.

In Table 3 I a use 507 days cut off from the reform ($max(RD) = 507$). This is the time period between the Central Stockholm and Gothenburg reforms, i.e. the longest possible time without overlapping data. I use Central Stockholm as the control group for the Gothenburg reform and vice verse. There are two reasons to omit outer Stockholm from the main regressions. Firstly, Figure 4 shows that the introduction of the reform in outer Stockholm was much more fuzzy than in central Stockholm and Gothenburg. This fact alone will make standard errors increase. Second, the reform in outer Stockholm was very close in time to the central Stockholm reform. By the above argument I cannot use them as control groups for each other if they are too close in time. In the **Online Appendix** I do include also the outer Stockholm reform in the regressions. The results are similar, but marginally weaker.

[18] In the **Online Appendix** I run a robustness check without this normalization, and find that the results are similar

Table 3: Effect of the reform, pooled and normalized around the reform. Using all but outer Stockholm reform.

	Panel A. First stage effects	
	(1)	(2)
	Accepted price	ln(Asking price)
γ, Reform effect	0.89***	0.15***
	(0.03)	(0.01)
Observations	5774	5762
Adjusted R^2	0.85	0.97

	Panel B. Effect on Buyer arrivals		
	(3)	(4)	(5)
	log(Online views / day)	log(Visitors)	log(Bidders)
γ, Reform effect	-0.55*	-0.24*	-0.23***
	(0.23)	(0.09)	(0.07)
Observations	4797	5687	5260
Adjusted R^2	0.22	0.22	0.38

	Panel C. Effect on transaction outcomes			
	(6)	(7)	(8)	(9)
	log(Sale price)	log(Days on market)	Price increase (percent)	Failed sale
γ, Reform effect	-0.01	0.23	-0.19***	0.03*
	(0.01)	(0.14)	(0.02)	(0.01)
Observations	5612	4949	5604	5774
Adjusted R^2	0.96	0.15	0.58	0.10

	Panel D. Effect on REA effort and buyer composition	
	(10)	(11)
	log(Number of viewings)	ln(Buyer age, oldest)
γ, Reform effect	0.03	0.04
	(0.02)	(0.03)
Observations	5774	5568
Adjusted R^2	0.32	0.11

Standard errors in parentheses, two-way clustered at the month and treatment region levels

*$p < 0.05$, *$\hat{p} < 0.01$, *$\hat{p}$* < 0.001

Note: Each column is a separate estimation of the following difference-in-difference regression, where I alter the Y variable: $\log(Y_{it}) = \alpha + \beta_r X_{it} + \zeta_{1r} RD + \zeta_{2r} RD^2 + \theta_{it} TreatmentGroup + \gamma_{it} Reformed + \mu_t + \mu_j + \mu_{rea} + u_{it}$. Data is normalized around the reform date. See page 23 for variable definitions.

Table 3 present the first main results of the paper. Panel (A) contains shows the reform compliance effect. Column 1 show the effect on the extensive margin, the list price type. The share of homes sold using *accepted price* increased by roughly 89 percent because of the reform. Column 2 show the intensive margin, the effect of the level of the list price. The list price level increased by 15 percent because of the reform. That a voluntary effort of REAs to price to market had a large positive effect on the list price provides empirical evidence that underpricing is in fact deliberate by the REAs. This is the first evidence of underpricing being optimal for the Real Estate Agents[19]. Previous work, such as Han and Strange (2016) and Merlo et al. (2015), find that under certain circumstances underpricing might be optimal for the sellers.

Panel (B) display the effect of the reform on buyer arrival rates, that fall across the board. Specifically, the number of online views per day listed online fell by 55 percent. This is a large point estimate significantly different from zero at the five percent level[20]. The number of prospective buyers showing up at the open houses fell by 24 percent. T the number of bidders participating in the bidding war fell by 23 percent. Some of the effect on the number of bidders is potentially mechanical. The first bid is often close to the list price. For a given sale price and bid increments, the higher the list price the fewer bids, and possibly – the fewer bids the fewer bidders. These effects are very large in magnitude compared to those in Han and Strange (2016), who find that reducing the list price by 10 percent reduce the number of bidders by 4 percent. These results are the first evidence that underpricing increase the buyer arrivals in all stages of the transaction, not only the number of bidders.

Panel (C) show the effect on the transaction. The effect on the sales price is tightly bound around zero: it is not statistically different from about zero and is with 95 percent probability somewhere between -2.5% to 1.5%. This result is not in line with any of the standard behavioral arguments. The anchoring theory of Tversky and Kahneman (1975) would imply that a higher list price increase sale prices. If home buyers are lured in to viewing homes by a low list price, and are susceptible to irrational overbidding, then setting a low list price might push up the sale price(e.g. Malmendier and Lee (2011)). The empirical real estate literature has come to no consensus regarding the effect of the list price on the sale price[21]. Hence, the null effect of the list price on the sale price I find is a new result.

[19]See sections 2.2 and 6 for a discussion regarding why the REAs, not the sellers, set the list price in Sweden.

[20]The 95 percent confidence interval is from -10 percent to -100 percent

[21]For example, Björklund et al. (2006) and Haurin et al. (2010) find that increasing the list price will increase the sale price, while Han and Strange (2016) and Merlo et al. (2015) find the opposite. Papers studying charm pricing usually find that listing just below a nominal threshold increase the sale price relative to listing just above the same threshold, see e.g. Beracha and Seiler (2014),Cardella and Seiler (2016) and Allen and Dare (2004).

There is no significant effect of the reform on the time on market. Because the standard errors are large it is not possible to rule out the fact that we would be able to find significant results had we had more observations (in this context, an observation is a date and region of a reform). The point estimate of the effect on time on market is about 23 percent. In some specifications this does come out as significant, which is in line with previous literature, see e.g. Yavas and Yang (1995), Kang and Gardner (1989), and Anglin et al. (2003).

The price increase, i.e. the relative difference between the list price and the sales price[22], fell by 19 percent because of the reform. This augments the argument based on column (2) above, that underpricing prior to the reform was intentional by the REAs. The probability of a failed sale increased by 3 percent due to the reform. A failed sale might be terribly painful for the seller[23]. But recall that these are from very low levels. The average share of failed sales in the sample is 4 percent, which increased by 3 percent to about 4.1 percent. Given a sample size of 5,772 a 0.1 percent gain in probability of failure means just a handful of extra failed sales. Although significant in the regressions, it is not that economically significant. Although he considers *individual underpricing* and not a regime shift, (Guren, 2016) find that individually underpricing will increase the probability of sale only marginally.

Panel (D) show the effect on the REAs effort and the composition of buyers. There is no significant effect on the work effort exerted by the real estate agents. This is unsurprising: given that agents already work full hours prior to the reform it is not obvious that they would work even more after the reform – especially since there is no effect on the sale price (their commission). Nor is there an effect on the buyers' composition. The composition include factors the number of buyers, or their ages.[24] In the table I measure the composition of sellers as the age of the oldest seller, but the results are robust to using other measures too.

5.2.1 Robustness to sample selection bias

This is to test for sample selection bias in the REA data I re-estimate the difference-in-difference regression (equation 2) on the the comprehensive data set. The comprehensive data set covers 80 percent of the universe of transactions in Sweden. Table 4 presents the results. The table includes only homes that was sold at least twice during the sample period and use apartment fixed effects. The apartment fixed effects make the regression akin to a Case-Schiller repeated sales index, albeit in a difference-in-difference framework. The effects are the same as those of the much smaller REA sample Listi prices increase and the price

[22]Formally, $PriceIncrease = log((SalePrice - listprice)/listprice)$

[23]I say might because some sellers out their home on the market intending to sell only if they achieve a high sales price, and are not really in the need to sell.

[24]The composition of buyers can vary if the the share of homes where a parent is a co-owner of the apartment in order to secure funding was affected, or if the share of homes being purchased by couples

increase falls due to the reform, but there is no significant effect neither on the sales price nor the time on market. In the appendix I estimate the same regression in the comprehensive data set without using apartment fixed effects. This increase the sample size to about 40,000 transactions but the results do not change.

Table 4: Effect of the reform, pooled and normalized around the reform. Using all but outer Stockholm reform. Using Large dataset and repeat sales only

	(1)	(2)	(3)	(4)
	ln(Asking price)	log(Sale price)	log(Days on market)	Price increase (percent)
γ, Reform effect	0.10***	0.01	0.05	-0.11***
	(0.01)	(0.01)	(0.05)	(0.02)
Observations	5798	5798	5798	5798
Adjusted R^2	0.99	0.99	0.47	0.58

Standard errors in parentheses, two-way clustered at the month and treatment region levels

*$p < 0.05$, *$\dot{p} < 0.01$, *$\dot{p}\dot{*} < 0.001$

Note: Each column is a separate estimation of the following difference-in-difference regression with different Y: $\log(Y_{it}) = \alpha + \beta_r X_{it} + \zeta_{1r} RD + \zeta_{2r} RD^2 + \theta_{it} TreatmentGroup + \gamma_{it} Reformed + \mu_t + \mu_j + \mu_{rea} + u_{it}$. Data is normalized around the reform date. See page 23 for variable definitions. The table uses the comprehensive dataset covering approximately 90% of all transactions in Sweden. It contains only repeated sales and use apartment fixed effects. Including non-repeat sales increase the sample size a lot but the results are not altered.

5.3 Effects of underpricing regimes on price dispersion and uncertainty

One particularly interesting feature of the reform is that it increased the information value to the buyers of the real estate advertisements. If the reform lead to better informed buyers/sellers, this could potentially lead to less price dispersion due to more well-informed buyers and sellers. In this section I test this explicitly.

A seller who is risk avert would prefer smaller uncertainty about the sale price and time to sell. To test whether this is the case a two stage process. First I calculate the standard deviation of the relevant dependent variables Y in each week and treatment region, effectively creating a panel data set of the standard deviations of the observations. On this panel data set I estimate the following difference-in-difference specification:

$$\log(Y_{Rw}) = \alpha + \beta X_{Rw} + \gamma Treated + \mu_w + \mu_R + \mu_{rea} + u_{Rw} \tag{3}$$

where Y_{Rw} are the relevant variables for the different stages of the sales process. X_{it} is a vector of (the natural logarithm of) linear controls for the characteristics of the homes (size

in rooms, sqm, fee, GPS-coordinates, etc.) as well as separate linear and quadratic time trends per region. μ_R are regional fixed effects that pick up any regional differences in Y. μ_w are fixed effects per listing week and will absorb any changes over time that happen in all three regions. $Treated$ is a dummy variable equaling one whenever the current region (central Stockholm, Non-central Stockholm, and Gothenburg) has been reformed, and zero otherwise[25].

The results using the REA data are shown in Table 5. There is no significant effect on the standard deviation of the list price or the sales price, nor on the time on market. Thus, the average spread of list prices, sales prices and time on market did not change significantly due to the reform. There is, however, a significant reduction in the standard deviation of the relative price increase. This shall be interpreted as: when homes are listed close to the market value instead of far below market value, the list price serves as a more precise signal about the market value of the home. The implication for the buyers is that when the list price is set close to market value it gives them a good idea about the value of the home at a first glance. A direct consequence of this would be that buyers need to spend less time searching for homes that are not within their budget.

Table 5: Aggregate variables: REA sample

	(1)	(2)	(3)	(4)	(5)
	std(Asking price)	std(Sale price)	std(Days on market)	std(Price increase)	Transactions per week per region
γ, treatment effect	-77934.13	-96317.91	9.44	-0.05***	-1.37
	(62153.82)	(61914.42)	(7.12)	(0.01)	(0.90)
Observations	783	783	783	783	783
Adjusted R^2	0.61	0.57	0.02	0.55	0.57

Standard errors in parentheses, two-way clustered at the month and treatment region levels

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Note: All regressions include fixed effects for the listing week and treatment region, and region specific: linear and quadratic time trends, size (in square meters and in rooms), monthly fee to the coop, construction year, floor in the building, longitude, and latitude. Using panel data created by collapsing the transaction level data onto averages (means) per listing week and treatment region from January 2010 through December 2014.

5.4 Heterogenous effects

So far we have been concerned with aggregate effects of the reform. In this subsection I analyze if the reform had different effects on different parts of the market. I do this by analyzing the results in the pooled regression from page 23, i.e. estimating the following model:

[25]Because i have the weekly fixed effects, μ_w I do not need dummy variables for "after treatment period"; they will be collinear with the μ_w's.

$$\begin{aligned}\log(Y_{it}) &= \alpha + \beta_r X_{it} + \zeta_{1r} RD + \zeta_{2r} RD^2 + \theta_{it} TreatmentGroup \\ &+\gamma_{1,it} Reformed * G_1 + \gamma_{2,it} Reformed * G_2 + \gamma_{3,it} Reformed * G_3 \\ &+\mu_t + \mu_j + \mu_{rea} + u_{it} \end{aligned} \tag{4}$$

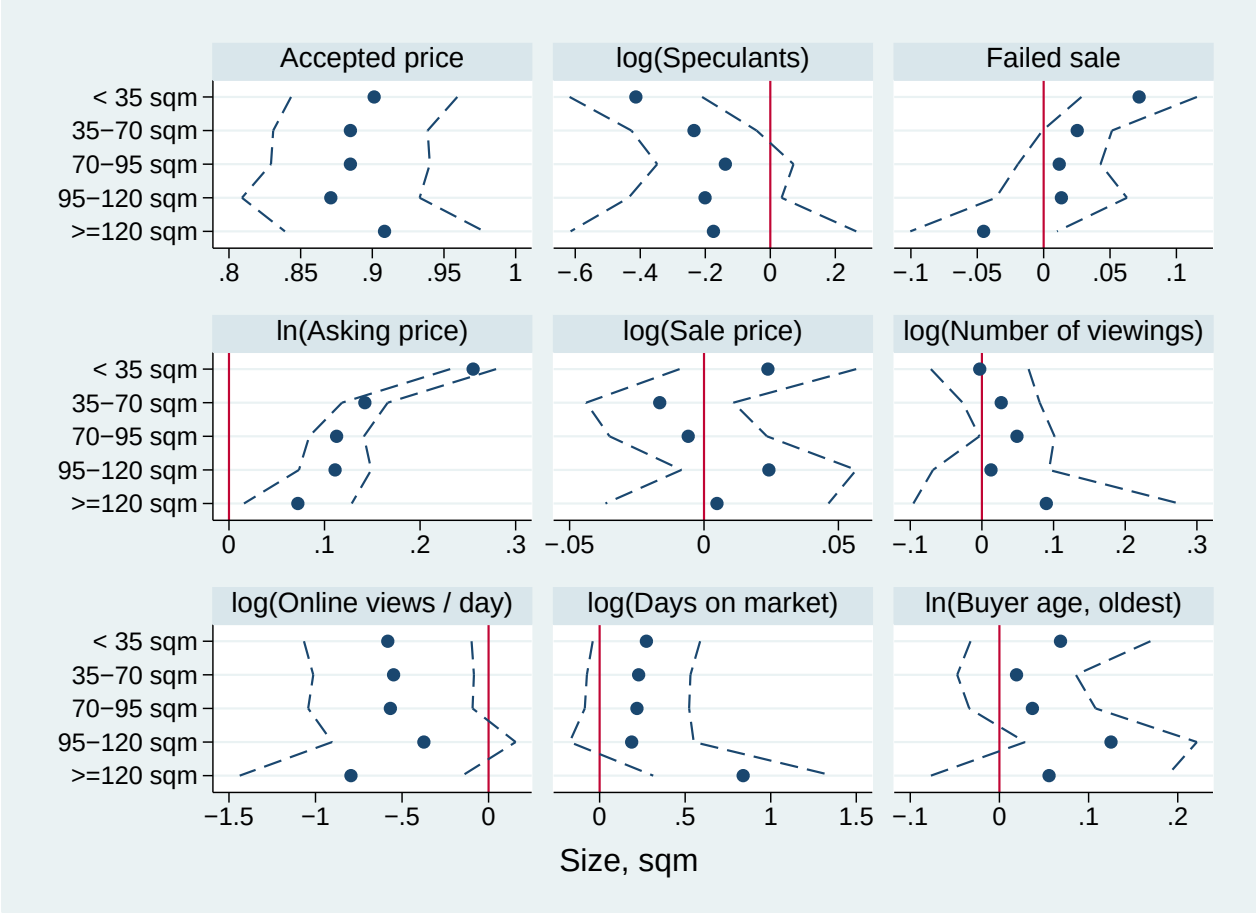
where Y_{it} is the relevant variables for the different stages of the sales process. X_{it} is a vector of (the natural logarithm of) linear controls for the characteristics of the homes (size in rooms, sqm, fee, GPS-coordinates, etc.). The subscript r indicates that these are interacted with regional dummies to create region-specific loadings. The ζs pick up region specific linear and quadratic time trends, respectively. $TreatmentGroup$ is a dummy variable equaling one if the transaction i is in the treated region and zero otherwise. $Reformed$ is a dummy equaling one if transaction i is located in a reformed region and was listed online after this region was reformed. The $Reformed$ variable is interacted with three dummy variables that cut the sample along to the dimension in which we are interested studying heterogeneity.I create dummy variables to be able to use fixed effects (FEs) to capture average differences across multiple dimensions. Specifically, μ_t are listing week FEs. μ_j are constituency FEs capturing geographical variation. μ_{rea} are individual real estate agent fixed effects capturing the different skills between individual real estate agents. Standard errors are clustered at the month (30-day RD groups) and reform region.

Figure 7 shows the effect of the reform on different sized apartments, measured by their size (sqm). The effect of the reform on the level of the list price is stronger for small apartments (25%) than on large apartments (8%). For small apartments the negative effect on the number of people attending the open house is large and significant (-50%). For large apartments it is smaller and no longer significant, possibly due to the smaller sample size. Similarly, for tiny homes the probability of a failed sale increase significantly due to the reform but not for larger homes. Again, this might be because of the larger number of small homes sold. The reform effect does not seem to vary across apartment size in terms of the share of homes sold using accepted price, the number of online views per day, the sales price, the time on market, the number of viewings organized by the real estate agent, nor the age of the oldest buyer. In the Online Appendix I split the sample along different dimensions.

6 Search Model

In the empirical analysis (Section 5) I find that a policy shift to remove underpricing reduce bueyr arrival rates significantly both online and at the open houses. I find a strong null-result

Figure 7: Reform effect for different sized apartments



Note: Heterogenous effects in different dimensions. The dashed lines mark 95% confidence intervals for the treatment effect in that particular group. $\log(Y_{it}) = \alpha + \beta_r X_{it} + \zeta_{1r} RD + \zeta_{2r} RD^2 + \theta_{it} TreatmentGroup + \gamma_{1,it} Reformed * G_1 + \gamma_{2,it} Reformed * G_2 + \gamma_{3,it} Reformed * G_3 + \mu_t + \mu_j + \mu_{rea} + u_{it}$. Data is normalized around the reform date. See page 29 for variable definitions.

on the sale price which is closely bounded around zero. To fix ideas about how to think about this mechanism I develop a search-and-matching model. The model is constructed to match the institutional setting where the list price is fully non-committing for the seller, and set optimally by the real estate agent (REA). The model can generate sales prices below, at, or under the list price. The model can explain the empirical findings both qualitatively and quantitatively as long as buyers follow a simple and realistic rule of thumb when choosing which homes to view online.

6.1 Preliminaries and timing

There is one-time period, and one home for sale.[26] There are three types of risk-neutral agents, a seller, an intermediary (real estate agent, REA), and $T \geq 0$ buyers interested in this particular type of home. The seller supplies a home for sale. The seller has a privately known reserve price P_R below which there will be no sale. The REA sets the list price optimally, trading off commission from this sale with the cost of loosing his license to broker real estate in the future. The buyers choose maximize their expected consumer surplus. The home selling process has the following stages:

1. All T buyers in the market learn their *iid* random budgets b_i, drawn from a distribution function F_T with support $(\underline{l}, \overline{l})$, where $0 \leq \underline{l} < \overline{l} < \infty$. The real estate agent set the list price, $P_L \in (\underline{l}, \overline{l})$.

2. Buyers search for homes online. They follow a rule-of-thumb and only view homes online that they can afford to buy at the posted price. I.e. they view the home online only if $P_L \leq b_i$.

3. After the online viewing has finished, all buyers viewing the home online receive an announcement with the total number of on-line viewers, $\overline{O}$. Not everyone viewing the home online are interested in purchasing the home. Specifically, only $O = \phi\overline{O}$ are interested in the home. [27] ϕ is known to all agents. The O buyers who like the home online choose optimally whether to pay a search cost c and go to the open house to view the home in reality.

4. At the open house, visitors learn their *iid* valuation of the home v_i, which are draws from the distribution function F_V with support $(\underline{l}, \overline{l})$.

[26] One way to think about the model is as a model of a specific segment of the housing market, i.e. one bedroom flats with a low fee in some neighborhood.

[27] The other $(1 - \phi)O$ might dislike the floor-plan, the lack of balcony, or are just window shoppers

5. All visitors to the open house bid optimally, contingent on their budgets b_i and valuations v_i, for the home in a second-price auction.

I will look for a symmetric equilibrium where each buyer uses the same action based on his draw of b_i, the number of other buyers viewing the home online O, the distribution of the other buyers' budgets F_B, and the distribution of all buyers valuations F_V. Recall that the valuations are still unknown when choosing whether to visit the open house. Below I describe the model in more detai.

6.2 The online stage: How the list price directs search

Buyers searching for homes online follow a rule of thumb: they only view homes online that they can afford to buy at the listing price, i.e. if $P_L \leq b_i$. Recall that there are in total T buyers in the market. The number of buyers following the rule of thumb and visiting a home online, $\overline{O}$, will hence be binomially distributed with parameters T and $1 - \frac{P_L - \underline{l}}{\overline{l} - \underline{l}}$.

Not all buyers viewing the home online are actually interested in purchasing it. Some may not like the floor-plan, and others may dislike the view from the kitchen window. Denote by ϕ the probability that a buyer viewing the home online is actually interested in purchasing it, and assume ϕ is known to all agents. The number of interested buyers at the end of the online viewing is then given by a binomially distributed random variable, O, with parameters $\overline{O}$ and ϕ.

Why it is plausible that the list price directs search: A rational buyer would want the expected sale price to direct his search, not some arbitrary list price. But, the list price is often then best estimate of the market value when searching for homes online on multiple listing services (MLS). This is true irrespective of a particular market being underpriced, overpriced or fairly priced. Further, on most MLS's buyers are able to narrow down their seraches by specifying a list price interval. Piazzesi et al. (2015) find that about two thirds of home buyers in the San Fransico Bay area do allow the list price to direct their search. (Rae and Sener, 2016) find that buyers in London, UK, also search by list prices.[28]

Why the rule-of-thumb: Most buyers know (or can learn) if a specific market is underpriced or overpriced, and the average extent of this miss-pricing. Prior to learning the details about a specific home, buyers are not able to form expectations about the market value of this particular home and the extent of it's miss-pricing. Even if they know that homes are on average underpriced by 20 percent in this market, they have no way of judging weather a particular home is underpriced by five or 45 percent.

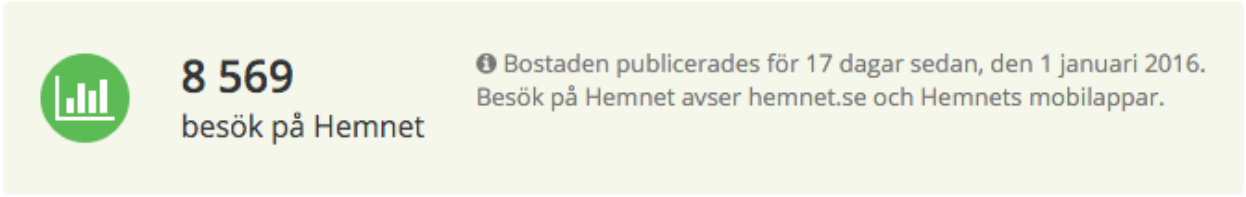
[28]This is augmented by anecdotal evidence in newspapers, see for example http://www.afr.com/real-estate/residential/25pc-underquoting-by-real-estate-agents-the-new-norm-20141107-11il7c.

Previous models deal with individual underpricing. In these models the buyer use the list price to signal something about his preferences, and has limited commitment to sell at the list price. For example, in Han and Strange (2016) the seller is committed to sell at the list price as long as there is exactly one "high type" buyer. Similarly in Albrecht et al. (2015), a low list price is a signal that the buyer is "motivated" to sell fast and thus may accept a low sale price. I study a regime shift with fully non-committing list prices. The implications of a regime shift Han and Strange (2016) type model is that the sellers' get paid more for their home in the case of a single "high type" buyer.[29] In the Albrecht et al. (2015) model a regime shift to remove underpricing would imply that some "motivated" sellers increase their list price and signal their type as being "relaxed". Thus they would start shading their preferences, countrary to the objective of the policy shift.

Previous work also disregard the role of the intermediary, the REA. If the REA does not do a good job in bringing in the right buyer, the seller is likely to hire anohther REA. This is an important mechanism to consider. A realistic assumption is that you hire a new REA if the current one does not even manage to attract two interested buyers.

6.3 The buyers' optimization problem: visit the open house or not?

Figure 8: Screenshot from hemnet.se showing the number of online views for a particular home for sale.



Note: Views online seen on hemnet.se. This information is available to all bidders at all big MLS's.

All buyers who expect from profiting on going to the open house viewing will do so. Denote by π the payoff for the buyers at the online viewing stage. Buyers who choose not to go to the open house viewing will have zero cost and payoff. Buyers choosing to go to the open house will face a search cost c.[30] If they actually get to purchase the home, they might

[29] Note: this does not neccecarily affect the expected sale price, which of course depend on the probability of a single "high type" buyer arriving, which is endogenous in their model.

[30] Han and Strange (2016) also have a cost per visitor for the seller. While this is reasonable in markets where home viewings are organized one-by-one it does not make sense in Sweden. In Sweden the open house

get a consumer surplus, ρ. The expected consumer surplus, at the online viewing stage, is thus given by:

$$E[\pi] = \begin{cases} Prob\left[win\right] E\left[\rho | win\right] - c & \text{if visit open house} \\ 0 & \text{otherwise} \end{cases}$$

There are three state variables the buyers take into account when choosing whether to go to the open house viewing or not: the list price P_L, their own budget b_i, and the number of other online viewers $\overline{O}$.[31] We will search for a symmetric equilibrium in the sense that, conditional on these state variables, all agents will make the same choice whether to go to open house or not. Assume this implies that all agents with budgets b_i above some $\tilde{b}^*$ level will visit the open house, but no buyer with budget below $\tilde{b}^*$ will visit the open house. This assumption is verified in the numerical solution below. Recall that at the online stage the list price P_L is a lower bound on budgets. Thus $\tilde{b}$ is bounded below by the list price P_L. The "binding" budget threshold, above which all agents choose to visit the open house, can thus be written as $b^* = \max\{\tilde{b}^*, P_L\}$. Clearly, $b^* \in [P_L, \bar{l}]$

6.4 The open house viewing stage

Denote the number of bouers at the open house there by H. H will follow a binomial distribution with parameters O and $(1 - b^*)$.

Denote the distribution of budgets of buyers present at the open house by by F_H. Assume F_H is a uniform distribution with support $[b^*, \bar{l}]$. Let $B_i \sim F_H$ be a random variable. Similarly, denote the distribution of valuations at the open house by F_V. Assume it is a uniform distribution with support $[\underline{l}, \bar{l}]$, and let $V_i \sim F_V$ be a random variable. Assume that B_i and V_i are independent. Independence is motivated by the fact that there is still a lot to learn about the home after viewing it online.[32] Let b_i and v_i be realizations of B_i and V_i, respectively.

viewings are usually scheduled well in advance by the REA, and can cater for virtually unlimited amounts of people. The marginal cost of an extra buyer is almost infinite, and is perhaps limited to the time it takes to enter their email address and name in the register of visitors.

[31] They also know the distribution of the other buyers' budgets F_O and valuations F_V, as well as the expected share of buyers that will actually like the home when viewing it online ϕ.

[32] And it is not clear that this learning does not benefit the poor more than the rich, or vice versa.

6.5 The budget-constrained auction mechanism

I assume all visitors to the open house also participates in the auction,[33] I follow the previous litterature by modelling this as a second-price auction with private values (see e.g. Han and Strange (2015)). With private values and a budget constraint it is optimal for bidders to bid their *willingness to pay*, $w_i = \min(v_i, b_i)$.[34]

Budget constraints are a natural ingredient of any model of the housing market.In this setup, however, the budget constraints introduce a discontinuity in the distribution function of willingness to pay, which complicates solving the model.[35]

Denote by F_W the distribution of willingness to pay for all buyers at the open house, with associated density f_W. Let $w_1, w_2, \ldots, w_H$ be independent draws from this distribution, and let $w^H_{(1)}, w^H_{(2)}, \ldots, w^H_{(H)}$ be a rearrangement of these draws such that $w^H_{(1)} \geq w^H_{(2)} \geq \ldots \geq w^H_{(H)}$. Denote by $F^H_{(w_j)}$ the distribution of $w^H_{(j)}$. $F^H_{(w_1)}$ is the distribution of the maximum order statistic of the willingness to pay, and $F^H_{(w_2)}$ is the distribution of the second highest order statistic. The winner of the auction will have a willingness to pay $w^H_{(1)}$ and will pay the sale price, $P_S = w^H_{(2)}$. The difference between his *valuation* and the sale price, $\rho = v^H_{(1)} - P_S$, is his consumer surplus.

A sale might fail for two reasons. The first reason is that the final sale price P_S derived from the auction falls below the seller's reservation price P_R. The second reason is if there are less than two buyers at the auction.[36] If the home is unsold the REA will get no commission. This is consistent with the fact that there are failed sales in the data.

6.6 The Real Estate Agent's problem: setting the list price

The utility function of the REA has two components. The first component is a commission $f(P_S)$, which is increasing in the sales price. To be consistent with most REA constracts in Sweden I assume that the REA will get 1.3 percent comission of the sale price up to the list price, and then 10 percent of the comission of every sale price in excess of the list price. The second component is a penalty from underpricing. Denote by $P_U = P_S/P_L$ the

[33] Two reasons motivate this assumption. First, participating in the auction is cheap for buyers' as described in section **??**. Second, empirically I find that the effect of the reform is about as large on the bidders (-23%) as it is on the number of visitors to the open house (-24%). In the data, the number of bidders is about one fifth of the number of visitors to the open house. One possible reason is that in reality bids are often in increments of SEK 50,000 (approx. USD 5,300), and sometimes move fast.

[34] See (Krishna, 2002, page 43) for proof.

[35] In fact, I know of no other paper using budget constrained auctions in a search model with housing.

[36] A second-price auction is silent on the price in case there are less than two buyers. I argue this is the most sensible approach in a one-period model. If a seller hires a real estate agent who does not manage to recruit more than one potential buyers, the seller might be skeptical that the REA really did his best – the REA might be insincere and try to sell the home cheap to a good friend, or he might be bad at his job.

ex-post (realized) underpricing. The penalty $\xi(P_U)$ is assumed to be increasing in the ex-post (realized) underpricing. This is to capture that underpricing is unfair marketing, which is illegal. Specifically, I assume that $\xi = (1 - P_U)^2$ if the home is underpriced ($P_U > 1$), and zero otherwize. For example, in Australia, underpricing by real estate can be penalized by a fine of about USD 17,000.[37]. In Sweden, intentional underpricing might result in loosing the REA-license, which is costly to obtain.

The REA know the total number of buyers in the market T, the distribution of their budgets and valuations, and their expected behaviour. Based on this knowledge he sets the list price P_L to maximize his expected utility,

$$u = f(P_S) - \tau\xi(P_U)$$

where τ is a weight on the penalty (to be calibrated), by solving

$$P_L^* \in argmax_{P_L \in [0,1]}(E[u]) \tag{5}$$

There are many reasons why hiring a real estate agent (REA) is needed for the average seller to sell his home for the highest possible price. First, only the REAs are able to publish the advertisement on the multiple listing services, which are the main source of potential buyers. Second, depending on the jurisdiction, the legal work might be risky if done without a licensed real estate agent (and their lawyers). Third, selling a home requires detailed knowledge not only about the legal aspects and sales, but also marketing, how to style the home etcetera. REAs are professionals and will probably do this better than the average seller.

The REA also has a lot to say about the list price. They are the ones punished if deliberate underpricing occured, not the sellers. Because their comission is increasing in the sale price their incentives to achieve a high sale price are at least partly aligned with the those of the seller. Because it is a one-period model I abstract from the misaligned incentives studied elsewhere in the literature(see Han and Strange (2015) for a recent review).[38] The previous literature allow the seller to set the list price, see e.g. Han and Strange (2016), Merlo et al. (2015), and Albrecht et al. (2015).

[37] Cite: http://www.domain.com.au/news/underquoting-reforms-six-changes-that-will-affect-buyers-and-sellers-20151204-glfnaf/

[38] The typical argument is that incentives are misaligned because the REA place more weight on achieving a a short time on market than achieving a high sale price, while the seller does the opposite.

6.7 Solution method and calibration

The distribution function of the willingness to pay will be discontinuous due to the truncation of the budget distribution. This complicates finding a closed form analytic solution of the model, and I solve it using numerical methods. The solution has two steps, finding the policy functions and simulating the solution.

6.7.1 Solution Method

To find the policy functions I solve the model on a grid of the state variables. For the number of online viewers, $\overline{O}$, I have a grid from 1 through T. For the list P_L the grid ranges from $\underline{l}$ to $\bar{l}$. For every grid point I seek a level $b^* = b^*(o)$ s.t. no buyers with a budget $b_j < b^*$ expect a surplus from going to the viewing, and all buyers with a budget $b_j >= b^*$ expect a surplus from going to the viewing. This results in a policy function $\mathfrak{b}(P_L, \overline{O})$ s.t it is optimal for all buyers viewing the home online with a budget exceeding $\mathfrak{b}(P_L, \overline{O})$ to visit the open house, but not for anyone else.

The policy functions are shown in figure 9. The policy functions are increasing in $\overline{O}$. The more people viewing the home online, the more competition there will be at the auction, all else equal. The policy functions are also increasing in P_L. For a given number of online viewers only viewing the home online if it's posted below their budget, a higher list price means richer buyers will compete for the home at the auction. Expected profits will fall, and hence the budget threshold – above which profits are expected to be positive – increase.

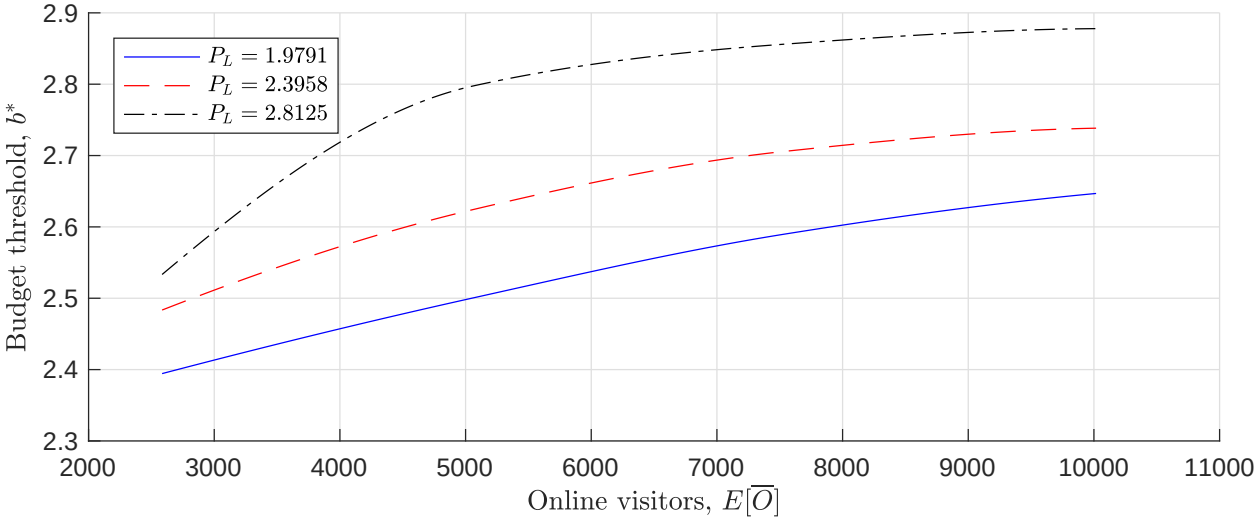
I simulate the model by drawing T number of budgets and values for 100,000 simulations. In every simulation, a particular P_L gives a $\overline{O}$. Buyers with policy function above above $\mathfrak{b}(P_L, \overline{O})$ will choose to visit the open house and participate in the auction. In order to find points not in the grid I interpolate on the policy functions $\mathfrak{b}(P_L, \overline{O})$. I use an outer loop on P_L to solve the REA's problem.

6.7.2 Calibration

I calibrate the model to to fit main moments of the data, as well as the empirical estimates of a reform to remove underpricing. I seek to minimize the mean squared difference between the simulated moments from the model and the estimates from the data. The calibration is shown in table 6.

There is 93 buyers in the market for this particular type of home. The calibrated search cost is tiny. This is a consequence of the assumption that the only profit the winning buyer gets from winning the auction is the difference between his valuation and the second highest willingness to pay. If we would include, say, the profit from reduced future search the search

Figure 9: Buyers' policy functions



Note: Policy functions for different list prices. If a a buyer has a budget exceeding exceeding the budget threshold b^* it is optimal for the buyer to visit the open house (given that only $\phi\overline{O}$ buyers are interested in the home in the first place).

cost would be reasonable. The weight on the penalty component in the REAs utility function is 2.68. The budget- and value distributons have support about [1,3], and the seller will not sell the home below 2.37 million SEK. After the reform, the average sales price is still about 2.5 percent above the average list price.

Table 6: Calibration

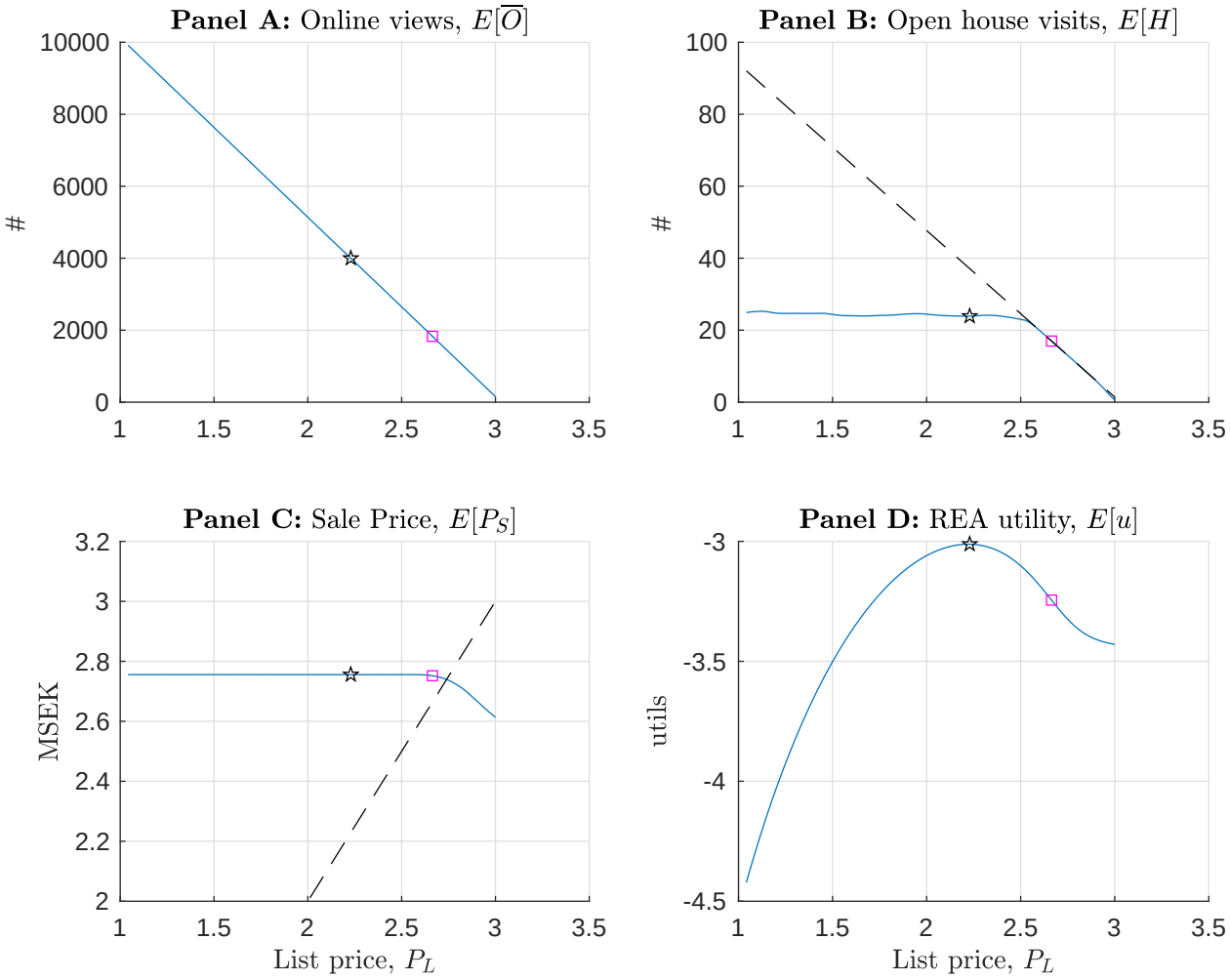
Name	Value	Description
T	93	Total number of buyers in the market
c	4.77e-08	Search cost, MSEK
τ	2.68	Weight on the underpricing penalty in the REA utility
$\underline{l}$	1.02	Lower support of distributions, MSEK
$\overline{l}$	3.03	Upper support of distributions, MSEK
P_R	2.37	Sellers reservation price, MSEK
μ	2.47e-02	Post reform list-sale spread, %

Note: The table shows the calibrated values.

6.8 Model results

Figure 10 shows the model results for different list prices P_L. Panel A shows that as the list price increases the expected (average) number of buyers visiting the home online falls.[39]

Figure 10: Model solution, showing optima and reformed results



Note: Model solution for different values of the list price P_L. The star highlights the optimal list price for the Real Estate Agent. The square marks the post-reform list price.

The dashed line Panel B shows the number of people viewing the home online who are interested in actually buying it, which is just $E[O] = \phi E[\overline{O}]$). The full blue line shows the number of visitors to the open house, $E[H]$. This is flat until a list price of about about MSEK 2.5, when it starts to fall linearly in the list price. Left of the kink, there is

[39]The linear functional form is a direct consequence of $\overline{O}$ following a binomial distribution with parameters T and $(1 - P_L)$.

endogenous truncation of buyers. Only iterested buyers with budgets exceeding b^* will visit the open house. Right of the kink, all interested buyers visiting the open house will view the home online.

Panel C shows the effect on the sale price. As long as $E[H]$ is flat the expected sale price P_S is unchanged. But P_S is virtually unchanged even as $E[H]$ starts to fall, as long as it is large enough. This is a feature of the second order statistic of the distribution of willingness' to pay: as long as the number of buyers is above some threshold, the expected sale price is not very sensitive to the exact number of buyers.

Panel D shows the utility of the REA. It has the expected concave shape. It has a maximum at $P_L = 2.2$.

6.9 The accepted price reform in the model

An *accepted price* reform in the model means that the list price is increased until it hits the expected sale price. Table 7 show the model results of such a reform. In the calibrated model the reform implies that the list price increased by 20 percent (empirically we find 15). AS a result the buyer arrivals fall: online by -55 percent (-55) and at the open house by -31 percent (-24). There is a small negative effect on the sale price -0.00 percent (-1). This effect is too small for me to be able to pick up empirically, given the standard errors I have in the regressions. The effect on the standard deviation of the ex-post underpricing is -0.03 (-0.05).

Empirically we find a null effect on the age of the oldest buyer, closely bounded around zero. Assuming that the age of the buyer is positively correlated with their budget, it makes sense to compare the *direction* of the effect on the age and the budgets. The effect on budget by the reform in the model is zero. Empirically we find that the probability of a failed sale is 4% prior to the reform, and that this increased marginally by 3% because of the reform. The model can replicate the direction of the effect of failed sales, but the magnitude is much larger than in the data.

The model can tell us more than we can find in the data. First we see that the valuations of the winning buyer is unchanged by the reform. The REA utility falls by eight percent due to the reform. For the REA the reform was sub-optimal and there are incentives for the individual REA to deviate from using the reformed list price. The effect on the REA's utility can explain the slow reform-reversal observed in Figure 2: about a year after the reform had taken place sales prices started to slowly diverge away from the list prices again.

Table 7: Effect of reform in model

	Means			Effect of reform		
Variable	Model	Data	Difference	Model	Data	Difference
A. Calibrated values						
$E[\overline{O}]$	3998.00	3998.00	0.00	-0.55	-0.55	-0.00
$E[H]$	24.07	23.82	0.25	-0.30	-0.24	-0.06
$E[P_S]$	2.76	2.76	-0.00	-0.00	-0.01	0.01
$E[P_L]$	2.22	2.36	-0.15	0.20	0.15	0.05
$E[std(P_U)]$	0.03	0.13	-0.10	-0.03	-0.05	0.02
B. Non-calibrated values						
$E[b_i\|win]$**	2.89	37.23	-34.34	0.00	0.04	-0.04
$Prob[fail]$	0.00	0.04	-0.04	11.98	0.03	11.95
C. Additional Model Results						
$E[v_i\|win]$	2.89	-	-	-0.00	-	-
$E[u]$	-3.01	-	-	-0.08	-	-
$E[\rho]$	0.14	-	-	0.01	-	-
$E[\pi]$	0.00	-	-	-0.01	-	-
ϕ	0.01	-	-	-	-	

Note: the table shows the values at the optima for the REA, as well as the values corresponding to market pricing regime where $P_L = E[P_S]$. The empirical effect in the last column is the reform effect estimated in table 3.

** Note that the empirically, I study the effect on age – which is assumed positively correlated with budget – whilst theoretically the effect is on the actual budgets.

7 Empirical Welfare Effects

There are at least two relevant components of the social welfare function to discuss: the effect on underpricing regimes on the search effort by buyers, and on the efficient allocation of the final good.

7.1 Welfare effects on the magnitude of search

The deep welfare effects of underpricing are hard to quantify exactly as they depend crucially on the match quality derived from each sale, and is beyond the scope of this paper. In this section I will briefly discuss potential welfare effects of underpricing regimes, and give crude estimates derived from my empirical estimates.

I find effects of the shift from an underpricing regime to a market regime on buyer arrivals. Using simple back-of-the envelope calculations we can translate these into welfare costs. The average central Stockholm home has 4,000 online views, which falls by 55% or 2 200 clicks when abolishing underpricing. There are about 26,000 homes sold annualy in central Stockhom which means underpricing generates 55 million extra online views annualy. Assuming every click takes 3 minutes[40] underpricing cause home buyers to spend almost three million extra hours browsing homes online annually. Assuming every hour is valued SEK 150 (about USD 20) this transalates in to annual costs of SEK 430m.

Underpricing also directs more people to the open house viewings. Applying the same type of analysis to the open houses, assuming each takes four hours (including travel time, reading finanncial reports of co-ops, etc) we end up with a cost of SEK 89m. Do the same type of analysis for outer Stockholm and Gothenburg and the total welfare costs of unneccesary buyer search comes in as SEK 950m. In total this corresponds to about 0.71 percent of the value of the homes sold. This is a large estimate. Anenberg and Bayer (2013) study the buy first/sell first problem using a search model for housing and find theoretically that the welfare effects of an optimal policy would be about 0.21% of the sales price.

Even if there was an effect of the list price on the sales price this would not affect welfare. Bajari et al. (2005) find theoretically that house price appreciation is a zero sum with no welfare consequences. If house prices would be affected to a large extent it would be justified to think about potential spillover effects on welfare through the household consumption channel, even for home owners who do not sell – see Campbell and Cocco (2007) who find that such effects might exist.

An increased time on market will be bad for eager sellers. In a market where the average

[40] I ran a small experiment with friends to see how long they spend viewing homes online. Note, also, that these are not MLS clicks but views on the REAs website

home is sold in less than three weeks, even a large relative increase is still just a matter of days. These increases are hence not likely to cause a large loss to the seller. To some extend a longer time on market might be good for buyers who will have more time to do due diligence on the home etc, and this would be particularly true in a very fast market where a home is likely to be sold just days after the open house. Because I do not find an empirical effect on time on market it will not affect welfare.

7.2 The allocation effect

Ascending bid auctions generally allocate the good to the buyer with the highest willingness to pay, and are efficient in this sense. The question at hand is whether the allocation differs in an underpricing regime and in the market price regime, given that buyer arrivals are fewer in the former.

Empirically we can proxy for an a change in allocation using two measures: the sale price and the age of the buyer. The sale price is the average second highest willingness to pay. If the sale price is affected by the reform, this means that the second highest valuation was altered by the reform. If the buyer with the second highest willingness to pay is changed, it is likely that also the highest willingness to pay buyer is affected. Empirically, I find a strong null-result on the sale price, indicating that the willingness to pay for the second highest buyer is virtually unaltered by the reform. Similarly, the age of the buyer is a direct measurement of one dimension of the buyers identity. I find that the reform had zero effect on the average age of the oldest buyer. The age of the oldest buyer is a more sensitive measure than the average age of the buyers, because it includes also homes that are co-owned by a parent (the parent is also liable for the mortgage debt).

The model fills in for the lack of data in regards to the effect of the allocation of the homes of the reform to reduce underpricing. The model find a zero effect of the budget of the buyer and on their valuation, see table 7, indicating there is no effect on the allocation efficiency due to the reform.[41]

8 Conclusion

This paper is the first to use a natural experiment to analyze the effect of a shift from underpricing regimes to market price regimes. Using a difference-in-difference methodology I find that the regime shift generates fewer buyer arrivals but no effect on the sales price. To explain these facts, I develop a search model that can replicate the empirical results if home

[41] This argument is augmented by plotting the simulated ID's of the buyers winning the auction – these are virtually unchanged until the list price get closer to the upper bound of the support.

buyers follow a rule of thumb – they only search for homes online with a list price below their budget. The model can further explain why the reform did not last in the long run.

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