

Competition and Incentives in Mortgage Markets: The Role of Brokers

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February 8, 2020

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Abstract

Mortgage brokers acting as expert advisors for households often receive commission payments from lenders. This paper analyzes the effects on welfare and market structure of regulations restricting broker services and compensation. Loan-level data from the universe of UK mortgage originations shows that (1) brokers increase upstream competition by facilitating sales of small, lower-cost lenders, and (2) commission rates distort brokers' advice and generate an agency problem with households. To study the net effect of these forces in equilibrium, I estimate a structural model that features households' demand for mortgage products and broker services, lenders' optimal pricing decisions, and broker-lender bilateral bargaining over commission rates. I use the estimates to evaluate the impact of policies restricting brokers' services and remuneration. A ban on commission payments leads to a 25% decrease in consumer welfare, whereas caps can increase consumer surplus by at least 10%.

JEL Codes: G21, G28, L14, M52, D12. **Keywords:** Expert advisors; intermediaries; mortgages; brokers; bargaining; vertical markets.

[¶]Stanford Graduate School of Business, CEPR. Email: roblesga@stanford.edu. I am deeply grateful to my advisors Alessandro Gavazza and Daniel Paravisini for their patient guidance, constant encouragement and invaluable advice. I also thank Matteo Benetton, Juliane Begenau, Giulia Brancaccio, Greg Buchak, Patrick Coen, Dan Greenwood (discussant), Jean-François Houde (discussant), Nicola Limodio, Gerard Llobet, William Matcham, Nicola Pavanini (discussant), Andrea Pozzi (discussant), Marta Santamaria, Mark Schankerman, Enrique Schroth (discussant), Amit Seru, John Sutton, Margarita Tsoutsoura and Ali Yurukoglu for all their help and comments. I would also like to thank seminar participants at LSE, Stanford, MIT, Harvard, UCLA, UPenn, Yale, NYU, CEPR, NBER, Oxford, Wisconsin-Madison, Duke, EIEF, Bocconi, Imperial, Science Po, TAU, Michigan, Maryland, CEMFI, UToronto, and Berkeley. The paper uses data from the Financial Conduct Authority that has been provided under a data-access agreement for external research purposes. The views expressed are exclusively those of the author and do not necessarily reflect the views of the Financial Conduct Authority. I acknowledge the economic support of the Economic and Social Research Council and CaixaBank Foundation. All errors are my own.

1 Introduction

Expert advisors often receive commission payments from upstream firms to sell their products to households. This form of compensation may generate an agency problem between experts and households by distorting advice households receive towards higher-commission, more expensive products. To address this conflict, regulators worldwide have proposed restricting payments that advisors receive from upstream firms in many financial and healthcare markets.¹ However, by restricting compensation for intermediaries, such policies could adversely impact competition and efficiency in both upstream and downstream markets. Empirical work evaluating the equilibrium net effect of such policies is, however, very limited. This paper fills this gap by providing suggestive evidence for these forces and modeling and quantifying the effects of restricting payments to expert advisors on welfare and market structure. It does so in the context of the UK mortgage market, where 50% of households originate their mortgages through a broker acting as an expert advisor.²

I first provide evidence that suggests that brokers react to supply-side incentives in the form of commissions, despite facing demand-side incentives that might discipline them to act in the best interest of households (e.g., repeated sales and reputation concerns). Mortgage brokers in the UK give advice to households on which mortgage product to originate. They also sort out the paperwork involved in applying and originating a mortgage. As compensation for these services, brokers get a fixed fee from consumers (on average, £140) and a per-sale commission from lenders (on average, £720). Brokers and lenders negotiate commission rates annually, and there is significant heterogeneity in these payments across broker-lender pairs. Using unique loan-level data for all mortgages originated in the UK during 2015 and 2016, I show that there is a strong positive correlation between commission payments and broker sales. After accounting for a rich set of observables and fixed effects, I find that a £100 increase in a broker's commission by a lender is related to a 2% increase in its market share with that broker.

Next, I provide evidence that is suggestive of a link between commissions and competition in upstream and downstream markets. Lenders may not always find it optimal to compensate

¹The Retail Distribution Review in the UK banned all upstream commissions for retail investment advice. The Netherlands and Australia introduced comparable bans on commission payments for complex financial products, and Canada is considering similar measures. In the US, the Consumer Financial Protection Bureau introduced new loan originator compensation requirements under the Truth in Lending Act, restricting mortgage brokers' upstream payments. In the context of healthcare markets, the Physician Payments Sunshine Act requires public reporting of all payments to physicians and hospitals from pharmaceutical and medical device companies.

²Mortgage brokers also have a significant market share in other developed countries. Brokers originate over 44% (pre-crisis) of residential mortgages in the US (National Association of Mortgage Brokers, <http://www.namb.org/>; and about 33% after the crisis, [Alexandrov & Koulayev 2018](#)), 53% in Australia (Mortgage and Finance Association of Australia, MFAA), and 55% of mortgages to first-time buyers in Canada (Canadian Mortgage and Housing Corporation, CMHC).

and form agreements with brokers. The reason is that the relationship between lenders and brokers is both vertical and horizontal. While brokers may provide an alternative distribution channel for lenders, brokers also compete downstream with lenders' in-house distribution channels (e.g., bank branches).³ Therefore, when considering whether to include brokers in their distribution network, lenders may consider possible business-stealing from their branches. In fact, I find that lenders pay on average higher commissions to brokers operating in counties where they have a lower branch density. Similarly, lenders are less likely to establish relationships with brokers in areas with more branch presence. These results suggest that brokers and bank branches are substitutes, competing for borrowers downstream.

Because brokers provide an alternative distribution channel, they also allow small, new lenders (known as "challenger" banks) with a limited branch network and lower brand recognition to access consumers. I find that challenger banks offer on average lower interest rates on their mortgages, and they also pay on average higher commissions to brokers. After accounting for observable characteristics, households originating their mortgage through a broker are 7 percentage points more likely to choose a product offered by one of these smaller lenders. Thus, in an industry that is very concentrated upstream, brokers seem to increase the market share of challenger banks and improve competition in geographical areas where they operate.

Motivated by these patterns in the data, I develop and estimate a static structural model of the UK mortgage market for first-time buyers. The model features households, brokers and lenders. Households are utility-maximizing agents in need of a mortgage for the purchase of a residential property. Lenders are heterogeneous multi-product firms selling differentiated mortgages and competing on interest rates. Brokers are firms providing mortgage advice to households and processing all application and origination paperwork with lenders in their network.

On the supply side, brokers and lenders bilaterally negotiate over the inclusion of the lender in the broker's network and the commission rate. I model these negotiations as a Nash-in-Nash bargaining game, assuming all negotiations take place separately and simultaneously. If a broker and a lender agree on a commission rate, then the broker can originate mortgages with the lender. If there is no agreement, the lender is off-network and the broker cannot originate its products. Heterogeneity of commission rates and network of providers might lead brokers to offer suboptimal products to borrowers. By endogenizing the network and all commission agreements, the model captures one side of the tradeoff that is relevant when

³Despite the rise of price comparison websites and online sales, there is a large positive correlation between the number of bank branches and a lender's market share in a given county. This strong relation between branch presence and non-intermediated sales suggests that borrowers going directly to lenders value branch proximity.

considering the role of brokers in upstream markets. Moreover, I model lenders choice of interest rates for each of their products as a maximization of expected profits.

On the demand side, households' choose between hiring a broker or going directly to lenders –i.e., they decide on a distribution channel. I model this decision as a discrete choice that depends on households' shopping costs, fees paid to the broker and expected payoffs from each distribution channel. Expected payoffs refer to households' indirect utility when choosing a mortgage product within the available choice set. I model households' mortgage choice as a discrete logit with households' preferences being a function of interest rates, product characteristics, nearby branches, and latent demand.⁴ For households originating their mortgage with a broker, I allow the choice to also depend on broker preferences over commissions and other product characteristics. In particular, each broker-household pair maximizes a weighted average of broker and household utilities.⁵ By modeling various channels that borrowers can get products from, including the broker channel, I can capture the other side of the tradeoff of having brokers in downstream markets.

When estimating demand parameters for broker and household preferences, a potential endogeneity concern is that prices may be correlated with unobservable, time-varying attributes affecting household and broker demand. To identify price elasticities, I use supply-side cost-shifters due to regulation and tax regimes as instrumental variables for interest rates and commission rates. I find that households prefer lower interest rates, higher loan-to-value bands, longer initial fixed periods and lenders with nearby bank branches. Households' preferences for branch proximity gives lenders additional market power due to local branch presence. Similarly, brokers prefer products with higher commissions, larger loan-to-value bands and shorter initial fixed periods.⁶ Brokers also find it more costly to originate mortgages with the small, new lenders. Estimates show that, on average, households going through the broker channel split the joint surplus almost fifty-fifty with the broker. Predicted market shares using these demand estimates replicate many features of out-of-sample data.

To identify households' shopping costs distribution I exploit heterogeneous market shares across broker and direct sales, after controlling for observables and expected indirect utility for each distribution channel. Estimates for shopping costs account for almost 20% of consumer surplus, equivalent to almost 1% of annual income of the average household. These estimates

⁴This flexible set up allows me to encompass most, if not all, empirically relevant features affecting households indirect utility in this market.

⁵This modeling decision is equivalent to a reduced-form bargaining between the broker and the consumer, with no outside options. A larger weight on the broker's utility implies brokers can extract a larger surplus when negotiating with households. These weights can be interpreted as reduced-form estimates of (a combination of) information asymmetries between brokers and households and demand-side incentives, such as repeated sales or reputation concerns.

⁶The most common mortgage products in the UK consist of an initial fixed period over which the interest is fixed (usually two, three and five years), after which the rate becomes variable for the remaining maturity. Almost all households refinance after the initial fixed period. Brokers may have an incentive to originate mortgages with shorter initial fixed periods, if households return to them when refinancing.

imply that households find it very costly to originate a mortgage on their own, with brokers generating efficiency gains for consumers when shopping for a mortgage. Interestingly, these estimates are in line with those previously reported in the literature for mortgage markets.⁷

On the supply side, estimates for lenders' marginal costs are on average greater for mortgage products with higher loan-to-value bands (capturing default risk) and longer initial fixed periods (pricing refinancing risk), which is intuitive. Lenders' marginal costs also differ depending on the distribution channel. Mortgages originated through a broker have on average a lower marginal cost than mortgages sold via direct sales, suggesting brokers are more efficient originating mortgages. However, it is not necessarily more profitable for lenders to originate mortgages through the broker channel. After accounting for commission payments, lender mark-ups for broker sales are on average lower than those for direct sales. Therefore, brokers are able to extract surplus from lenders via commission payments.

Finally, to identify bargaining power in broker-lender negotiations, I exploit cross-sectional and time-series variation in outside options for both brokers and lenders. In particular, I use geographical variation in bank branch networks that is orthogonal to the mortgage market. The intuition is simple: differences in branch presence affect lenders' incentives to form an agreement with brokers and their willingness to offer a higher commission rate. Estimates for bargaining parameters reject take-it-or-leave-it offers as a model for setting commission payments in this market. That is, observed dispersion in commission rates would be very hard to explain with models where only lenders or brokers determine commissions, and the other party decides whether to accept or reject the offered rate. This result is common in the literature on business-to-business transactions.⁸

In the last section of the paper, I use the estimated parameters to simulate policies restricting broker services and compensation. First, I consider a scenario where there are no brokers in this market. Policies of such nature have been discussed frequently by regulators in the US and UK. All households use the direct sales channel and need to incur shopping costs. Moreover, households originating their mortgages directly with lenders have a strong preference for banks with nearby branches. Only the largest lenders have a dense branch network, causing competition to fall (Herfindahl-Hirschman Index increases by 35%). In addition, lenders face higher marginal costs for direct sales than for broker sales. The combination of these forces leads lenders to increase prices by 24%. Consumer surplus decreases by 50%, an equivalent to a 2% fall in annual income for the average household.

I also consider the effects of implementing mandatory advice and forcing all households to use brokers when originating their mortgages. Similar policies have been implemented by several regulators (e.g., IL state regulator in US). Shopping costs automatically drop

⁷For estimates on search costs for mortgages, see, for example, [Allen et al. \(2014a,b, 2019\)](#) and [Woodward & Hall \(2012\)](#).

⁸See, for example, [Grennan \(2013\)](#) and [Crawford & Yurukoglu \(2012\)](#)

to zero and lenders' marginal costs fall (since broker sales are more efficient than direct sales). Moreover, large lenders lose their market power from branch presence and start competing directly with challenger banks for brokers. Upstream competition increases, with the Herfindahl-Hirschman Index falling by 27%. However, because now brokers are the only available distribution channel, they are able to extract higher rents from lenders and average commission rates go up by 42%. Lenders pass this additional cost to households, with prices increasing by 9%.⁹ Overall, results show that households are better off having both distribution channels available and benefiting from downstream competition between direct and broker sales.

Finally, motivated by recent regulations, I simulate a ban on all payments between lenders and brokers. This is a more involved counterfactual for several reasons. Broadly, two countervailing forces largely determine the results: broker market power and lender market power. A ban on commissions helps align incentives between households and brokers. By disincentivizing brokers from extracting surplus from households, the ban reduces broker market power downstream. However, in general equilibrium, brokers also adjust their fees to households and their network and agreements with lenders. Given that brokers no longer receive compensation from lenders, brokers increase fees to households. One of the limitations of the model is that, since broker fees are exogenous, the model cannot address changes in how much brokers charge households for their services. For the main estimates I assume broker fees to households increase such that brokers' average per-sale profits remain as in the baseline.¹⁰

Simultaneously, the upstream network of lenders and brokers changes. Brokers have a higher cost of originating mortgages with challenger banks. Under a ban, challenger banks are no longer able to compensate brokers for this extra cost. Therefore, and despite challenger banks offering lower prices to households, brokers reduce their agreements with challenger banks by 72%. The broker-lender network becomes much narrower, and upstream competition falls in the intermediated sales market.

Higher broker fees and a narrower network of lenders lead more households to originate their mortgage directly with lenders. Shopping costs increase. Moreover, due to differentiated products and preferences for nearby branches, larger lenders have a higher market power. Challenger banks' market share decreases and competition also falls in the direct sales market. Combining the effects for broker and direct sales, market share of challengers goes down by 16%, and the Herfindahl-Hirschman Index increases by 21%. Lenders' average marginal cost

⁹In this counterfactual, I am assuming no entry in the broker market. Given the significant increase in broker profits, we would expect entry at the broker level. This should reduce commission rates and mortgage prices for households should fall. Therefore, the reported estimates are a lower bound on consumer surplus.

¹⁰The estimates for all simulations are for a baseline of assumptions about demand, costs, and the nature of bargaining. Whenever possible I evaluated the robustness of my estimates to changes in these assumptions. One example is by allowing other forms of pass-through in broker fees to consumers.

also goes up, as well as prices. The net effect of these forces is a decrease in consumer surplus equivalent to almost a 1% fall in average annual income. When compared with the baseline with no restrictions on commission payments, a ban reduces broker market power (partial equilibrium effect) at the expense of increasing lender market power (general equilibrium effect).

Alternatively, imposing a cap on commission rates at 0.4% of the loan leads to an increase in consumer surplus. Intuitively, a cap results in a decrease in broker market power that is sufficiently large to compensate for the increase in lender market power. A cap allows brokers to get revenue from lenders, causing household broker fees to increase but not as much as in the case of a ban. In this market, commissions act partly as a subsidy for advice provided to households. A cap also allows challenger banks to compensate brokers enough for them to distribute their products. All in all, the competition effect dominates and prices fall by 5%. These estimates suggest that capping, rather than banning, upstream payments might be better for consumers in this market.

Overall, my paper illustrates that when implementing and evaluating policies restricting compensation of expert advisors, it is key to consider the equilibrium effects and trade-offs for competition and efficiency. Thus, “one size fit all” policies addressing the interplay of consumer surplus and advice are likely to be ineffective if they ignore the nature of market structure. In very concentrated upstream markets, intermediaries may be allowing small, new firms to increase their market share and access consumers. Limiting these firms from providing incentives for intermediaries may reduce upstream competition and ultimately have adverse effects on consumers.

Contributions to the Literature. This paper contributes mainly to three strands of literature. First, it complements existing approaches in household finance (Campbell & Cocco 2003; Campbell 2012; Best et al. 2019; DeFusco & Paciorek 2017) by analyzing the role that brokers play in borrowers’ demand in mortgage markets (often dominated by intermediated sales). Woodward & Hall (2010, 2012) consider broker fees when analyzing originations in the US mortgage market. They find evidence of significant price dispersion in broker fees and show that groups that are likely less informed pay higher brokerage fees. Jiang et al. (2014) also study the role of mortgage brokers on mortgage delinquency between 2004 and 2008. They find that brokers originated lower-quality loans, which were 50% more likely to be delinquent than bank-originated loans. Allen et al. (2014b) focus on the role of brokers in Canadian mortgage markets, and how they may improve consumer outcomes by searching over and negotiating with multiple lenders. These papers focus on demand-side interactions between brokers and borrowers, and how brokers’ financial incentives can generate biased advice and be detrimental for consumers. This paper adds to this literature by explicitly accounting for supply-side interactions between brokers and lenders, and developing

a structural model to quantify net equilibrium effects from regulations restricting broker services and lender compensation. In that sense, this paper adds to the recent trend of using structural techniques to analyze market structure and welfare in markets with financial products, such as pensions (Hastings et al. 2017), insurance (Kojen & Yogo 2016), retail deposits (Egan et al. 2017), credit cards (Nelson 2019), mortgages (Allen et al. 2014a, Benetton 2018, Benetton et al. 2019, Buchak et al. 2018, Buchak et al. 2019, Jiang 2020), corporate lending (Crawford, Pavanini & Schivardi 2018), personal loans (Cuesta & Sepulveda 2019) and auto loans (Einav et al. 2012, Buchak 2019, Grunewald et al. 2019).

Second, this paper fits into a vast literature on the role of intermediaries. Intermediaries can create value by guaranteeing quality and certifying information (Biglaiser et al. 2017, Biglaiser & Li 2018), which can alleviate information asymmetries in many markets, such as labor markets (Autor 2009, Stanton & Thomas 2015) and insurance markets (Anagol et al. 2017). Intermediaries can also lessen trading frictions (Gavazza 2016), reduce search costs (Salz 2017, Allen et al. 2014b), promote innovation and adoption of new technologies (Howells 2006), and facilitate entry (Ahn et al. 2011). This paper is closest to settings in which intermediaries take the form of expert advisors and adds to the growing empirical literature that examines agency problems in expert services. For example, in the prescription drug market, Iizuka (2007, 2012) and Ho & Pakes (2014) find doctors react to financial incentives when dispensing generic drugs. Financial advisors are also not immune to conflicts of interest, with many of them having misconduct records and being repeat offenders (Egan et al. 2019). In the housing market, Levitt & Syverson (2008) show how real estate agents exploit their informational advantage to their financial benefit when advising clients on the timing and sales price of their houses. Similarly, Guiso et al. (2018) find evidence of distorted advice when analyzing lenders' in-house mortgage recommendations to borrowers. Financial incentives can also amplify the effects of high search costs by inducing brokers to steer consumers towards inferior products (Egan 2019).

Though closely related, this paper differs from prior work on expert advisors in that it estimates welfare effects from a policy restricting supply-side financial incentives. A recent theoretical literature that, similar in spirit to this paper, analyzes market effects in the presence of commission payments to financial advisors (e.g., Inderst & Ottaviani 2009, 2012a,b,c; Inderst 2015; Heidhues et al. 2016; Martimort et al. 2019). However, given the possible trade-offs in the market, the overall effect on consumers of banning such commissions is theoretically ambiguous. The empirical literature on the topic is almost inexistent. Grennan et al. (2018) study payments between pharmaceutical firms and physicians. They use a structural model to estimate the equilibrium response of prices and quantities to a ban on these financial incentives and find a positive effect on consumer welfare of such policy. This paper differs from their approach in that it analyzes intermediation services in financial markets, which face different trade-offs than those in the healthcare sector. For

example, in many financial markets, consumers can directly access providers without the need to consult with an expert advisor, which is often not the case for medical treatments. Therefore, in market structures where consumers can bypass the intermediary, the exposure of households to market power from providers and intermediaries differs from settings similar to that in [Grennan et al. \(2018\)](#). These differences lead to contrasting welfare effects of policies restricting upstream payments.

Finally, my analysis relates to the recent empirical literature on bargaining. Many of the existing papers focus on the healthcare sector and the interactions between hospitals, insurance companies, suppliers, and firms (see, e.g., [Grennan 2013](#), [Gowrisankaran et al. 2015](#), [Ho 2009](#), [Ho & Lee 2019](#), [Ho & Lee 2017](#), [Grennan & Swanson 2019](#)), and on the telecommunications industry and the relationships between television channels, programming distributors, and viewers (see, e.g., [Crawford & Yurukoglu 2012](#), [Crawford, Lee, Whinston & Yurukoglu 2018](#)). This paper introduces bargaining to analyze vertical payments in credit markets, adding to recent papers incorporating negotiated prices in financial markets (e.g., [Allen et al. 2019](#)). Moreover, this work also contributes to the literature by modeling bargaining in markets where consumers have the option to bypass the intermediary and directly purchase the good from providers via their in-house distribution channels. This type of vertical structure is also analyzed in [Donna et al. \(2018\)](#) for the Portuguese outdoor advertising industry. Similarly to their setting, in my framework when providers and intermediaries negotiate, they acknowledge that their relationship is both vertical (intermediaries provide an alternative distribution channel for providers) and horizontal (intermediaries compete with providers' in-house distribution channels). I exploit this vertical-horizontal structure in a novel identification strategy using geographical and time variation in lenders' branch networks and their outside options to access consumers.

Overview. The rest of the paper proceeds as follows. Section 2 describes the data and some stylized facts about the UK mortgage market. Section 3 shows suggestive evidence on the role of brokers on competition, efficiency and recommendations to households. The goal of this section is to motivate the key trade-offs I will be including in the model. In Section 4, I develop a general equilibrium model for the mortgage market. In Section 5, I discuss estimation and identification of demand and supply parameters. Section 6 presents the estimation results. Section 7 performs counterfactual simulations and welfare analysis of policies restricting broker services and remuneration. Section 8 concludes.

2 Institutional Setting and Data

2.1 The UK Mortgage Market

The UK mortgage market has several institutional features that differentiate it from mortgage markets in the US, Canada, and Continental Europe. For example, the UK has no long-term fixed-rate mortgages. Most products feature a relatively low (usually fixed) interest rate for an initial period of usually two, three, or five years followed by a (usually floating) reset rate that is significantly higher. Reset rates last until the end of the mortgage term, unless borrowers decide to refinance. Additionally, most mortgage contracts include early repayment charges, which typically account for 5% or 10% of the outstanding loan and are in place until the end of the initial fixed period. Given the significant size of these charges and the jump in the reset rate, most borrowers refinance around the time when the initial duration ends, making remortgaging a relatively frequent event in this market (see, e.g., [Cloyne et al. 2019](#)).

Another important aspect of the UK mortgage market is individual-based pricing or negotiation between the lender and the borrower is limited. All borrowers purchasing the same mortgage product pay close to the advertised rate. Lenders' pricing of default risk in this market seems to be driven by loan-to-value ratios (see, e.g., [Best et al. 2019](#)), whereas the pricing of refinancing risk is embedded in the duration of the initial fixed period (see, e.g., [Benetton 2018](#)). Therefore, products with the same maximum loan-to-value and initial fixed period should have very similar interest rates for a given lender. I test this assertion by regressing loan-level interest rates on an extensive set of dummy variables. [Figure A.1](#) reports the adjusted R-squared that results from such regressions. I consider a product to be a triplet of the maximum loan-to-value, initial period, and lender, and I find that product-month fixed effects and the corresponding lender fees account for more than 90% of the variation in mortgage rates. The adjusted R-squared does not increase once I control for borrower characteristics (age, income, credit score, employment status) and location of the property. Moreover, the residual variation cannot be explained after including a dummy for the mortgage being originated through a broker.¹¹

In terms of market structure, the UK mortgage market is very concentrated upstream. The six largest lenders in the market account for more than 75% of mortgage originations. [Panel A in Figure A.2](#) shows the consolidation process that these lenders, the so-called “Big Six,” have experienced over the last decades. Through a series of mergers and acquisitions, they have been able to achieve significant market power at a national level. However, the last several years have also seen significant entry in the market from the so-called “Challenger

¹¹In the rest of the paper, I take this institutional feature as given and assume no individual-based pricing within product type. Conditional on approval for a given product, a lender charges same price regardless of borrower characteristics and distribution channel (broker/direct). I address the possibility of this institutional feature changing when discussing counterfactual policy simulations.

Banks.” Panel B in Figure A.2 presents the timeline for the main entrants in the mortgage market. Many of these entrants have a very limited branch network and promote their products mostly through on-line distribution channels and intermediaries. This strategy has proven successful partly because of the strong presence of mortgage brokers in the UK market. In 2017, more than 70% of first-time-buyers and 60% of home-movers originated their mortgage through a broker. Brokers also have a significant market share in the remortgaging market, especially for those borrowers who refinance with a different lender. Although many individual brokers are present in the form of one-person firms, the broker market is dominated by the largest 20 broker companies. These brokerage firms account for more than 60% of all new originations and have direct communication with lenders. I will discuss the relationship between lenders and broker companies in more detail when describing the data in the next subsection.

2.2 Data

The main dataset is the Product Sales Database (hereafter, PSD), which is a comprehensive regulatory dataset containing the universe of residential mortgage originations in the UK. These data are collected quarterly by the Financial Conduct Authority (FCA) and are only available to restricted members of staff and associated researchers at the FCA and the Bank of England. For the purposes of this paper, I focus on the year 2015 and the first half of 2016. During this period, I observe for each mortgage origination details on the loan (interest rate, loan amount, initial fixed period, lender, fees), the borrower (income, age, credit score), and the property (value, location). I also have information on the distribution channel, that is, whether a broker intermediates the sale and, if so, the identity of the brokerage. Table 1 summarizes the data. I observe more than 2 million contracts of which almost 90% are mortgages with initial fixed periods of two, three, and five years. More than 50% of borrowers in my sample are either external or internal remortgagors, which is not surprising given the frequency of refinancing in this market. The average interest rate is 2.57 percentage points, and lenders charge on average an origination fee of £467. The average loan is almost £160,000 with a loan-to-value of 60%, a loan-to-income of 3.1, and an average maturity of 25 years. Borrowers are, on average, 38 years old, have an annual income of £62,000. Borrowers are richer and have higher credit scores than the average UK resident.

I complement the PSD data with novel information on broker companies that is also collected by the FCA. For each mortgage origination in the PSD data, I observe commission payments (from lenders to brokers for each sale), broker fees (from borrowers to brokers), and supplementary details on contract agreements between lenders and brokers. Table 2 summarizes the data. Panel A compares the fraction of intermediated sales and the average per-sale broker remuneration across borrower types. More than 70% of first-time-buyers

originate their mortgage through a brokerage. Intermediation is also the most popular distribution channel in the home-movers and external remortgagors markets, with shares above 60%. Only 11% of internal remortgagors (those refinancing with the same lender) hired a broker when renewing their mortgage. On average, a broker will receive over £800 per mortgage, with most of the revenue coming from lenders' commissions and only a small fraction (if any at all) from broker fees. Figure A.3 plots the distribution of broker fees, revealing that most broker companies charge borrowers zero fees for their services. On the other hand, commissions from lenders are quite generous. Figure A.4 shows the distribution of commission rates across borrower types. Commission rates range between 0.3% and 0.8% of the loan, and there is significant heterogeneity across brokers, lenders and time. However, in a given quarter, there is no variation in commission rates at the lender-broker pair. Lenders and brokers set contracts such that commission rates are the same for all products within each lender-broker pair.

There is also heterogeneity in the broker-lender network. Panel B of Table 2 reports the average number of agreements between brokers and lenders. The average lender deals with 13 broker companies, whereas the average brokerage sells products from 8 lenders. However, there is heterogeneity both across brokers and across lenders. For example, one lender has no dealings with brokers, whereas another lender has agreements with all brokers. Likewise, some broker companies have very few lenders in their network, whereas others include almost every lender. There is also variation in broker-lender networks across time. Throughout the sample period, 18% new agreements between brokers and lenders were created and 11% of broker-lender relationships stopped.

Finally, I collect quarterly postcode-level data on all bank branches in the UK from Experian's Goad and Shop*Point datasets. There is significant geographical heterogeneity in branch presence across UK lenders, which is correlated with historical headquarters. The panel structure of the data allows me also to identify branch openings and closures for all lenders. Figure A.5 plots time-series variation in the number of branches for the largest lenders. Aggregate total branches fall by almost 17% during my sample period. Despite the general downward trend, branch openings and closures are very heterogeneous across lenders and geographical areas (see Figure A.6). For example, London and other large urban conurbations experience large openings for some lenders, whereas some rural areas are essentially bank-branch deserts.

Overall, the combination of these three sources of data provides me with a very rich, loan-level dataset that is ideal for understanding the role of brokers in this market and analyzing the effects of policies restricting broker services and remuneration. This paper is the first to exploit these combined datasets and the first one to address the role of broker financial incentives on market structure and welfare.

3 Motivating Evidence

A key economic trade-off consumers face in the presence of brokers and commission payments is that, on the one hand, commissions may distort brokers' recommendations towards high-commission, more expensive products; but, on the other hand, brokers may increase upstream competition and efficiency, leading to overall lower prices. I now present motivating evidence suggesting that both sides of this trade-off are present in the UK mortgage market, and that the data supports the inclusion of these forces in the model.

3.1 Brokers' Sales and Commissions

Commission payments from lenders can incentivize brokers to recommend high-commission products to consumers. These incentives may not be in the best of interest of consumers if, for example, products offering high commissions are also more expensive or worse quality than other available products. Figure A.7 illustrates this concern with an example in the data for two lenders offering one of the most popular products in the market: a two-year fixed, 75% loan-to-value mortgage. Lender B's product is always cheaper, but lender A's product pays a higher commission to brokers. Despite being more expensive, lender A's product has a higher market share via direct sales. Unobservable characteristics, such as more advertising or lax screening, could explain this gap in direct sales between lenders A and B. The misalignment of incentives between brokers and consumers relates to the even larger difference in market shares observed for intermediated sales between lenders A and B. This section provides suggestive evidence that these differences across similar products and consumers can partly be explained by differences in commission rates.

It is not obvious how much supply-side incentives, in the form of commission payments, influence brokers' recommendations to households. In the UK mortgage market, there are also demand-side incentives that can discipline brokers to act in their customers' best interests. For example, repeated sales in the form of frequent refinancing can help align borrowers' and brokers' incentives. Brokers may want to maintain a good relationship with households in order to ensure they return for future mortgage transactions.¹² Brokers can also be motivated by reputation concerns. Broker businesses often depend heavily on referrals, creating incentives for brokers to provide high-quality services to ensure future recommendations.¹³ All in all, whether brokers react to commissions in markets with repeated sales and reputation concerns is an empirical question, requiring quantification of demand and supply-side incentives.

¹²68% of households say they are satisfied with their broker and would use the same intermediary in the future. See FCA's consumer survey *Financial Lives Survey 2017*.

¹³In the UK, 23% of borrowers choose their broker because a real estate agent recommends it, and 29% because a friend or relative suggests it. See FCA's consumer survey *Financial Lives Survey 2017*.

To understand whether broker sales react to changes in commission rates, I estimate the following fixed-effects specification at the product-broker-month-county level:

$$Share_{bjtc} = \alpha + \theta Commission_{blt} + \delta_{jtc} + \gamma_{btc} + \psi_{blc} + \epsilon_{bjtc}, \quad (1)$$

where the dependent variable is the percentage share of product j in broker b 's sales portfolio at month t in county c . The independent variable $Commission_{blt}$ is the per-sale commission rate that broker b receives from lender l in month t . To solve some of the endogeneity concerns when regressing product shares on commissions, I control for confounders by absorbing a rich set of fixed effects at the county level. Product-time-county fixed effects account for time-varying product characteristics that could affect brokers' product preferences, such as interest rates, advertisement, and fees. Broker-time-county fixed effects control for time-varying broker characteristics that could influence brokers' choices, such as their borrower clientèle. Finally, broker-lender-county fixed effects account for preexisting dealings between a broker and a lender that could result in preferential treatment. This specification addresses the obvious endogeneity concerns; however, the estimate for θ could still be biased if there exist confounding variables that vary at the broker-product-time-county level.¹⁴

Table 3 presents estimates for equation 1. The first column uses the entire sample, while the second column focuses exclusively on first-time-buyers. Estimates for the coefficient of interest, θ , are positive and significant, with values of 0.163 for all borrowers and 0.271 for first-time buyers. Thus, products with a 13% (£100) higher commission rate for a broker have, on average, almost a 2% higher market share within a broker's portfolio. Estimates in Table 3 exploit within-broker-product variation across time within a county, showing that an increase in a product's commission will, on average, increase the products' share within a broker's sales portfolio. I interpret this result as suggestive evidence that, after controlling for the obvious confounders, brokers seem to react to changes in commission rates.

Brokers may also have preferences across product characteristics, other than commissions. For example, brokers may be more likely to recommend products that require households to refinance more frequently.¹⁵ Because commission payments are a function of the size of the loan, brokers have incentives for households to borrow as much as possible.¹⁶ For example,

¹⁴I will further discuss these endogeneity issues when estimating the model. At that stage, I will try to address these concerns using an instrumental variables approach in a slightly different specification exploiting time-variation in cost-shifters at the broker-lender level.

¹⁵All lenders pay commissions to brokers for borrowers who are externally refinancing, and 65% of them also do it for those who are internally refinancing.

¹⁶In the US, the media and consumer groups have argued that brokers advice to households to borrow beyond their means exacerbated the financial crisis. See, for example, Plevin and Craig, "Deal Fees under Fire Amid Mortgage Crisis; Guaranteed Rewards of Bankers, Middlemen Are in the Spotlight," Wall Street Journal, January 17, 2008; and "Steered wrong: Brokers, borrowers, and subprime loans," *Center for Responsible Lending*, 2008. Similar concerns have been raised in Europe by the Basel Committee on Banking Supervision's Report, "Customer suitability in the retail sale of financial products and services," 2008.

brokers may prefer to originate higher loan-to-value products, conditional on a given property.

Broker preferences are, however, difficult to disentangle from consumer preferences. Brokers sell mortgages with shorter initial periods and higher loan-to-value bands than mortgages originated via direct sales. Still, these choices can be explained by selection into intermediation driven by differences in borrower and product characteristics. If households originating their mortgages via brokers differ from those going directly to lenders, then brokers could be selecting the best products conditional on such differences. To get a sense of any evidence in the data that might suggest selection (on observables) into brokerage, I calculate borrowers' propensity scores for originating mortgages with high loan-to-value and a short initial fixed period. I use as predictors the borrower's characteristics (income, age, credit score, and whether it is a joint application), property characteristics (house price and location), and month of the year. Figure A.8 plots these propensity scores separately for direct and intermediated sales. Based on observable characteristics, borrowers going through brokers are slightly more likely to buy a mortgage with high loan-to-value and short initial period. Still, I cannot reject that distributions for both channels are statistically different. Even if selection on observable characteristics cannot explain differences in choices, there could still be differences across unobservable (to the econometrician) characteristics across products and consumers.¹⁷

3.2 Upstream Competition and Commissions

Despite the recent uptake of online distribution channels in many markets, bank branches still play a crucial role in mortgage originations in the UK. The top plot in Figure A.9 shows that lenders with a more dense branch network in a given county have a higher market share of direct sales in that same county. The strong positive correlation between direct sales and branch presence still holds after adding lender and area fixed effects to account for local demand and lender preferences.¹⁸ The bottom plot in Figure A.9 shows that, on average, lenders are also more likely to pay higher commission rates to brokers operating in counties

¹⁷In the model in Section 4, I explicitly account for borrowers' selection into intermediation and brokers' incentives both within and across product types. I am able to separately identify the borrower and broker preferences over product characteristics, other than commissions, under certain assumptions regarding unobservable characteristics.

¹⁸One possible explanation argues that recent changes in regulation implemented by the Mortgage Market Review (MMR) in April 2014 have intensified the importance of bank branches as a distribution channel. The MMR requires lenders to provide advice for all sales that require any "interaction" with borrowers. Lenders have been very conservative in their interpretation of these "interaction trigger" and now provide lengthy advice to almost all of their borrowers, except for internal remortgagors. Although some lenders give the option of speaking to an advisor over the phone, most borrowers are redirected to the nearest branch for an appointment with a specialized advisor to discuss their mortgage application. Both face-to-face and telephone interviews of almost two hours on average. However, no such requirement exists for borrowers originating their mortgages via brokers. Lenders seem to be taking advantage of this fact and are using commissions to promote their products to intermediaries in areas where borrowers would have to travel a significant distance to their nearest branch for an interview.

where they have less branch density (and lower direct sales market share). This correlation is even larger in the so-called “bank-branch deserts”, where brokers can potentially increase welfare by both lowering lenders’ distribution costs and reducing borrowers’ shopping costs.

Commissions also allow challenger banks to promote their products in the market without the need to set up extensive (and expensive) branch networks. Panel A in Figure A.10 plots average interest and commission rates for challenger and non-challenger lenders over the sample period. On average, challenger banks offer lower rates and higher commissions. However, there is heterogeneity across products and brokers. Panel B in Figure A.10 shows the corresponding market shares for direct and intermediated sales channels across lender types. On average, challenger banks account for a higher market share in brokers’ sales than in direct sales. To formalize this relationship between challenger banks and intermediated sales, I estimate the following specification:

$$Challenger_{ijt} = \alpha + \delta Intermediated_{ijt} + \beta X_{ijt} + \epsilon_{ijt}, \quad (2)$$

where $Challenger_{ijt}$ is a dummy equal to one if household i at time t purchased mortgage product j from a challenger bank, and zero otherwise. The independent variable $Intermediated_{ijt}$ is a dummy variable equal to one if the household originated the mortgage through a broker, and zero if it used the direct channel instead. Covariates X_{ijt} control for observable borrower, product, geographical, and time-period characteristics.

Table 4 shows estimates for equation 2. After controlling for borrower and product characteristics and year-month and county fixed effects, first-time-buyers going to a broker have a 7 percentage point higher probability of originating their mortgage through a challenger bank. Although this relationship can be driven by unobservables and selection into intermediation, brokers seem to be increasing challenger banks’ market shares. Given that for many products in the market, challenger banks offer better rates than the Big Six, commissions can benefit households via their allocative role in the broker channel, inducing higher matching rates between borrowers and challenger banks.

3.3 The Need for a Model

The results in this section provide suggestive evidence that in this market brokers might steer consumers to high-commission product (potentially reducing consumer surplus). Brokers can also increase upstream competition among lenders by allowing challenger banks to increase their market shares without the need to invest in an extensive branch network. Moreover, brokers may reduce costs for established banks in areas where they have limited branch density, reducing their distributional costs and eventually resulting in efficiency gains and lower prices. Finally, as shown in section 2.2, consumers currently pay very low fees (in many instances, no fee at all) when hiring a broker. These low charges are possible only

because brokers are getting most of their revenue directly from lenders. Commission payments decrease the price consumers pay for valuable expert services that reduce household search costs and increase the information on available products. These results suggest the presence of a trade-off of having brokers in this market. Therefore, the net effect of broker services and commission payments on welfare will depend on which of all these forces dominates in equilibrium.

To evaluate the overall impact of policies restricting broker services and remuneration, we need to empirically assess the relative sizes of each side of the trade-off on consumer surplus. This may prove to be difficult for three reasons. First, no counterfactual scenario without commission payments exists in this market. This limitation precludes evaluating the performance of such a policy in this context. The second challenge arises because contract negotiations between lenders and brokers endogenously determine commission payments in this market. To evaluate the effects of a hypothetical cap or ban on such commissions, understanding the incentives and the trade-offs lenders and brokers face when deciding whom to include or exclude from their sales networks and what commissions to set in such agreements is necessary. Finally, consumers endogenously (1) what product to purchase and (2) whether to hire a broker. These choices depend on observable and unobservable (to the econometrician) characteristics of products, borrowers and brokers.

In the rest of the paper, I present and quantify a structural model of the UK mortgage market that features the trade-offs discussed so far. Such a framework will help overcome the empirical limitations described in this section and will enable me to evaluate the net effect on consumer surplus of restricting broker services and upstream commissions.

4 A Model of the UK Mortgage Market

4.1 Set-up

In this section, I develop a static structural model of the UK mortgage market that predicts: (i) first-time-buyers demand for mortgage products, (ii) first-time-buyers demand for broker services, (iii) interest rates offered by lenders, and (iv) negotiated lender-broker-specific sales commissions. I later estimate this model and use it as a tool to simulate counterfactual policy analysis.¹⁹

The model focuses on the interactions between lenders, brokers and households in the

¹⁹The model is static. Therefore, the timing of purchase is exogenous (i.e., I do not model the participation decision of buying versus renting). I also abstract from issues related to refinancing and defaulting. As in [Benetton \(2018\)](#), I find this assumption reasonable for this market, since (1) almost all first-time-buyers in the UK refinance after the initial fixed period or shortly thereafter, and (2) strategic default in the UK mortgage market is unlikely since all loans are recourse. Moreover, I focus exclusively on first-time-buyers. The reason for focusing on these group of borrowers is to abstract from pre-existing relations between brokers, borrowers and lenders (e.g., learning).

UK mortgage market. Figure 1 describes the vertical and horizontal relations in this market between all main players. A *household* consists of one or two potential borrowers in need of a mortgage for the purchase of their first residential property. A *lender* is a bank or building society selling differentiated mortgage products to households. A *broker* is a firm that helps households get a mortgage by providing advice on available products and sorting out application and origination paperwork with the lender. Assume there are markets labeled $t = 1, \dots, T$, each with households indexed by $i = 1, \dots, I_t$ and with heterogeneous shopping costs and preferences across product characteristics. I define a market as half-year in my data, and each household can only be active in one market and purchase only one product. In each market there are $l = 1, \dots, L_t$ lenders, each selling J_{lt} horizontally differentiated mortgage products, indexed by $j = 1, \dots, J_{lt}$. Likewise, each market has B_t brokers, indexed by $b = 1, \dots, B_t$.

The timing of events is as follows. On the supply side, brokers and lenders bilaterally negotiate (separately and simultaneously) over the inclusion of a lender in a broker’s network. If successful, a per-sale commission rate is set. If unsuccessful, then the lender is out-of-network and the broker cannot originate any of the lender’s mortgages. Once all bilateral negotiations are over, the broker-lender network is determined, with a menu of commission rates for each broker and a set of lenders with whom it can do business. Next, lenders set prices in the form of interest rates for all their mortgage products to maximize expected profits. On the demand side, households decide whether to hire a broker or originate their mortgage directly with a lender (e.g., bank branches). I will refer to the former as the intermediated channel and to the latter as the direct channel. Once households have committed to a sales channel, they choose the mortgage product that maximizes their indirect utility among those available in their choice set. In the case where households originate a mortgage through a broker, brokers’ preferences also affect households’ mortgage choices. I solve the model by backwards induction, starting with household demand for mortgages conditional on their previous choice of sales channel.

4.2 Demand

4.2.1 Mortgage Product Choice

Following the characteristics approach (Lancaster 1979), I assume households’ mortgage demand is a function of observable household characteristics, random preferences, product attributes, and a vector of preference parameters. At this stage, households have already decided on a sales channel and need to originate one mortgage among all available mortgage products. Households’ maximization problem differs depending on their chosen sales channel, which is predetermined at this stage.

Direct Channel. Consider household i in market t that has opted for lenders' in-house distribution channels. I make the parametric assumption that the indirect utility of such household has the following linear form:

$$V_{ijlt}^D = \alpha_i r_{jlt} + \beta_i X_{jl} + \lambda_i \text{Branches}_{ilt} + \xi_{jlt} + \epsilon_{ijlt}, \quad (3)$$

where r_{jlt} is the interest rate of product j offered by lender l in market t ; X_{jl} are time-invariant product characteristics including lender, maximum loan-to-value, and initial fixed period; Branches_{ilt} accounts for the number of branches that lender l has in household i 's county in market t ; ξ_{jlt} captures unobservable product-lender-market characteristics affecting household utility in a market (e.g., advertising, screening); and ϵ_{ijlt} is an idiosyncratic taste shock. By adding branches in the horizontal differentiation dimension, I account for costs associated with application and origination processes that households may face, along the lines of [Hastings et al. \(2017\)](#) and [Benetton \(2018\)](#). Moreover, local share of bank branches can proxy for unobserved pre-existing borrower-lender relations (e.g., current accounts).

Household i will purchase mortgage product jl if and only if it attains the highest indirect utility among all available products in the household's consideration choice set, C_{it} , which I assume is household specific and restricted by household characteristics. That is, household i will choose product j from lender l if (1) it is part of the available choice set, and (2) $V_{ijlt}^D > V_{ikst}^D, \forall ks \in C_{it}$. Consider $V_{11}, V_{21}, \dots, V_{j1}, \dots, V_{jL}$ to be the utilities for all product-lender alternatives, where J and L are the number of products and lenders in choice set C_{it} , respectively. Then, the probability that alternative jl is chosen at a purchase occasion is:

$$s_{ijlt} = \Pr(jl \text{ chosen} | C_{it}) = \Pr(V_{ijlt}^D > V_{ikst}^D \text{ for all } ks \in C_{it}). \quad (4)$$

Intermediated Channel. Consider now household i has, instead, hired broker b in market t . Let $b(i)$ denote this broker-household pair. I assume that each broker-household pair $b(i)$ is a composite agent that maximizes the joint indirect utility, which I assume to be a weighted average of the indirect utility of the household, V_{ijlt}^b , and that of the broker, W_{bjlt} . Moreover, I make the parametric assumption that the indirect utility of the pair $b(i)$ for the purchase of product j from lender l in market t takes the following form:

$$\begin{aligned} V_{b(i)jlt} = & (1 - \theta_b) \underbrace{(\beta_i X_{jl} + \alpha_i r_{jlt} + \xi_{jlt} + \epsilon_{ijlt})}_{\text{Household's Utility } (V_{ijlt}^b)} \\ & + \theta_b \underbrace{(\gamma_1 c_{lbt} + \gamma_2 X_{jl} + \zeta_{btl})}_{\text{Broker's Utility } (W_{bjlt})}, \end{aligned} \quad (5)$$

where households' indirect utility, V_{ijlt}^b , is analogous to that of Equation 3 in the direct channel, except for bank branches not affecting mortgage choices through the broker channel.²⁰ The

²⁰Section 3.2 suggests that branch presence matters only for direct sales. Moreover, when adding this

indirect utility of broker b , W_{bjlt} , includes a per-sale commission rate c_{lbt} from lender l for selling product j ; product characteristics X_{jl} over which the broker may have some preferences (loan-to-value, initial fixed period, lender); and unobservable (to the econometrician) broker-lender-market characteristics, ζ_{blt} , such as preferential treatment or unobservable costs. Parameter θ_b captures the average downstream market power of broker b and the share of surplus a broker can extract. I interpret this parameter as the magnitude of the agency problem the average household faces when dealing with broker b and the negotiation power the broker has over the consumer. If θ_b is equal to zero, then broker and household incentives are aligned. This alignment might result from strong demand-side incentives (e.g. repeated sales, reputation concerns) or households' having very high outside options and low switching costs. In either case, the broker finds it optimal to choose a product that maximizes household utility. If, on the other hand, θ_b is equal to one, then supply-side incentives dominate and the broker can extract all surplus from households.

Each broker-household pair chooses the mortgage product that maximizes the joint surplus subject to their available choice set, $C_{b(i)t}$. This choice set is broker-household specific, and it is restricted by household characteristics (as in the direct channel) and broker b 's network of lenders. At this stage, a broker can only originate mortgages with lenders with whom she reached an agreement in the previous bargaining stage. I denote this subset of lenders N_{bt} . Therefore, broker-household $b(i)$ will choose product j from lender l in N_{bt} if (1) it is part of the available choice set $C_{b(i)t}$, and (2) $V_{b(i)jlt} > V_{b(i)kst}, \forall ks \in C_{b(i)t}$. Finally, the probability that product jl is chosen, $s_{b(i)jlt}$, conditional on the available choice set, $C_{b(i)t}$, has an analogous form to the one defined in Equation 4 for the direct channel.

4.2.2 Sales Channel Choice

Prior to choosing a mortgage product, households decide whether to hire a broker or go directly to lenders' in-house distribution channels. I assume each household i has a shopping cost κ_i . Shopping costs are heterogeneous and assigned via i.i.d. draws from a distribution F_κ . Households using the direct sales channel incur shopping costs κ_i to learn about available products in market t and deal with the administrative aspects of the application. Households choosing the broker channel do not have to incur such shopping costs.²¹ Instead, households are matched to broker b with probability π_{bit} and pay a broker fee f_{bit} for the broker's services. There are three implicit assumptions: (1) households do not search across brokers, and (2) there is no competition among brokers. The main implication is that broker fees to

coefficient in the estimation for broker sales, the effect is small and not significantly different from zero. After controlling for commissions, branch proximity does not seem to play a role when originating a mortgage through a broker.

²¹I am implicitly assuming that shopping costs for households via brokers are zero. Alternatively, κ_i can be interpreted as the cost difference between both channels: $\kappa_i \equiv \kappa_i^D - \kappa_i^B$

households are exogenous.²²

Household i chooses the sales channel that provides the highest (net) ex-ante expected utility, which depends on household shopping costs, broker fees, and ex-ante expected maximum indirect utility from each sales channel. Let $\hat{\kappa}_i$ be the shopping cost that makes household i indifferent between both sales channels. This indifference cut-off value is:

$$\underbrace{E\left[\max_{jl} V_{ijlt}^D(\eta) \mid \text{Direct}\right]}_{\text{Direct Channel}} - \hat{\kappa}_i = \underbrace{\sum_{b \in B_t} \pi_{b(i)t} \left(E\left[\max_{jl} V_{b(i)jlt}(\eta) \mid b\right] - \alpha_i f_{bit} \right)}_{\text{Broker Channel}}, \quad (6)$$

where η is a vector of all household-preference parameters; $E\left[\max_{jl} V_{ijlt}(\eta) \mid \text{Direct}\right]$ and $E\left[\max_{jl} V_{b(i)jlt}(\eta) \mid b\right]$ are the ex-ante expected household utilities of household i from going directly to the lender and hiring broker b , respectively; $\pi_{b(i)t}$ is the probability that household i is matched to broker b ; f_{bit} is the broker fee paid by household i when hiring broker b ; and α_i is the price coefficient in Equations 3 and 5 (used to transform money into utils and make the fee comparable to the expected utilities). If household i has a shopping cost κ_i that is greater than $\hat{\kappa}_i$, the household chooses to hire a broker. Alternatively, if κ_i is smaller than $\hat{\kappa}_i$, the household selects the direct sales channel and shops for a mortgage across lenders' in-house distribution channels.

4.3 Supply

4.3.1 Lender Mortgage Pricing

Each market t contains L_t lenders that are for-profit organizations selling mortgage products to households. They maximize expected profits by setting interest rates (prices) for each of their products. I define the set of products offered by lender l in market t as J_{lt} . Lender l 's profits from a direct sale of product j in market t are:

$$\Pi_{jt}^D = t_j (r_{jt} - mc_{jt}^D), \quad (7)$$

where t_j is the initial fixed period for product j , r_{jt} is the initial rate for that product in market t , and mc_{jt}^D is the marginal cost of selling product j in market t through a direct distribution channel. Similarly, lender l 's profits from selling product j in J_{lt} in market t via an intermediated sale from broker b are:

$$\Pi_{jt}^b = t_j (r_{jt} - mc_{jt}^B) - c_{lbt}, \quad (8)$$

²²Figure A.3 shows how broker fees in this market are small, with many broker companies offering their services at a zero fee. In the current equilibrium, households do not search across brokers (see FCA's consumer survey *Financial Lives Survey 2017*). However, this behavior might change in counterfactual analysis where broker fees significantly increase. I will address this possibility when discussing counterfactual simulations.

where c_{lbt} is the commission paid to broker b in market t for the sale of product j from lender l , and mc_{jt}^B is the marginal cost of selling product j in market t through the broker channel. I allow for marginal costs to vary across sales channels, because there could be ways in which brokers reduce lenders' origination costs (e.g., screening, income verification). Households' loan quantity is equal to one, and it is not affected by changes in the interest rate. That is, a change in the interest rate affects households' choice probabilities across products (including loan-to-value bands), but not the associated loan amount (within a loan-to-value band). Therefore, I only account for households' discrete choice in lenders' profits, as opposed to previous work that also endogeneizes households' choice of loan amount (see [Benetton 2018](#)). Finally, I assume all households refinance at the end of the initial fixed period and there is no default.

Using demand choice probabilities in Equation 4 and cut-off shopping costs in Equation 6, lender l 's expected profits from serving household i in market t are:

$$\Pi_{it}^l = \underbrace{F_{\kappa}(\hat{\kappa}_i) * \sum_{j \in J_{it}} (s_{ijlt} * \Pi_{jt}^D)}_{\text{Revenue from Direct Sales}} + \underbrace{[1 - F_{\kappa}(\hat{\kappa}_i)] * \sum_{j \in J_{it}} \sum_{b \in N_{it}} (\pi_{b(i)t} * s_{b(i)jt} * \Pi_{jt}^b)}_{\text{Revenue from Broker Sales}}, \quad (9)$$

where s_{ijlt} and $s_{b(i)jt}$ are choice probabilities for household i choosing product jl conditional on sales channel; $F_{\kappa}(\hat{\kappa}_i)$ is the probability that household i chooses to go directly to the lender's distribution channel; and $1 - F_{\kappa}(\hat{\kappa}_i)$ is the probability that household i hires a broker. Conditional on other lenders' interest rates, lender l decides in each market t the initial rate for each product j in J_{it} that maximizes the sum of Equation 9 across all households in each market. Thus, in each market, lender l solves the following maximization problem:

$$\max_{\{r_{jt}\}_{j \in J_{it}}} \Pi_t^l = \sum_{i \in I_t} \Pi_{it}^l(r_{1t}, \dots, r_{J_{it}}), \quad (10)$$

Optimal interest rates are determined by the first-order conditions with respect to the interest rate of product j in market t . These first order conditions capture (1) the extra profits for both direct and intermediated sales due to a higher interest rate, (2) the effect of higher rates on choice probabilities for all products from lender l , and (3) the change in the probability of households choosing the direct channel due to higher interest rates. Solving the first order conditions gives the following optimal interest rate (I omit the market subscript for simplicity):

$$\begin{aligned}
r_j^* = & \sum_{i \in I_m} \left[\underbrace{mc_j^D \rho_j^D + \sum_{b=1}^B \pi_{b(i)} (mc_j^B + \frac{c_{tb}}{t_j}) \rho_j^b}_{\text{Effective average marginal cost}} \right. \\
& - \underbrace{F_{\hat{\kappa}} s_{ijl} \frac{\rho_j^D}{F_{\hat{\kappa}} \frac{\partial s_{ijl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{ijl}} - (1 - F_{\hat{\kappa}}) \sum_{b=1}^B \pi_{b(i)} s_{b(i)jl} \frac{\rho_j^b}{(1 - F_{\hat{\kappa}}) \frac{\partial s_{b(i)jl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{b(i)jl}}}_{\text{Full mark-up}} \\
& - \underbrace{\sum_{k \neq j \in J_l} \frac{1}{t_j} \left(F_{\hat{\kappa}} \frac{\partial s_{ikl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}}{\partial r_j} s_{ikl} \right) \frac{\Pi_k^D \rho_k^D}{F_{\hat{\kappa}} \frac{\partial s_{ijl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{ijl}}}_{\text{Other products via direct}} \\
& \left. - \underbrace{\sum_{k \neq j \in J_l} \frac{1}{t_j} \sum_{b=1}^B \pi_{b(i)} \left((1 - F_{\hat{\kappa}}) \frac{\partial s_{b(i)kl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}}{\partial r_j} s_{b(i)kl} \right) \frac{\Pi_k^B \rho_k^b}{(1 - F_{\hat{\kappa}}) \frac{\partial s_{b(i)jl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{b(i)jl}}}_{\text{Other products via brokers}} \right], \tag{11}
\end{aligned}$$

where ρ_j^D is the effective probability of household i going direct and purchasing product j ; and ρ_j^b is the effective probability of household i going to broker b and purchasing product j .²³ The optimal rate depends on average marginal costs and mark-ups, as well as other products sold by both distribution channels.²⁴

4.3.2 Broker-Lender Bargaining over Commissions

In each market t , before setting prices and making any sales, brokers and lenders bilaterally meet and bargain á la Nash to determine whether to form an agreement. If successful, they set a per-sale commission that is expressed as a percentage of the final loan amount. $L_t \times B_t$ contracts are possible, and brokers and lenders have complete information about all payoff

²³Expressions for both ρ_j^D and ρ_j^b are:

$$\begin{aligned}
\rho_j^D &= \frac{F_{\hat{\kappa}} \frac{\partial s_{ijl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{ijl}}{\left[F_{\hat{\kappa}} \frac{\partial s_{ijl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{ijl} + (1 - F_{\hat{\kappa}}) \sum_{b \in B} \pi_{b(i)} \frac{\partial s_{b(i)jl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} \sum_{b \in B} \pi_{b(i)} s_{b(i)jl} \right]} \\
\rho_j^b &= \frac{(1 - F_{\hat{\kappa}}) \frac{\partial s_{b(i)jl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{b(i)jl}}{\left[F_{\hat{\kappa}} \frac{\partial s_{ijl}}{\partial r_j} + f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} s_{ijl} + (1 - F_{\hat{\kappa}}) \sum_{b \in B} \pi_{b(i)} \frac{\partial s_{b(i)jl}}{\partial r_j} - f_{\hat{\kappa}} \frac{\partial \hat{\kappa}_i}{\partial r_j} \sum_{b \in B} \pi_{b(i)} s_{b(i)jl} \right]}.
\end{aligned}$$

²⁴Note that if no brokers exist in the market and all lenders offer only one product, expression (11) collapses to the standard mark-up pricing formula: $r_j^* = \sum_{i \in I_m} \left(mc_j^D - s_{ijl} \times \left(\frac{\partial s_{ijl}}{\partial r_j} \right)^{-1} \right)$.

functions. Negotiated commissions for each contract solve the Nash bargaining solution for that contract. Thus, the equilibrium commission vector maximizes the Nash product of each pair’s gains from trade, conditional on agreements reached by all other pairs. Moreover, given that the agreement value for a broker dealing with a given lender may change depending on whether she has reached an agreement with another lender with similar mortgage products, I assume each contract remains the same even if negotiation for another contract fails. Thus, all negotiations within market t are simultaneous and separate, such that commissions set in other meetings are not known but conjectured. This setting is motivated by the model presented in [Horn & Wolinsky \(1988\)](#), and it is commonly used in other empirical papers (see, e.g., [Crawford & Yurukoglu 2012](#), [Grennan 2013](#), [Gowrisankaran et al. 2015](#), [Ho & Lee 2019, 2017](#), [Crawford, Lee, Whinston & Yurukoglu 2018](#)).²⁵ Despite these assumptions, lenders and brokers’ payoffs still depend on outcomes of bilateral negotiations to which they are not party. I start by considering the ex-ante payoff structures for brokers and lenders, and their resulting participation constraints. I then show the Nash bargaining solution to each contract.

Each broker seeks to maximize her ex-ante expected payoff from serving all households that hire her services. Given lenders’ expected rates and households’ expected mortgage and sales channel choices, the ex-ante expected utility for broker b in market t , as a function of commissions and network structure N_{bt} , is:

$$W_{bt}(\mathbf{c}_{bt}, N_{bt}) = \sum_{i \in I_t} \left(1 - F_\kappa[\hat{\kappa}_i(\mathbf{c}_t)] \right) * \pi_{b(i)t} * \sum_{j \in J_{b(i)t}, N_{bt}} s_{b(i)jt}(\mathbf{c}_{bt}) W_{bjt}(c_{lbt}), \quad (12)$$

where \mathbf{c}_{bt} is a vector of commission payments for broker b ; $W_{bjt}(c_{lbt})$ is the broker’s utility from originating product j with lender l in market t as defined in Equation 5; $(1 - F_\kappa[\hat{\kappa}_i(\mathbf{c}_t)])$ is the households’ probability of choosing the brokerage channel (which is a function of commission payments for all brokers in market t). Similarly, the ex-ante expected profits to lender l in market t , conditional on commissions and network structure N_{lt} , are:

$$\begin{aligned} \Pi_t^l(\mathbf{c}_{lt}, N_{lt}) = \sum_{i \in I_t} \left(\underbrace{F_\kappa[\hat{\kappa}_i(\mathbf{c}_t)] \sum_{j \in J_{it}} (s_{ijlt} * \Pi_{jt}^D)}_{\text{Revenue from Direct Sales}} \right. \\ \left. + \underbrace{[1 - F_\kappa[\hat{\kappa}_i(\mathbf{c}_t)]] \sum_{j \in J_{it}} \sum_{b \in N_{it}} (\pi_{b(i)t} * s_{b(i)jt} * \Pi_{jt}^b)}_{\text{Revenue from Broker Sales}} \right), \end{aligned} \quad (13)$$

²⁵Recently, [Collard-Wexler et al. \(2019\)](#) have provided a non-cooperative foundation for this bargaining solution based on Rubinstein’s model of alternating offer bargaining.

where \mathbf{c}_t is a vector with all commissions in market t ; \mathbf{c}_{lt} is a vector with all commissions paid by lender l in market t ; and lender profits Π_{jt}^D and Π_{jt}^b are defined by Equations (7) and (8), respectively.

Brokers and lenders' ex-ante expected profits in the Nash bargaining model determine the agreement and disagreement payoffs. Using Equations (12) and (9), the exponentiated product of the net payoffs from agreement is:

$$\begin{aligned}
NP_t^{lb}(\mathbf{c}_{lt}|\mathbf{c}_{-lt}) &= \underbrace{[\Pi_t^l(\mathbf{c}_{lt}|\mathbf{c}_{-lt}) - \Pi_t^l(0|\mathbf{c}_{-lt})]}_{\text{Gains from trade for lender } l}]^{\beta_{lb}} \\
&\times \underbrace{[W_{bt}(\mathbf{c}_{lt}|\mathbf{c}_{-lt}; N_{bt}) - W_{bt}(0|\mathbf{c}_{-lt}; N_{bt} \setminus J_l)]}_{\text{Gains from trade for broker } b}]^{1-\beta_{lb}}, \tag{14}
\end{aligned}$$

where $\Pi_t^l(0|\mathbf{c}_{-lt})$ is lender disagreement payoff (i.e., payoffs from excluding broker b , but maintaining brokers with whom there is already an agreements); $W_{bt}(0|\mathbf{c}_{-lt}; N_{bt} \setminus J_l)$ is broker disagreement payoff (i.e., excluding all products from lender l from the network, but maintaining rest of lenders with already an agreement); and β_{lb} is the bargaining power of lender l when negotiating with broker b . Setting $\beta_{lb} = 0.5$ assumes symmetric Nash bargaining, and setting $\beta_{lb} = 0$ assumes Nash-Bertrand pricing behavior by lenders. Disagreement payoffs imply all commissions for broker b for the sale of all products from lender l are set to zero. That is, products for each lender are an indivisible block, meaning that if bargaining breaks down between a lender and a broker, the broker cannot originate any of the lender's products and the lender will not be part of the broker's network. Moreover, lenders face no capacity constraints. Hence, in the event of a disagreement between a lender and a broker, the broker can originate a mortgage with his ex-post second choice of lender without facing any restrictions on the lender's side.

The Nash bargaining solution is the commission vector \mathbf{c}_t^* that maximizes Equation (14) for each Nash bargaining contract, conditioning on the outcomes of all other contracts. Therefore, each \mathbf{c}_{lt}^* in \mathbf{c}_t^* solves the following maximization problem:

$$\max_{\mathbf{c}_{lt}} NP_t^{lb}(\mathbf{c}_{lt}|\mathbf{c}_{-lt}^*) \text{ such that}$$

$$(1) \Pi_t^l(\mathbf{c}_{lt}|\mathbf{c}_{-lt}^*; N_{lt}) - \Pi_t^l(0|\mathbf{c}_{-lt}^*; N_{lt} \setminus b) \geq 0 \text{ (Lender Participation Constraint)}$$

$$(2) W_{bt}(\mathbf{c}_{lt}|\mathbf{c}_{-lt}^*; N_{bt}) - W_{bt}(0|\mathbf{c}_{-lt}^*; N_{bt} \setminus J_l) \geq 0 \text{ (Broker Participation Constraint)},$$

where \mathbf{c}_{-lt}^* is the equilibrium commission vector, excluding the commission of the lender-broker pair in the negotiation. Participation constraints (1) and (2) need to be imposed because an agreement is not mandatory and either broker or lender can unilaterally walk

away. Expanding the participation constraint of lender l dealing with broker b , I get:

$$\begin{aligned}
\Delta \Pi_t^l(c_{lbt} | \mathbf{c}_{-lbt}^*) &= \sum_{i \in I_t} \left[\underbrace{\left(1 - F_\kappa[\hat{\kappa}_{it}(c_{lbt} | \mathbf{c}_{-lbt}^*)]\right) \sum_{j \in J_{lt}} \pi_{b(i)t} s_{b(i)jlt}(c_{lbt} | \mathbf{c}_{-lbt}^*) \Pi_{ijt}^b(c_{lbt})}_{\text{Expected profits from dealing with broker } b} \right. \\
&+ \underbrace{\left(F_\kappa[\hat{\kappa}_{im}(c_{lbt} | \mathbf{c}_{-lbt}^*)] - F_\kappa[\hat{\kappa}_{it}(0 | \mathbf{c}_{-lbt}^*)]\right)}_{\text{Change in sales channel choices}} * \\
&* \underbrace{\sum_{j \in J_{lm}} \left(s_{ijlt} \Pi_{ijt}^D - \sum_{b' \neq b} \pi_{b'(i)t} s_{b'(i)jlt}(\mathbf{c}_{-lbt}^*) \Pi_{ijt}^{b'}(\mathbf{c}_{-lbt}^*)\right)}_{\text{Gains/losses from other sales channels}} \left. \right] \\
&\geq 0.
\end{aligned} \tag{15}$$

Equation (15) implies that, for the lender's participation constraint to be non-binding, commission payments need to be below a certain threshold, \bar{c}_{lbt} . Similarly, I can expand the participation constraint of broker b dealing with lender l :

$$\begin{aligned}
\Delta W_{bt}(c_{lbt} | \mathbf{c}_{-lbt}^*) &= \sum_{i \in I_t} \pi_{b(i)t} \left[\underbrace{\left(1 - F_\kappa[\hat{\kappa}_{im}(c_{lbt} | \mathbf{c}_{-lbt}^*)]\right) \sum_{j \in J_{lt}} s_{b(i)jlt}(c_{lbt} | \mathbf{c}_{-lbt}^*) W_{b(i)jt}(c_{lbt})}_{\text{Profits from selling products from lender } l} \right. \\
&+ \underbrace{\left(1 - F_\kappa[\hat{\kappa}_{it}(c_{lbt} | \mathbf{c}_{-lbt}^*)]\right) \sum_{\substack{k \notin J_{lt} \\ l' \neq l}} s_{b(i)kl't}(c_{lbt} | \mathbf{c}_{-lbt}^*) W_{b(i)jt}(c_{l't})}_{\text{Gains/losses from other product sales + changes in sales channel choices}} \\
&- \underbrace{\left(1 - F_\kappa[\hat{\kappa}_{it}(0 | \mathbf{c}_{-lbt}^*)]\right) \sum_{\substack{k \notin J_{lt} \\ l' \neq l}} s_{b(i)kl't}(0 | \mathbf{c}_{-lbt}^*) W_{b(i)jt}(c_{l't})}_{\text{Gains/losses from other product sales + changes in sales channel choices}} \left. \right] \\
&\geq 0.
\end{aligned} \tag{16}$$

Equation (16) shows that for the broker's participation constraint to be non-binding, commission payments need to be above a certain threshold, \underline{c}_{lbt} . Therefore, for a broker and a lender to begin negotiations, the maximum commission a lender is willing to pay must be higher than the minimum commission a broker is willing to accept, that is, $\bar{c}_{lbt} > \underline{c}_{lbt}$. Both lenders and brokers may have incentives to not reach an agreement. A lender's decision

to reach an agreement with a broker depends on downstream competition between brokerage services and the lender’s in-house distribution channels. A lender may prefer to exclude brokers operating in areas where it has an extensive branch network and its outside option (i.e., direct sales) is much higher. On the other hand, a broker may prefer to exclude a lender from her network if the profits she gets from selling other products is sufficiently larger. The intuition is that when jointly agreeing on a mortgage product with households, brokers need to split the surplus (as given by Equation 5). If the broker has limited bargaining power (i.e., θ_b is very low), the household’s utility dominates the broker’s utility, and mortgage choices for the pair are driven by households’ preferences. However, if brokers refrain from including low-commission lenders in their networks, households’ will be forced to choose among choice sets that are beneficial for brokers. Thus, brokers might be better off with narrow networks of providers. The downside is that households will anticipate a more limited choice set and may decide to switch to direct sales instead. The latter effect may be small for some lenders, causing brokers to exclude them from their network if their commission is not sufficiently high.

Given each pair’s maximization problem, three outcomes are possible in terms of agreement and optimal commission. First, if $\bar{c}_{lbt} < \underline{c}_{lbt}$, no agreement is reached and the broker is not allowed to originate mortgages with that lender. Second, if, on the other hand, $\bar{c}_{lbt} \geq \underline{c}_{lbt}$ and both participation constraints are not binding, each pair chooses an optimal commission rate, c_{lbt}^* , such that the first derivatives with respect to commission payments are equal to zero, $\partial \log(NP_t^{lb}) / \partial c_{lbt} = 0$. Finally, if at least one of the participation constraints is binding, the optimal commission is either \bar{c}_{lbt} or \underline{c}_{lbt} .

5 Estimation and Identification

5.1 Demand

5.1.1 Household Preference Parameters

I assume demand taste shocks ε_{ijlm} and $\epsilon_{b(i)jlm}$ in the indirect utilities are identically and independently distributed across households, products, and lenders with a type I extreme value distribution. Conditional on going through the direct channel, the probability of household i choosing product j from lender l in market t is:

$$s_{ijlt} \equiv Pr(jl \text{ chosen} | C_{it}) = \frac{\exp(\bar{V}_{ijlt})}{\sum_{ks \in C_{it}} \exp(\bar{V}_{ikst})}, \quad (17)$$

where \bar{V}_{ijlt} is household indirect utility in Equation 3 excluding the error term ε_{ijlt} ; and C_{it} is the available choice set of household i in market t . If household i hires broker b , the

probability of choosing product j from lender l in market t is:

$$s_{b(i)jlt} \equiv \Pr(jl \text{ chosen} \mid C_{b(i)t}) = \frac{\exp(\bar{V}_{b(i)jlt})}{\sum_{ks \in C_{b(i)t}} \exp(\bar{V}_{b(i)kst})}, \quad (18)$$

where $\bar{V}_{b(i)jlt}$ is broker-household indirect utility in Equation 5 without the error term $\epsilon_{b(i)jlt}$; and $C_{b(i)t}$ is the available choice set of broker-household $b(i)$ in market t . Given these choice probabilities, the log-likelihood for direct and intermediated channels is:

$$\ln(L_i \mid \eta_i, \delta_{jlt}^G, \delta_{btl}) = \sum_{jl \in C_i} \mathbb{1}_{ijlt} \left(\mathbb{1}_i^D \ln(s_{ijlt}) + \sum_{b \in B_t} \mathbb{1}_i^b \ln(s_{b(i)jlt}) \right), \quad (19)$$

where η_i is a vector of all demand parameters, $\mathbb{1}_{ijlt}$ is a dummy equal to one if household i buys product j from lender l in market t , $\mathbb{1}_i^D$ is a dummy equal to one if household i chooses the direct channel, and $\mathbb{1}_i^b$ is a dummy equal to one if household i hires broker b . Each choice probability includes (1) product-lender-market-income-region fixed effects, δ_{jlt}^G , to account for product mean utility in an income-region group G (i.e., the part of utility obtained from product j from lender l in market t that is common across all households i in group G); and (2) broker-lender-market fixed effects, δ_{btl} , to control for broker-lender mean utility (i.e., the part of the utility obtained from originating a product with lender l that is common across all households going to broker b in market t). Households belong to groups, G , based on their income quartile q , region g , and market t .

Choice Set Construction.— One of the limitations of having transaction data is that households' choice sets are unobserved.²⁶ To identify preference parameters, I use lenders' affordability criteria to create a household-specific counterfactual choice set depending on their observable characteristics. First, I divide households into groups based on geographical regions and year-quarter. I assume households in each group can access all products sold in that region during that quarter, but not those sold in other regions or other quarters. The geographical restriction affects mostly building societies and smaller banks, because they often have limited coverage. The time restriction is needed to account for the entry and exit of products. Next, I consider all households that purchased a given product and select those with the lowest credit score, the highest loan-to-income ratio, and the highest age. I carry out this process for every product. I then assume a household will not qualify for that product if it has (1) a lower credit score, (2) a larger loan-to-income ratio, or (3) it is older than any of the cut-off values. The rationale for these restrictions is based on lenders' most common set of affordability criteria, which rely on credit scores, loan-to-income, and age

²⁶Preference parameters can be biased if I include products that are not in households' choice sets (Goeree 2008) and consideration sets (Honka et al. 2017).

(i.e., it is a supply-side driven choice set). Finally, for households hiring a broker, I further restrict the choice set of the household-broker pair to products sold by lenders with whom the broker has reached an agreement at the bargaining stage. As the outside option for all households and broker-household pairs, I group mortgages offered by other small lenders with market shares below 0.2% as the representative outside products ($j = 0$).²⁷

Identification.— After constructing choice sets for each household, I estimate demand parameters in the log-likelihood in Equation 19. To identify household and broker preferences over product characteristics, I use a two-step instrumental variables approach to explicitly account for possible correlations between (1) interest rates, r_{jlt} , and unobservable product characteristics, ξ_{jlt} ; and (2) commissions, c_{lbt} , and unobservable broker-lender relationships varying over time (ζ_{lbt}). In a first step, I maximize the log-likelihood and recover estimates for household preferences over branches (λ), broker preferences over product characteristics other than commissions (γ_2), product-lender-market-group fixed effects (δ_{jlt}^G), and broker-lender-market fixed effects (δ_{lbt}). Broker and household preferences are separately identified as long as household preference parameters for product characteristics remain constant across sales channels. That is, brokers cannot distort household preferences over product characteristics. Preferences on bank branches are identified as long as households value nearby branches only when originating their mortgage directly through lenders. That is, for households going through brokers, branches do not play a role.

In a second step, I regress the estimated product-lender-market fixed effects ($\hat{\delta}_{jlt}^G$) on interest rates and product characteristics:

$$\hat{\delta}_{jlt}^G = [\alpha^G r_{jlt} + \psi_1^G \text{High LTV} + \psi_2^G \text{Two-Year Fixed}] \times \mathbb{1}[i = \text{Income-Region } G] + \text{Lender FE} + \text{Market FE} + \varepsilon_{ijlt}, \quad (20)$$

where *High LTV* is a dummy equal to one if LTV is 85% or higher. Because interest rates are potentially correlated with unobservable product characteristics included in the error term, I use an instrumental variable approach in order to get consistent estimates of demand parameters α^G , ψ_1^G , and ψ_2^G . In particular, I use two cost shifters as instruments for the interest rate. I use risk weights associated with capital requirements, which vary across time, lender, and loan-to-value bands. I also use the rate for euro interest rate swaps for two, three, and five years. Swap rates vary across time and type, and are a hedging instrument lenders use when selling mortgages with fixed periods of two, three, and five years, respectively. Both instruments allow me to exploit variation across markets, lenders and products. For identification, I am assuming these instruments are uncorrelated with unobserved product

²⁷This approach is similar to Egan et al. (2017) and Benetton (2018), where the outside good is an aggregate of products from banks outside the largest ones.

characteristics once I control for lender and market fixed effects.

Moreover, I regress the estimated broker-lender-market fixed effects ($\hat{\delta}_{lbm}$) on commissions and broker dummies:

$$\hat{\delta}_{lbt} = \sum_b \mathbb{1}[i = \text{Broker } b] \left(\frac{\theta_b}{1 - \theta_b} \gamma_1 c_{lbt} \right) + \mu_{bt} + \phi_{lt} + \nu_{bl} + \varepsilon_{lbt}, \quad (21)$$

where $\mathbb{1}[i = \text{Broker } b]$ is a dummy equal to one for broker b . I normalize γ_1 to one, and absorb a rich set of fixed effects captured by μ_{bt} , ϕ_{lt} , and ν_{bl} . As a robustness check and in order to control for possible correlations between the broker-lender-market commissions and unobservable (to the econometrician) broker-lender-market relationships that might affect brokers' choices, I use supply-shifters instrumental variables. I use as cost shifters for lenders and brokers the business rates (taxes) in counties where the lender has its headquarters and the broker has its principal place of business. This instrument exploits variation across markets, lenders, and brokers. For identification, I assume these instruments are uncorrelated with unobserved time-varying broker and lender characteristics once I control for lender, broker, and market fixed effects.

5.1.2 Household Shopping Costs Distribution

Household i in group G knows the average ex-ante expected maximum utility that households in the same group get from each sales channel.²⁸ These ex-ante expected utilities can be computed using the choice probabilities in Equation 4 for both direct and intermediated sales. Let $\hat{\kappa}_G$ be the shopping cost that makes household i in group G indifferent between both sales channels. This indifference cut-off value is:

$$\underbrace{\left(\sum_{i \in G} E[\max_{jl} V_{ijlt}(\eta) | \text{Direct}] \right)}_{\text{Direct Channel}} - \hat{\kappa}_G = \sum_{b \in G} \pi_{b(G)t} \underbrace{\sum_{i \in G} \left(E[\max_{jl} V_{b(i)jlt}(\eta) | b] - \alpha_G f_{Gbt} \right)}_{\text{Broker Channel}}, \quad (22)$$

where η is a vector of all preferences parameters estimated in the mortgage choice problem; $E[\max_{jl} V_{ijlt}(\eta) | \text{Direct}]$ and $E[\max_{jl} V_{b(i)jlt}(\eta) | b]$ are the ex-ante expected household utilities of household i in group G going directly to the lender and hiring broker b , respectively;

²⁸Recent consumer surveys at the Financial Conduct Authority have shown that 67% of borrowers only consulted one broker when originating their mortgage. In another survey for UK financial products, [Finney & Kempson \(2008\)](#) find most consumers only consulted at most one source of information before making a purchase. [Chater et al. \(2010\)](#) reach a similar conclusion after studying several European countries. Moreover, the FCA's Financial Lives Survey 2017 indicates 23% of borrowers chose their broker because a real estate agent recommended it and 29% because it was recommended by a friend or relative. This indicates that this referral is influential for some consumers. Given households' limited search for a broker and the importance of referrals, the assumption that households only know the average utility similar households got when choosing the brokerage channel seems reasonable.

$\pi_{b(G)t}$ is the probability that a household in group G is matched to broker b ; and f_{Gbt} is the broker fee paid by households in group G when hiring broker b . This indifference condition in Equation 22 implies that, if household i in group G has a shopping cost κ_i that is greater than $\hat{\kappa}_G$, the household decides to hire a broker. Similarly, if the household has a shopping cost κ_i smaller than $\hat{\kappa}_G$, the household chooses the direct sales channel and shops for a mortgage across lenders' in-house distribution channels.

Using Equation 22 and the preference parameters estimated in the previous section, I can estimate the mean and standard deviation of the shopping cost distribution across groups. First, I calculate for each household the average expected ex-ante utility that it will receive from each sales channel. For the direct channel, following Small & Rosen (1981), household i will get an ex-ante expected maximum utility equal to:

$$E\left[\max_{jl} V_{ijlt}(\hat{\eta}) | Direct\right] = \ln \left[\sum_{ks \in J_{it}} \exp(V_{ijlt}(\hat{\eta}, Direct)) \right], \quad (23)$$

where $\hat{\eta}$ is the vector of demand-preference parameters estimated in the previous subsection.

For broker sales, each broker-household pair maximizes the joint utility in Equation 5. Therefore, I need to split the ex-ante expected maximum utility of the pair into that of the broker and that of the household. To do so, I first simulate draws from the distribution of the household's error term for each product assuming a type I extreme value distribution. For each draw, I compute the utility of the broker-household pair for each product in the pair's choice set and select the product that gives the pair the highest utility. I then compute the household's utility for that choice. Finally, I take the average of the maximum household utilities across draws, which will give me a numerical approximation of the household's expected ex-ante utility from that broker.

After computing all ex-ante expected maximum utilities for all channels and all income-region groups, I can rewrite equation 22 as:

$$\hat{U}_G^{Direct} - \hat{\kappa}_G = \hat{U}_G^{Broker}, \quad (24)$$

where \hat{U}_G^{Direct} is the estimated expected maximum indirect utility of going direct, and \hat{U}_G^{Broker} is estimated average expected net maximum indirect utility of choosing the broker channel (after subtracting broker fees and multiplying by the probability of being paired with that particular broker). The probability of household i in group G chooses the direct channel depend on whether its shopping cost κ_i is smaller than $\hat{\kappa}_G$, as determined by Equation 24. I assume that search costs κ follow a normal distribution with mean μ and standard deviation

σ . Therefore, the log-likelihood function is:

$$\text{Ln} [L(\mu, \sigma^2; y_i, \hat{\kappa}_G)] = \sum_i \ln \left(\left[F(\hat{\kappa}_G | \mu, \sigma^2) \right]^{y_i} \left[1 - F(\hat{\kappa}_G | \mu, \sigma^2) \right]^{1-y_i} \right), \quad (25)$$

where $F(\cdot)$ is the cdf of κ , and y_i is a dummy variable equal to one if the household chose to go directly to the lender, and zero if it hired a broker.

Identification.— Identification of the search cost distribution parameters, μ and σ , comes from variation in consumer choices and their expected utilities.

5.2 Supply

5.2.1 Lender Marginal Costs

The estimation of lenders' marginal costs is based on the optimal pricing formula derived in Section 4.3.1. Using the estimated preference parameters and cut-off search costs, I can back out from equation 11 the average effective marginal costs (AMC_{jt}), which are a weighted average of the marginal costs from direct and intermediated sales. I then assume that marginal costs from intermediated sales are a function of product characteristics, whereas marginal costs from direct sales are the same as those of intermediated sales plus a premium. I regress the estimated average marginal costs on product characteristics (weighted) and normalized commission rates. I obtain a two-step estimator of the cost parameters at the product level with the following linear specification:

$$AMC_{jt} = \varphi_1 X_{jt} \rho_{jt}^D + \varphi_2 X_{jt} \sum_{b=1}^B \pi_{bt} \rho_{jt}^b + \varphi_3 \sum_{b=1}^B \frac{c_{lb}}{t_j} \pi_{bt} \rho_{jt}^b + \tau_t + \varepsilon_{jt}, \quad (26)$$

where AMC_{jt} is the average marginal costs; X_{jt} are the same product characteristics that affect borrower demand (loan-to-value band, initial period and lender); ρ_{jt}^D and ρ_{jt}^B are weights defined in equations 23 and 23 respectively; c_{lb} are commission payments; t_j is the initial period; τ_t are market fixed effects; and ε_{jt} is a structural error capturing unobservable variables that might affect average marginal costs (e.g., screening, advertising). This two-step estimation allows be to differentiate between the marginal costs of direct and intermediated sales.

Identification.— I recover effective average marginal costs by inverting lenders' optimal first-order conditions. Then, to separately identify direct and intermediated marginal costs, I exploit variation across product choice probabilities conditional on sales channels and changes in household choices of direct versus intermediated channels. I also require that,

for intermediated sales, the lender has to pay an additional commission to brokers. Finally, to address any concern about endogeneity in ρ_{jt}^D and ρ_{jt}^b due to omitted variable bias, I use product characteristics and ρ values of other lenders as an instrument for a lender’s own product characteristics and ρ values.

5.2.2 Broker-Lender Bargaining Parameters

The bargaining parameters depend on the protocol of the bargaining game and the gains from trade of both lenders and brokers, as defined in section 4.3.2. Given estimates for demand preferences, household search costs, and marginal costs, I can compute both agreement and disagreement payoffs as described in the model for all broker-lender pairs for which I observe an agreement in equilibrium. I choose the values of β_{bl} that minimize the distance between observed equilibrium commissions and the estimated optimal commissions from the model, as determined by the first-order conditions in the bargaining game.

Identification.— For each broker-lender pair, I invert the first-order conditions in each pair’s bargaining problem. At this stage, the only unknowns are the bargaining parameters. To identify them separately from the outside options, I exploit geographical and time variation in lenders’ branch networks. These sources of variation will affect lenders’ and brokers’ outside options, but not their bargaining parameters. Moreover, I use the timing of negotiations. Demand realizations and changes in branch networks happen more frequently than commission renegotiations. This provides an additional source of variation to identify bargaining parameters separately from changes in outside options. Finally, I also use cross-sectional variation on commission payments across lenders and brokers, as well as time variation (commissions are renegotiated at least once during my sample period).

6 Estimation Results

6.1 Demand Parameters: Preferences and Search Costs

For estimating the demand parameters described in subsection 5.1, I use a 25% random sample as a training sample, and then use the remaining 75% of the data for cross-validation. Panel A in Table 5 reports the estimated demand parameters of the households’ mortgage choice problem for the 25% random sample.

The average point estimate of the coefficient on interest rates across all income-region groups is significant and equal to -0.91, implying borrowers dislike more expensive mortgages. The corresponding average own-product demand elasticity is equal to 3.34, and the cross-product demand elasticity equals 0.02. That is, on average, a 1% increase in the interest rate decreases the market share of the mortgage by 3%, whereas the shares of other mortgages

increase by 0.02%. I also find that first-time-buyers value more mortgages with higher leverage (ψ_1) and longer initial fixed periods (ψ_2). This type of borrower is often credit constrained, and a higher loan-to-value allows for lower down-payments. Longer fixed periods minimize switching costs involved in refinancing, as well as interest rate risk. Borrowers also value the fraction of branches in nearby postcodes when purchasing the mortgage directly from lenders. This effect disappears when borrowers originate the mortgage through a broker.

Panel A in Table 5 also presents estimates for brokers' distortions to households' choices (brokers' downstream market power). The average distortion is equal to 0.37, as captured by parameter θ . Figure 2 shows the distribution of θ across broker companies, with values ranging between 0.28 and 0.45. Although brokers are heterogeneous in their influence on borrowers, I can reject the null hypothesis of benevolent brokers (θ equal to zero) at a 5% significance level for all broker companies. In addition, brokers seem to have a preference for products with higher leverage ($\bar{\gamma}_{21}$) and shorter initial fixed periods ($\bar{\gamma}_{22}$). This preference is not surprising given the financial incentives brokers face. As already described in section 3, brokers get fees and commission payments every time households remortgage. Thus, making this event happen as often as possible is in their best interest. Considering that the commission payment is a percentage of the loan amount, brokers can nudge households towards higher loan-to-value products. Results also show evidence of lender geographical market power. The estimate for household preferences for bank branches (λ) is positive and significant. Moreover, it is 30% of the size of the average estimate for interest rates, implying households going directly to lenders have a strong preference for nearby branches.

In terms of the fit of the model, Figure B.1 compares the distribution of estimated and observed market shares for both training and cross-validation samples. The model fits the out-of-sample data quite well, both in terms of mean and variance. The fit is also good when accounting for product characteristics, namely, lender, initial period, and loan-to-value band. Figure B.2 plots estimated and observed market shares across these dimensions. The main limitation is that the model over-predicts the share of shorter initial period mortgages and has a higher variance for products with loan-to-value bands above 85%.

Panel B in Table 5 presents estimates for the mean and standard deviation of borrowers' search cost distributions across income-region groups, as described in section 5.1.2. I use the entire sample to estimate these parameters. I find the average search cost for all first-time-buyers is equal to 3.3, with a variance of 0.5. Panel A in Figure C.1 shows how borrowers in London have a lower average search cost than those in other regions in the UK. Similarly, Panel B in Figure C.1 shows that average search costs increase with income, while the variance decreases.

6.2 Supply Parameters: Marginal Costs and Bargaining

The first column of Table 6 presents average estimates for marginal costs. The average marginal cost is 1.82 percentage points. Small banks have higher average marginal costs, resulting partly from higher capital requirements (Benetton 2018). Mortgages with longer initial deals and higher loan-to-values are also more expensive on average. The second and third columns of Table 6 differentiate between average marginal costs for direct and intermediated sales, with intermediated sales being, on average, 7% less costly to originate than direct sales. Figure D.1 plots marginal cost distributions for both origination channels, illustrating the lower mean and higher variance of broker sales' marginal costs.

This differential in marginal costs across sales channels is higher for the Big Six, for whom intermediated sales are 12% cheaper. Challenger banks face similar marginal costs, regardless of sales channel, whereas both small banks and building societies find it more costly to originate mortgages through intermediaries rather than through in-house distribution channels. This heterogeneity can be partly driven by the Big Six having intermediary-only online platforms that facilitate the application process and take advantage of economies of scale, which can ultimately reduce the cost of originations via brokers, for example, through quicker income verification. Intermediated sales also have a lower marginal cost for low loan-to-value products.

Given marginal costs, I compute average mark-ups and find average mark-up is 22%, which is close to the range that other papers studying the UK mortgage market have reported (see, e.g., Benetton 2018). Table 7 shows the existing variation in mark-ups across lender types and other product characteristics. Most importantly, once I differentiate between mark-ups for direct and intermediated sales (accounting for commission payments), intermediated sales are estimated to be 37% less profitable for lenders than their in-house direct sales. This finding holds for all lenders and all product types, implying that brokers have some market power when negotiating with lenders and are able to extract surplus from lenders given borrowers' preferences for the brokerage channel.

Finally, given demand and cost estimates, Table 8 reports my estimates for bargaining parameters, as described in section 5.2.2. Higher values indicate relatively more bargaining power for lenders. Bargaining parameters are heterogeneous and range between 0.19 and 0.72. These values reject the hypothesis of take-it-or-leave-it offers, because bargaining parameters are neither one, which would imply lenders choose mutually agreeable commissions that make brokers' participation constraints binding, nor zero, which would imply brokers offer commissions that make lenders' participation constraints binding. I find that large brokers have a 50% lower bargaining power when facing the Big Six and building societies than when negotiating with challengers and small banks. Small brokers, on the other hand, are able to equally split the surplus when negotiating with all types of lenders. Among lenders, the

Big Six have a bargaining power of 0.72 when dealing with large brokers, but that situation is reversed when negotiating with small brokers. The same happens to building societies. Challengers, however, only have a bargaining power of 0.28 when facing large brokers, but are able to extract 50% of the surplus against small brokers. Similarly, small banks have a higher bargaining parameter in negotiations with small brokers.

7 Counterfactual Scenarios

In this section, I use the estimates from the model to simulate two sets of counterfactual scenarios. The first set of counterfactual policies restricts the channels through which households can originate a mortgage. First, I consider a policy banning broker services in this market. Next, I implement a ban on direct sales, that is, I make brokers' advice mandatory. In the second set of policy counterfactuals, I consider equilibrium effects from restricting commission payments. from a complete ban to different caps. In all simulations, I make assumptions consistent with a short-run analysis. I assume lenders do not change their available products and that no entry or exit occur in the market. Lenders also do not modify their branch network. I also impose that preferences remain invariant and that lenders' marginal costs are not affected by the policy change. I recognize that some of the assumptions underlying the results in the simulations are strong, but they are necessary to produce policy counterfactuals in this setting.

7.1 Restrictions on Broker Services and Direct Sales

First, I simulate an equilibrium without any brokerage services. Column (1) in Table 9 reports estimates of a counterfactual in which households can only originate their mortgages via lenders' in-house distribution channels. In this scenario, competition decreases with the Herfindahl-Hirschman Index increasing by 35%. Prices go up by almost 25%, and lender profits increase by 12% (even more for the large lenders). Household search costs increase by more than 150%. Larger search costs and higher prices result in consumer surplus decreasing by 51%. This large fall in consumer welfare suggests that the positive roles of brokers (lower search costs and more upstream competition) dominate the negative ones, and households are better off having these intermediaries in the market despite their distorted incentives.

Next, I consider an equilibrium with mandatory brokers' advices (i.e., without any direct sales). Column (2) in Table 9 shows estimates of a counterfactual scenario banning direct sales and making expert advice from brokers mandatory. In this simulation, lenders with extensive branch networks lose their local market power (due to household preferences for nearby branches). Competition increases with the Herfindahl-Hirschman Index falling by 27% and the share of the Big Six decreasing by 17%. Moreover, marginal costs go down by

12%, because now all sales are done via brokers (which are more efficient). However, brokers are able to extract most of this gain in efficiency by increasing their commission rates by 42%. This change is driven by a drastic fall in outside options for the Big Six. Overall, lender profits decrease by 20% and prices increase by 9%. The net effect on consumer surplus is a decrease of 6%.

To generate estimates in Column (2), I make two assumptions that might change in the long-run and could affect the overall effect on consumer surplus. First, I assume no entry in the broker market. Given the increase in broker revenues due to higher commissions, it seems reasonable to expect some entry in this market. More brokers would result in lower commissions for banks and, most likely, lower prices for households. This effect will increase consumer surplus. The second assumption is that broker fees to households remain constant. However, if brokers also increased their fees to households, consumer surplus would decrease. The magnitude of this additional fall will depend on the level of competition among brokers, which I do not model. Thus, Column (2) is a lower bound on the losses.

Overall, banning either broker sales or direct sales will decrease consumer welfare in the short-run. These results suggest that consumers are better off with the baseline model in which there is competition among brokers and branches.

7.2 Restrictions on Commission Rates

Reduced-form evidence in Section 3 suggests brokers react to supply-side incentives. Estimates for brokers' distortion parameters θ_b in Section 6 also reject the hypothesis of benevolent brokers, indicating brokers' choices respond to commission payments. To align households' and brokers' incentives, regulators have imposed restrictions on upstream payments to intermediaries. To address the effects of such policies, I use the estimated model to explore the equilibrium impact of changes in commission rates.

First, I consider equilibrium effects of imposing a ban on commission payments between brokers and lenders. In this counterfactual, I assume broker fees to households' increase such that the average per-sale profit each broker company receives is the same as in the estimated baseline model.²⁹ In Appendix D, I run the same policy counterfactual but make alternative assumptions on broker pass-through. I obtain qualitatively similar results for different increases in broker downstream fees.

Column (3) in Table 9 shows results when implementing a ban on commissions given the assumptions mentioned above. This policy proves to be detrimental for consumers. Market concentration and prices go up, as well as marginal costs and search costs. Consumer surplus

²⁹I need to make an assumption on broker pass-through since my model does not endogenize broker fees to households. Since most broker companies in the baseline charge zero fees, it would be unrealistic not to change fees in the counterfactual. Broker companies need to make money, and, if lenders no longer make payments, it seems reasonable to assume household fees will go up.

falls by more than 25%, and profits for the Big Six increase by more than 27%. To illustrate the mechanism that seems to dominate in this equilibrium, consider a household with large search costs. In the baseline model, this household chooses the brokerage channel. However, because broker fees to households increase significantly in this counterfactual, this household now decides to originate its mortgage via lenders' in-house distribution channels. As shown in the estimated model by the coefficient on nearby branches λ , lenders' with extensive branch networks are able to get a higher market share from households going direct. When setting interest rates, the Big Six anticipate this increase in direct sales and increase prices, resulting in lower consumer surplus. Given the relevance of branches and other in-house distribution channels in the new equilibrium, challenger banks are likely to invest in their own channels in the long-run. In addition, some broker companies could be forced to exit the market given the decrease in their market share as a result of higher household fees. I do not capture these long-run equilibrium effects in my estimates.

An alternative policy to align households' and brokers' incentives is to impose a cap on commission payments. I assume this cap to be equal to the average commission in the baseline model (0.4% of the loan amount). This regulation allows brokers to still get some revenue from lenders, and therefore broker fees to households do not increase as much as in the case of a ban. This policy also has implications for the network of broker-lender pairs. For some pairs, their new optimal commission, c_{ibt}^* , as defined in Section 4.3.2, is below the cap, c_t^{cap} . For these cases, nothing changes and the link still holds. For other pairs, the cap violates the broker's participation constraint and the link is broken. Finally, for some pairs, the cap could be binding, and the link holds with an equilibrium commission equal to c_t^{cap} . Column (4) in Table 9 reports estimates for a regulation imposing a cap. Direct sales increase only by 30% and search costs only go up by 13% (both significantly less than in the case of a ban). Prices fall by 5%, and the overall impact on consumer surplus is positive, with an increase of almost 10%. These results are driven because, despite brokers having narrower networks of lenders and household broker fees going up, households that do hire brokers get, on average, a much better deal than in the baseline model.

Figure 3 plots the relationship between consumer surplus and different levels of caps on commissions. This non-monotonic relationship results from a trade-off between broker market power and lender local market power. Households originating their mortgages via brokers face broker market power in the sense that brokers can extract surplus from them (positive values of θ). On the other hand, households going directly to lenders prefer nearby branches. This preference gives lenders local market power, which they can exploit when setting interest rates. A very restrictive cap reduces broker market power at the expense of increasing lender market power. In the case of a ban, the gains of reducing broker market power do not compensate for the welfare loss of increasing lender market power.

The final set of policy counterfactuals considers cases in which, instead of capping

commission payments, the regulator fixes commissions to an homogeneous rate. This policy will have the following equilibrium effects. First, a different set of broker-lender links will break. As in the case of a cap, some agreements with higher rates in the baseline will no longer be in place. Additionally, some links with lower rates in the baseline will also no longer hold. Therefore, broker networks will be significantly narrower than in the baseline. This effect will reduce household payoffs from going to brokers and will lead some households to shift to the direct channel (decreasing lender competition and increasing prices). The second equilibrium effect of this policy is that household and broker incentives are more aligned than in the baseline. Household expected utility of going to the broker goes up and some households will shift to the broker channel. However, it is important to highlight that, even though heterogeneity of commissions across lenders no longer distorts brokers' advice, brokers still have their own incentives and these do not necessarily match those of the household. Theoretically, the overall effect of these policies is ambiguous.

Columns (5) and (6) in Table 9 report estimates for regulations fixing commission rates to 0.4% and 0.7%, respectively. Estimates in Column (5) have very similar averages to the baseline with no restrictions. Estimates in Column (6) result in a 11% lower consumer surplus, driven by a larger shift of households into the direct channel. Both policies affect selection into brokers and, consequently, which households are better and worse off because of the regulation. When commission rates are fixed at 0.7%, broker networks are mostly composed by challenger banks. Therefore, households whose payoffs are larger with these banks are more likely to go to brokers. However, these households also have, on average, lower search costs. In equilibrium, households with larger search costs but preferences for the Big Six go direct, while households with lower search costs but preferences for products by the challenger banks go to brokers. The Big Six are able to increase their prices and overall consumer surplus decreases by 11%. In the case where commission rates are set to 0.4%, the two equilibrium effects mentioned above counterbalance each other and the overall impact on consumer surplus is almost analogous to the baseline.

8 Conclusion

Regulations restricting upstream payments for expert advisors have been at the center of the academic and policy debate in many financial and healthcare markets. This paper contributes to this debate by providing a quantitative framework to understand the supply and demand effects through which these policies may impact consumers. The analysis focuses on the UK mortgage market, where brokers, acting as expert advisors, improve upstream competition among lenders and reduce household shopping costs. In this market, restrictions on commission payments help align households' and brokers' incentives. However, they also reduce upstream competition and efficiency. If the gains from reducing the agency

problem between households and brokers do not compensate for the losses generated by less competition upstream, restricting broker commissions may not benefit the average household. I conclude that policies restricting financial relationships between intermediaries and upstream firms should consider the market structure and supply-side equilibrium effects when evaluating the overall policy response.

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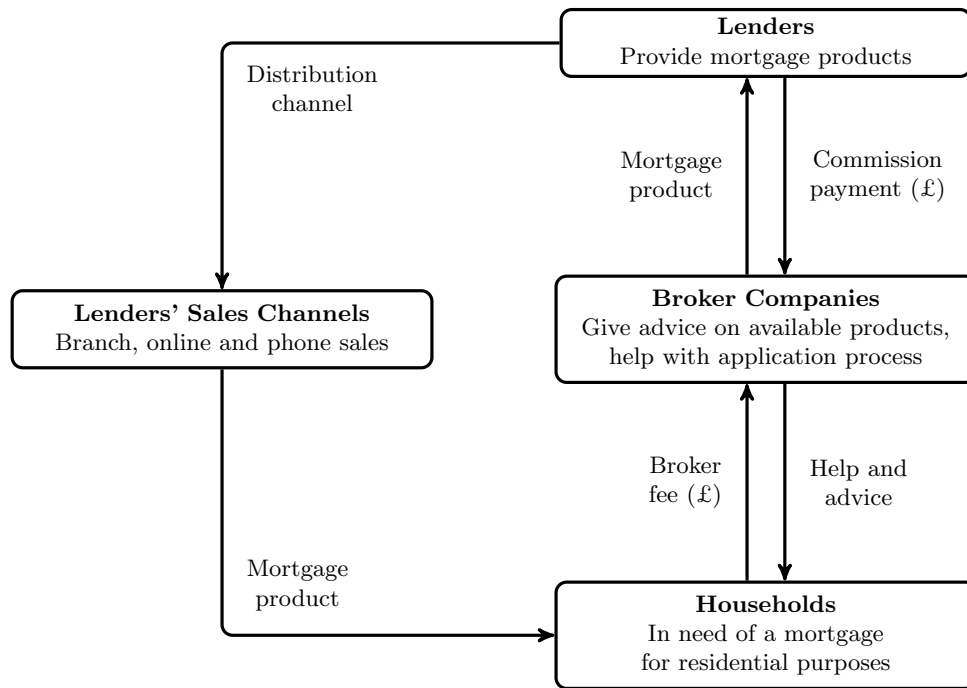
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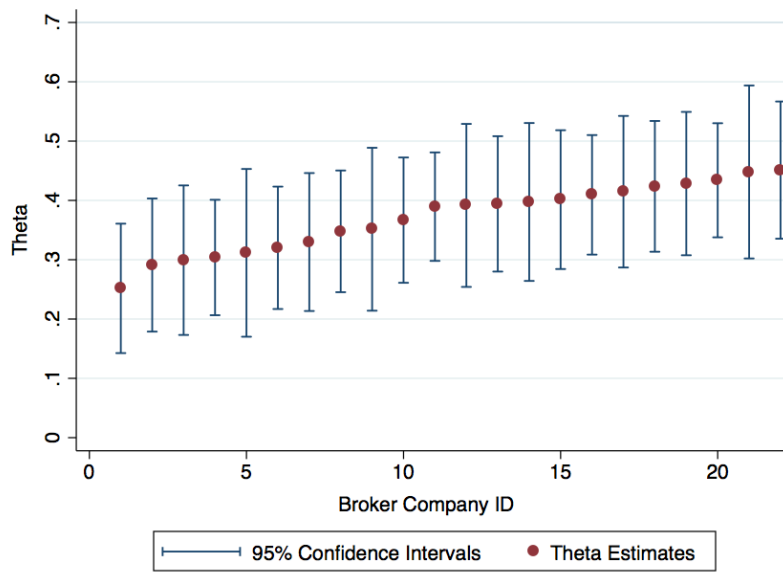
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Figure 1: Vertical and Horizontal Relations in the UK Mortgage Market



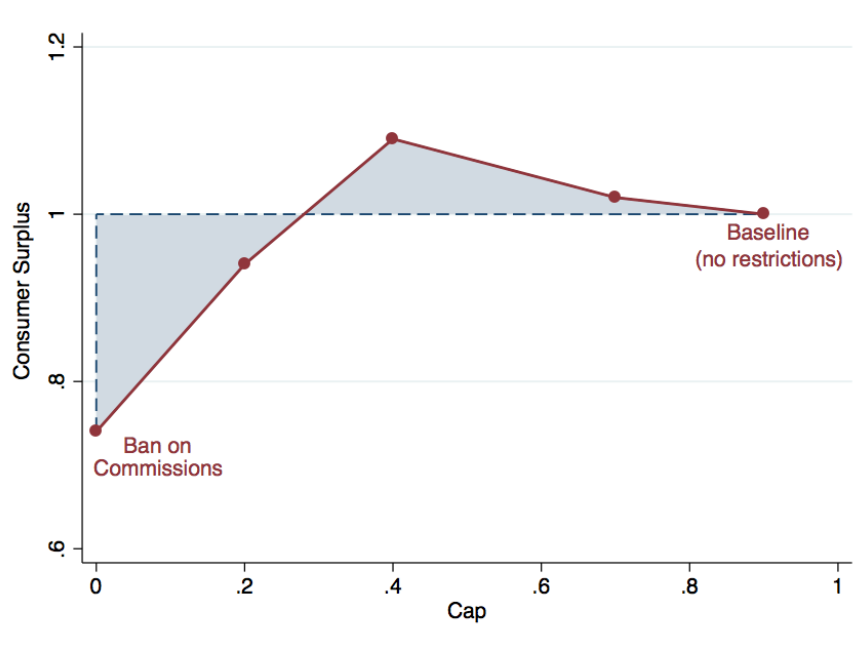
Note: This figure displays the main relations in the UK mortgage market between lenders, brokers and borrowers. Households in need of a mortgage can go directly to lenders' in-house distribution channels. Alternatively, they can pay a fee and hire a broker company to provide them with advice on available products and help them with all paperwork involved in the application and origination of the mortgage. For each sale, the broker also receives a commission payment from the lender. Broker companies can only originate mortgages with lenders with whom they have an agreement and are part of their network. The relationship between lenders and brokers is both vertical (brokers provide an alternative distribution channel for lenders to sell their products) and horizontal (brokers and lenders also compete in the downstream market).

Figure 2: Estimates for Broker Market Power



Note: The figure plots estimates of parameter θ_b for the largest 20 broker companies in the market and two aggregate categories for small and medium brokers. These parameters are obtained after regressing the estimated broker-lender-market fixed effects (δ_{blt}) on commission rates interacted with broker dummies. The regression also controls for market, broker and lender fixed effects. To account for concerns about endogeneity of commission rates, I use changes in business rates in the county of broker's headquarters as an instrumental variable for commissions (supply-side cost shifter). Standard errors are computed by block-bootstrapping.

Figure 3: Consumer Surplus and Restrictions on Commissions



Note: The figure plots changes in consumer surplus (relative to the baseline estimates with no regulation) as a function of cap on the maximum commission rate. Baseline and counterfactual consumer surplus is computed as defined in subsection 5.1.2. A cap equal to zero is equivalent to imposing a ban on commissions. A cap equal or greater than a 0.9% commission rate is not binding, that is, it is equivalent to having no restrictions on commissions. As the cap becomes more restrictive, consumer surplus first increases. Then, it hits an inflexion point (between a 0.6% and a 0.2% cap) and starts decreasing at a faster rate. The intuition is that, as the cap tightens, broker market power decreases and lender market power increases.

Table 1: Summary Statistics

	N	Mean	SD	Min	Max
Panel A: Loan Characteristics					
Interest Rate (%)	2,236,025	2.57	0.79	1.26	6.2
Lender Fee (£)	2,236,025	467	631	0	2405
Loan Value (£1000)	2,236,025	159	129	49	903
Loan-to-Value (%)	2,236,025	60	23	15	98
Maturity (Years)	2,236,025	25	8	2	45
Initial Period (Years)	2,236,025	3.22	2.4	1	10
Panel B: Borrower Characteristics					
First-Time-Buyers	2,236,025	0.19	0.39	0	1
Home-Movers	2,236,025	0.23	0.42	0	1
Internal Remortgagors	2,236,025	0.22	0.41	0	1
External Remortgagors	2,236,025	0.36	0.48	0	1
Gross Income (£1000)	1,506,724	62.13	48.2	10	523
Age (Years)	1,506,724	38	9.6	18	85
Loan-to-Income	1,506,724	3.12	1.2	1.3	5.2
Credit Score	984,471	482	66.3	250	765

Note: This table reports sample statistics (sample size, mean, standard deviation, and minimum and maximum values) for the PSD data. An observation is a prime mortgage originated in the UK between January 2015 and June 2016. The sample includes first-time buyers, home-movers and refinancing (both external and internal). Subprime mortgages are excluded from the sample.

Table 2: Summary Statistics for Broker Sales and Broker-Lender Agreements.

PANEL A: Intermediated sales and broker payments.

	All Borrowers	First-Time Buyers	Home Movers	Internal Remortgagors	External Remortgagors
Intermediated	46%	72%	64%	11%	63%
Commission (£)	723	661	845	708	543
Commission Rate (% loan)	0.41	0.42	0.41	0.41	0.37
Broker Fee (£)	141	167	164	3	129
N	2,236,025	426,958	510,833	797,430	500,804

PANEL B: Agreements between largest lenders and broker companies.

	Mean	SD	Min	Max
Number of Brokers per Lender	13	7	0	23
Number of Lenders per Broker	8	3	3	14

Note: This table reports summary statistics for FCA data on broker sales and remuneration for all UK mortgages originated between January 2015 and June 2016. Panel A summarizes the percentage of borrowers who originate their mortgage through a broker and the average per-sale commissions and fees brokers receive by lenders and households, respectively. Panel B reports data on all agreements between the largest 16 lenders and 23 broker companies. These brokers and lenders account for 87% of the market. When estimating the model, I will focus on these set of lenders and brokers.

Table 3: Product Market Shares and Commissions.

Dependent Variable: Product Market Share in Broker Sales (%)	All Borrowers (1)	Only FTBs (2)
Commission Rate (% loan)	0.163* (0.097)	0.271* (0.180)
Product-Time-County FE	Yes	Yes
Broker-Time-County FE	Yes	Yes
Broker-Lender-County FE	Yes	Yes
Observations	327,750	153,416
Adjusted R-squared	0.953	0.937
Average Dependent Variable (%)	0.53	0.47
Average Commission Rate (%)	0.40	0.41
Average Total Commission per Loan (£)	776	802

Note: The unit of observation is at the product-broker-month-county level. The dependent variable is the product market share in a broker's sales portfolio each month in a county. *Commission Rate* is the percentage of the loan amount paid by the lender to the broker for the sale of a product. Column (1) uses a sample with all borrowers, while Column (2) focuses on first-time buyers. Standard errors in parentheses are clustered at the broker and county levels, and (*) corresponds to a p-value lower than 0.1.

Table 4: Probability of Getting a Product from a Challenger Bank.

Dependent Variable: Challenger (0/1)	(1) All Borrowers (exc. Internal Remortgagors)	(2) First-Time-Buyers Only
Intermediated	0.0476*** (0.001)	0.0674*** (0.003)
Max. LTV Band FE	Yes	Yes
Fixed Period FE	Yes	Yes
County FE	Yes	Yes
Year-Month FE	Yes	Yes
Borrower Characteristics (income, age, credit score)	Yes	Yes
Observations	489,352	159,486
R-squared	0.24	0.33

Note: The unit of observation is at the household level. Dependent variable, *Challenger*, is a dummy equal to one if the borrower chose a mortgage from a challenger bank, and zero otherwise. *Intermediated* equals one if mortgage originated with a broker, and zero if originated directly with a lender. Robust standard errors in parentheses such that (***) corresponds to a p-value lower than 0.01.

Table 5: Demand Estimates

PANEL A: Household and Broker Preference Parameters

	Interest Rate Borrower (α)	High LTV Borrower (ψ_1)	2-Year Fixed Borrower (ψ_2)	Branches Direct (λ)	Commission Broker (θ)	High LTV Broker ($\bar{\gamma}_{21}$)	2-Year Fixed Broker ($\bar{\gamma}_{22}$)
Estimate	-0.91	0.45	-0.21	0.33	0.37	0.14	0.27
SE	0.39	0.10	0.07	0.09	0.11	0.02	0.08
N Likelihood	7,493,244	7,493,244	7,493,244	7,493,244	7,493,244	7,493,244	7,493,244
N Borrowers	91,137	91,137	91,137	91,137	91,137	91,137	91,137
N 2nd Stage	5,208	5,208	5,208	-	483	-	-
Lender FE	Yes	Yes	Yes	-	Yes	-	-
Market FE	Yes	Yes	Yes	-	Yes	-	-
Broker FE	-	-	-	-	Yes	-	-
F-stat	102	102	102	-	26	-	-

PANEL B: Shopping Cost Parameters

Shopping Costs	All Borrowers	London	Other Regions	Q1 Income	Q2 Income	Q3 Income	Q4 Income
Mean (μ)	3.3	2.9	4.1	3.1	3.3	3.9	5.0
Stand. Dev. (σ)	0.5	0.4	0.7	0.8	0.7	0.5	0.2

Note: Panel A shows the structural demand estimates of the logit model for demand for mortgage products. The model is estimated for a 25% random sample. Standard errors are computed by bootstrapping. The F-stat is the F statistics for the excluded instrument in the second stage instrumental variable regressions for both product-market and broker-lender-market estimated fixed effects. N likelihood is the total number of observations in the first stage (borrower-product pairs). N second stage is the number of observations in the second stages. N borrowers is the total number of borrowers in the 25% random sample. Panel B presents the estimates for the mean and standard deviation of the shopping cost distribution (assumed to be normally distributed). I use the entire sample for this part of the estimation, as well as the previously estimated preference parameters in Panel A.

Table 6: Estimates for Lender Marginal Costs

	Total	Direct	Intermediated
All	1.82	1.93	1.79
Lender Type			
Big Six	1.80	1.95	1.71
Challengers	1.84	1.87	1.83
Small Banks	2.31	2.16	2.40
Building Societies	1.87	1.78	1.93
Initial Period			
2-Years	1.73	1.75	1.73
3-Years	1.94	2.02	1.89
5-Years	1.98	2.10	1.84
LTV Band			
LTV ≤ 80	1.60	1.79	1.50
LTV >80	2.03	2.04	2.03

Note: Marginal costs are expressed in percentage points and computed for direct and intermediated sales. Total average marginal costs take into account direct and intermediated sales for each product in each time period. Marginal costs are also reported by different product characteristics: lender, initial period and loan-to-value band.

Table 7: Estimates for Lender Mark-Ups

	Total	Direct	Intermediated (Pre-Commission)	Intermediated (Post-Commission)
All	22%	28%	32%	18%
Lender Type				
Big Six	22%	26%	36%	20%
Challengers	19%	30%	33%	17%
Small Banks	13%	27%	20%	7%
Building Societies	24%	36%	31%	16%
Initial Period				
2-Years	19%	29%	31%	15%
3-Years	24%	28%	34%	19%
5-Years	25%	27%	37%	23%
LTV Band				
LTV ≤ 80	23%	26%	38%	21%
LTV >80	17%	20%	20%	16%

Note: Mark-ups are expressed as a percentage of the interest rate. Average mark-ups are reported for all products and by different product characteristics: lender, initial period and loan-to-value band. Mark-ups are also different for direct and intermediated sales. For broker sales, mark-ups are reported separately before and after commission payments.

Table 8: Estimated Lender Bargaining Parameters

	Large Brokers	Small Brokers
Big Six	0.72	0.41
Challengers	0.28	0.40
Building Societies	0.61	0.47
Small Banks	0.19	0.31

Note: This table reports estimated bargaining parameters (β) by lender and broker type. Larger values of the bargaining parameters indicate relatively more bargaining power for lenders when negotiating with brokers. That is, lenders get a larger fraction of the surplus when negotiating with brokers.

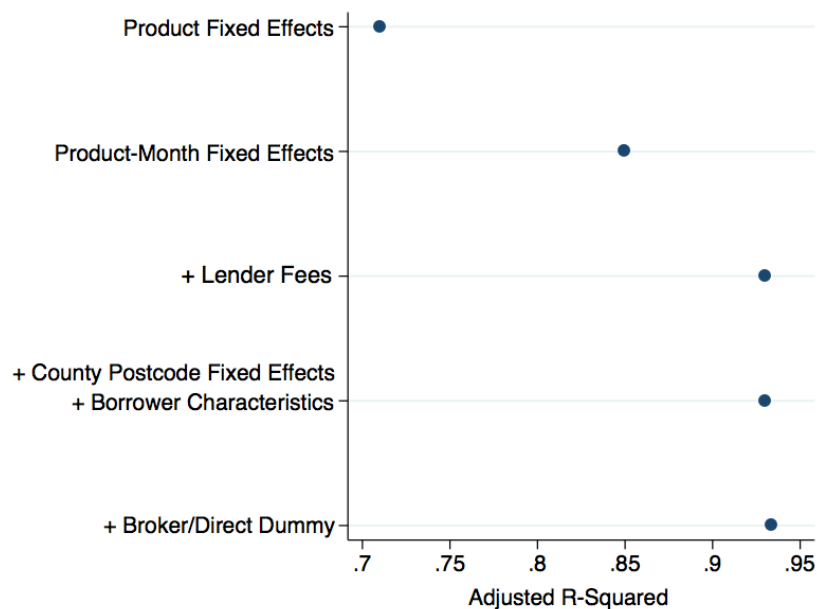
Table 9: Counterfactual Restrictions on Broker Services and Remuneration

	Ban on Brokerage % Δ	Ban on Direct Sales % Δ	Ban on Commissions % Δ	Cap at 0.4% % Δ	Fixed at 0.4% % Δ	Fixed at 0.7% % Δ
Market Structure						
HHI	35%	-27%	21%	5%	-3%	12%
Share Big Six	19%	-17%	12%	3%	-2%	8%
Pass-Through						
Prices	24%	9%	11%	-5%	-1%	8%
Marginal Cost	13%	-12%	9%	-1%	-4%	5%
Lender Profits	12%	-20%	7%	-2%	0%	5%
Commission Rates	-100%	42%	-100%	-35%	-17%	49%
Demand						
Share Direct	357%	-100%	115%	30%	-1%	14%
Shopping Costs	156%	-100%	83%	13%	-1%	19%
Consumer Surplus	-51%	-6%	-26%	9%	2%	-11%

Note: The table reports changes in estimated outcomes for different counterfactual scenarios. Column (1) reports estimates when restricting brokerage services, that is, the case when all mortgages are originated through lenders' in-house distribution channels. Column (2) presents estimates of banning direct sales and making brokers' advice mandatory. Column (3) shows estimates for policies imposing a ban on commissions. Column (4) simulates a cap on commission equal to 0.4%. Column (5) sets all commissions equal to 0.4%. Column (6) fixes all commissions at 0.7%.

Appendix A Facts: Additional Material

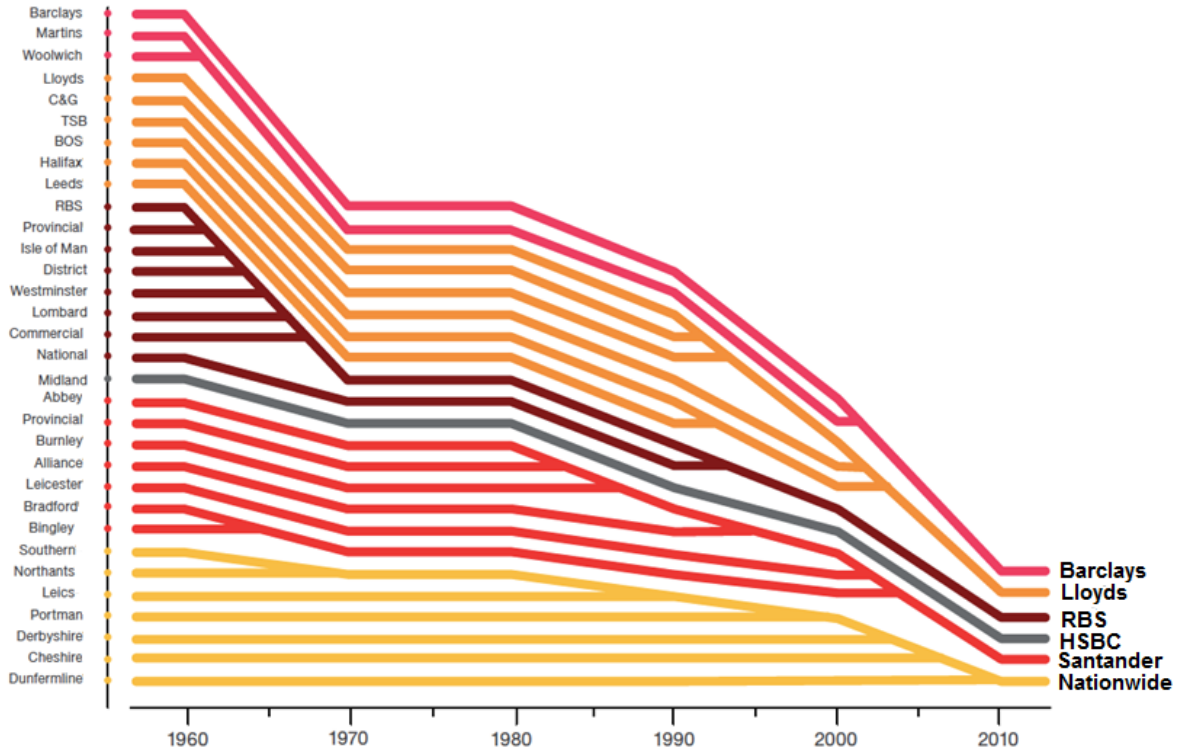
Figure A.1: Explained variation in mortgage pricing



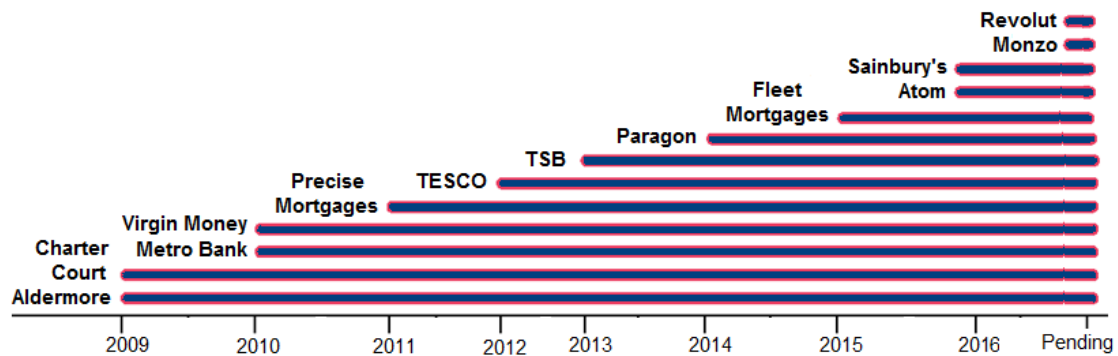
Note: The figure reports the adjusted R^2 when regressing loan-level interest rates on a set of dummy variables. First row includes only dummies for the product, defined as a triplet including lender, maximum loan-to-value band and initial fixed period. Second row interacts product fixed effects with fixed effects for origination month. Third row adds dummies for lender fees (values of £0, £500 and £1000). Fourth row includes dummies for the location of the house and borrower characteristics (income, age, credit score). Finally, fifth row adds a dummy accounting for whether the mortgage was originated by a broker or directly through the lender's in-house distribution channels.

Figure A.2: Consolidation and Entry in the UK Mortgage Market

PANEL A: Consolidation in the UK banking sector over the last 50 years

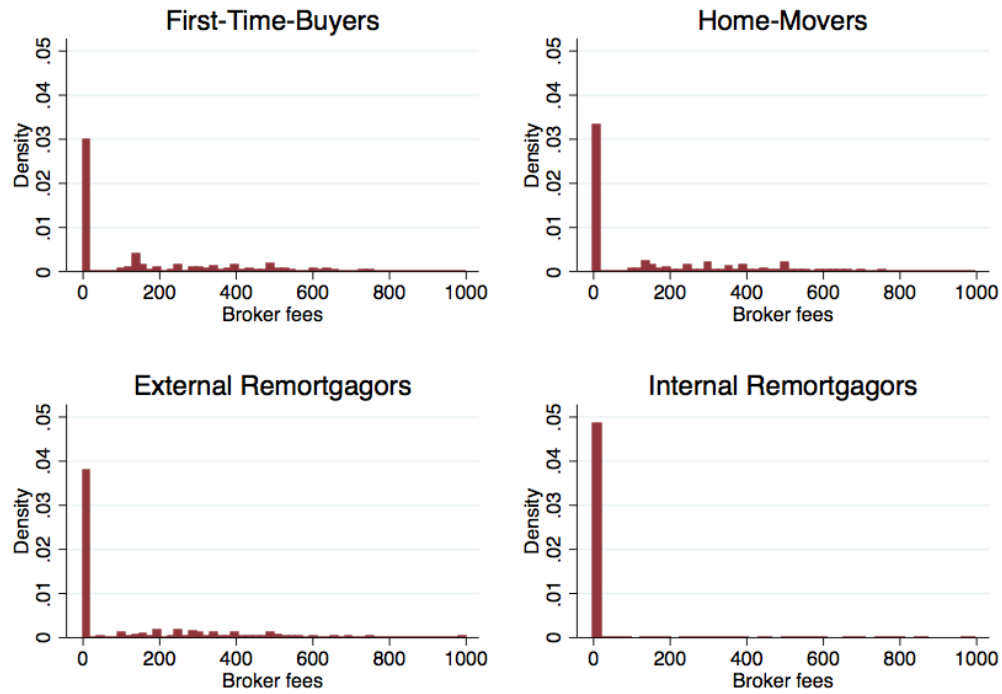


PANEL B: Entry in the UK banking sector over the last 10 years (not exhaustive)



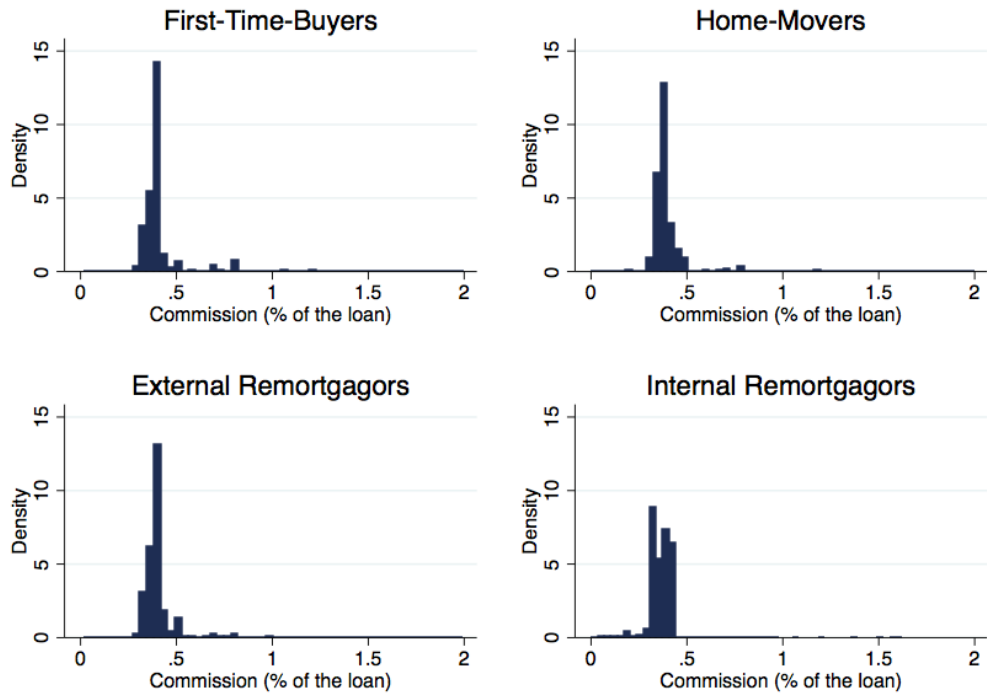
Notes: Panels A shows mergers and acquisitions for the Big Six lenders in the UK. Panel B presents a non-exhaustive timeline of recent entrants in the UK mortgage market. Graphs use data adapted from PwC Report "Who are you calling a challenger?", Bankers Magazine, and Quarterly Bulletin, Q4, Bank of England, 2010, plus additional dates from lenders' own websites.

Figure A.3: Distribution of Broker Fees Across Borrower Types



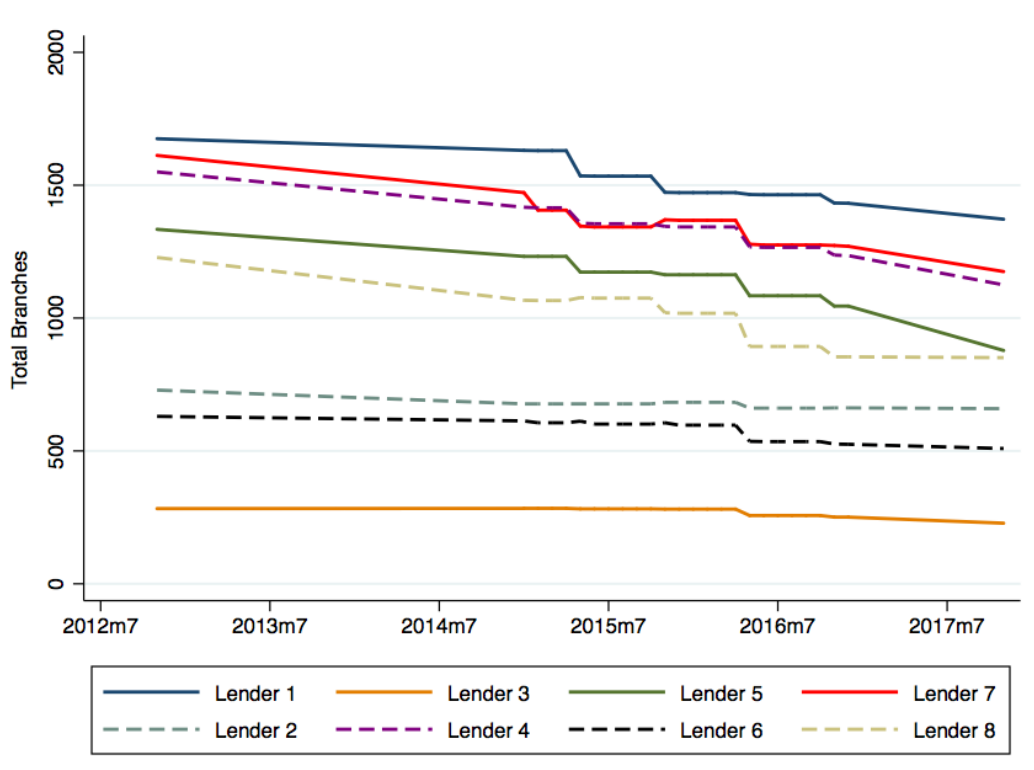
Note: Each figure plots the distribution of fees paid by households to brokers for all mortgages originated by a broker in the UK between January 2015 and June 2016. Broker fees are expressed in pounds. First-time buyers are borrowers originating their first mortgage. Home-movers are changing properties and originating a new mortgage. Internal remortgagors are borrowers refinancing with the same lender, while external remortgagors are borrowers refinancing their mortgage with a different lender.

Figure A.4: Distribution of Commissions Across Borrower Types



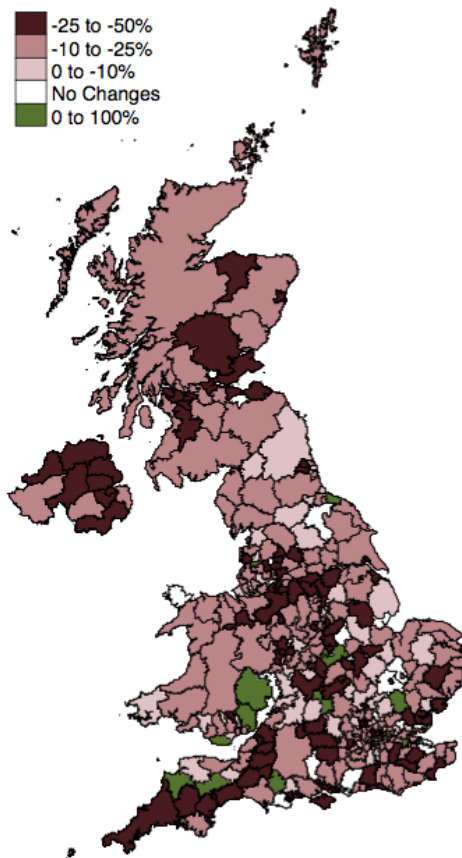
Note: Each figure plots the distribution of commission rates paid by lenders to brokers for all mortgages originated by a broker in the UK between January 2015 and June 2016. Commission rates are expressed as a percentage of the loan amount. First-time buyers are borrowers originating their first mortgage. Home-movers are changing properties and originating a new mortgage. Internal remortgagors are borrowers refinancing with the same lender, while external remortgagors are borrowers refinancing their mortgage with a different lender.

Figure A.5: Total Branches for largest lenders



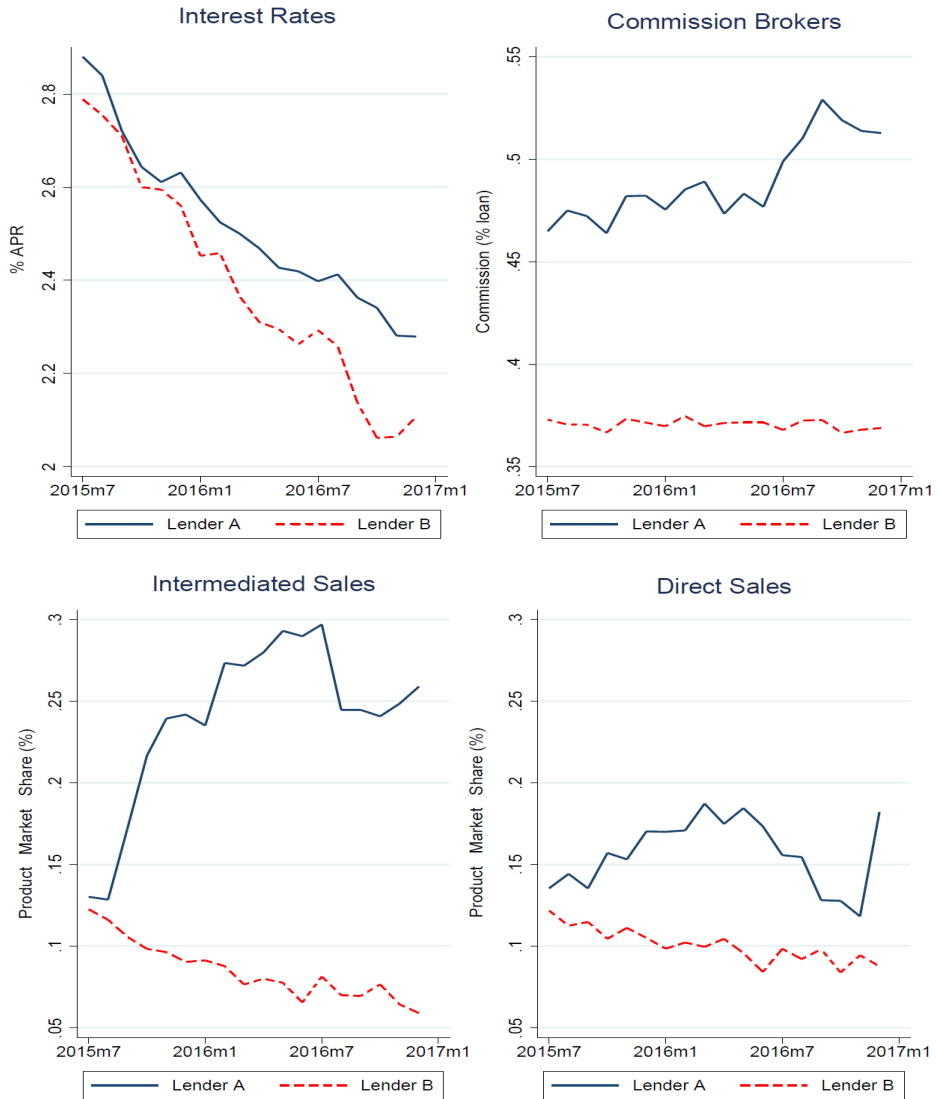
Note: The figure plots total bank branches in the UK between 2013 and 2017 for the eight largest mortgage lenders. The figure uses data from Experian Shop*Point and Goad datasets. Total branches account for all openings and closures during the time period.

Figure A.6: Branch closures and openings at the local authority level.



Note: The figure plots the percentage change in total bank branch density in a local authority district between December 2014 and January 2017. The map uses data gathered from Experian Goad and Shop*Point datasets.

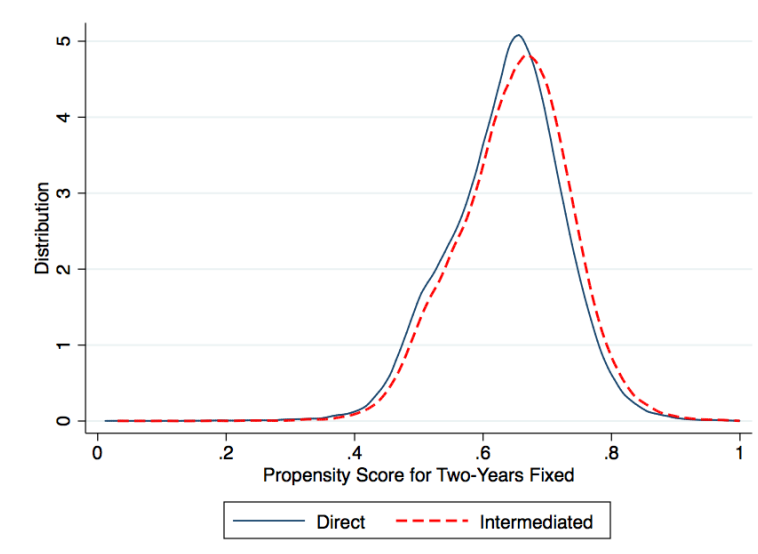
Figure A.7: Example of Sales and Prices for Popular Mortgage Product



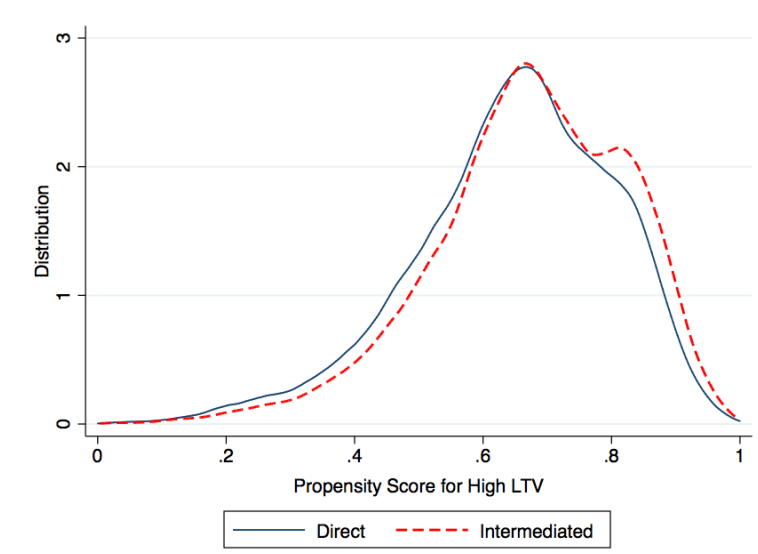
Note: The figure plots prices, commissions, and sales from July 2015 to December 2016 for two lenders offering one of the most popular products in the market (2-year fixed, 75% LTV). Mortgage prices in the top, left figure are measured by the annual percentage rate (APR), which includes interest rates and lender fees. Commission rates in the top, right figure are expressed as a percentage of the loan and are an average of all broker agreements for each lender. The y-axes in the right and left bottom figures represent direct and broker market shares, respectively.

Figure A.8: Selection into Intermediation

PANEL A: Probability of Getting a 2-Year Mortgage

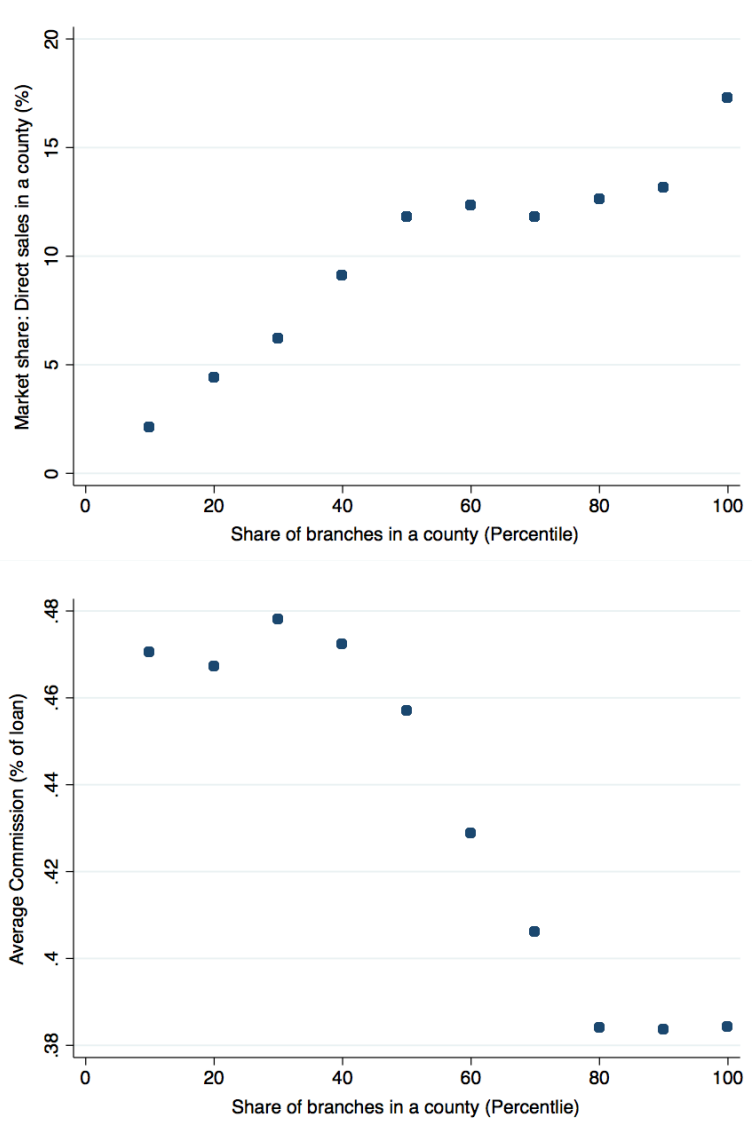


PANEL B: Probability of Getting a High Loan-to-Value Mortgage



Notes: Panel A plots the probability that a first-time-buyer gets a two-year mortgage based on its observable characteristics (age, income, credit score, partner, house price, location) and month dummies. Panel B plots the probability that a first-time-buyer originates a mortgage with a loan-to-value greater than 85% based on its observable characteristics (age, income, credit score, partner, house price, location) and month dummies. The analogous probability for choosing. The solid line is for borrowers originating their mortgages via direct sales. The dotted line is for borrowers originating their mortgage through a broker.

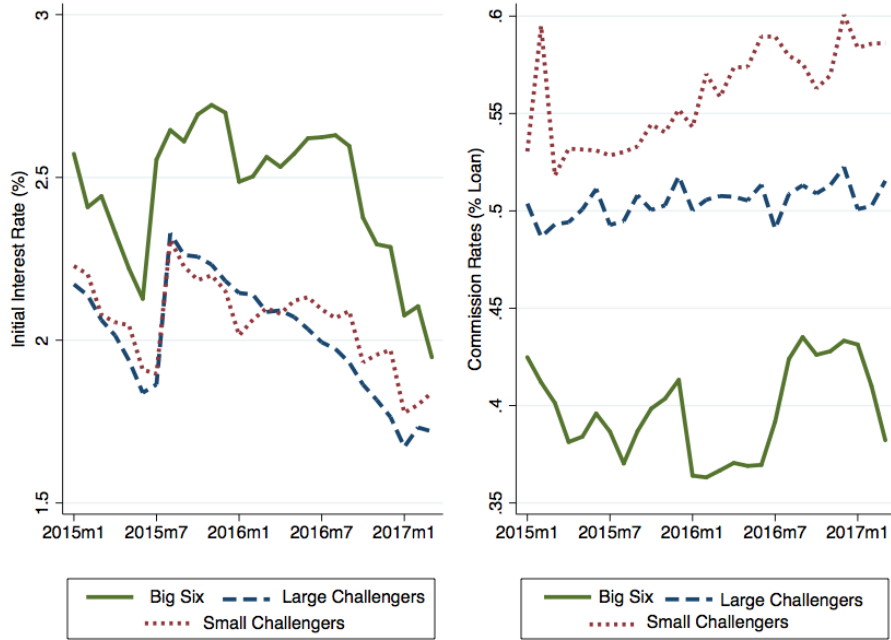
Figure A.9: Correlations between Branch Density, Direct Sales and Commissions



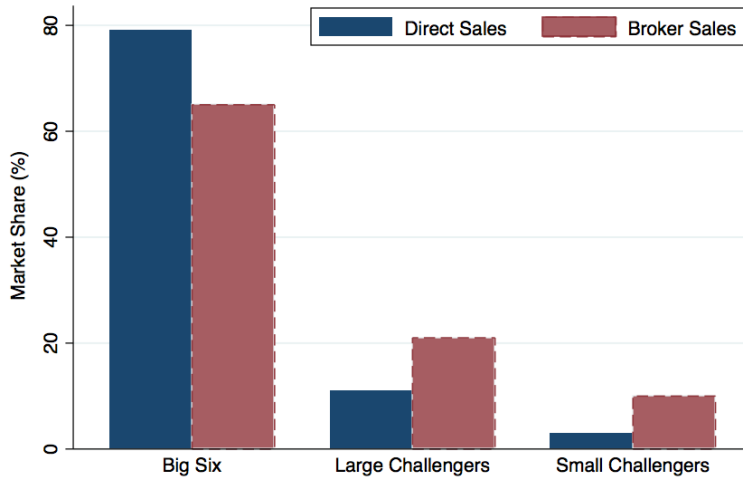
Note: The top figure reports the relationship between local branch density and direct sales. The bottom figure documents the relationship between local branch density and broker commissions. In both figures, the X-axis sorts all county-lender pairs according to the lender's concentration of branches in the county and groups them by deciles, with higher deciles meaning larger branch densities in the county. The Y-axis in the top figure represents the average market share as a percentage of direct sales in the county for lenders in each decile category. The Y-axis in the bottom figure plots the average commission rate offered to brokers in a county by lenders in each decile category.

Figure A.10: Commissions and Market Shares across Lenders

PANEL A: Interest Rates and Commissions by Lender Type



PANEL B: Market Shares by Lender Type and Distribution Channel

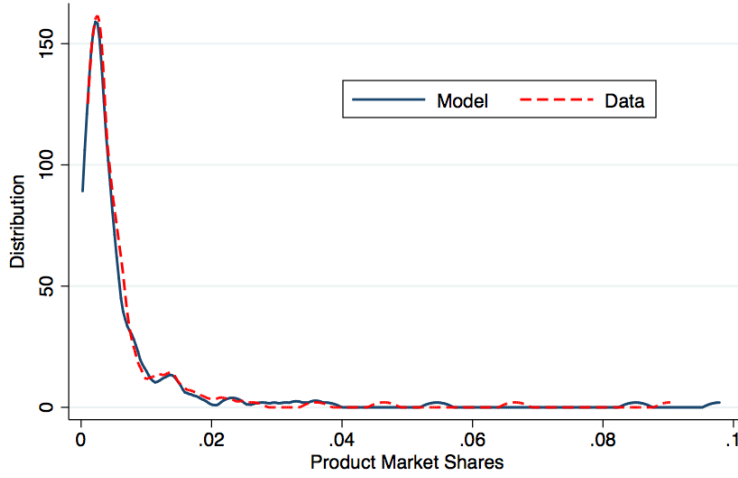


Note: Panel A plots interest rates (left) and commission rates (right) of all mortgages originated in the UK between 2015 and 2016. Each line represents a lender type, differentiating between the Big Six, Large Challengers and Small Challengers. On average, challenger banks offer higher commission rates to brokers and lower interest rates to consumers. Panel B plots the market share of Big Six and Challenger banks for direct and broker sales. Challenger banks have a relatively higher market share in the broker channel.

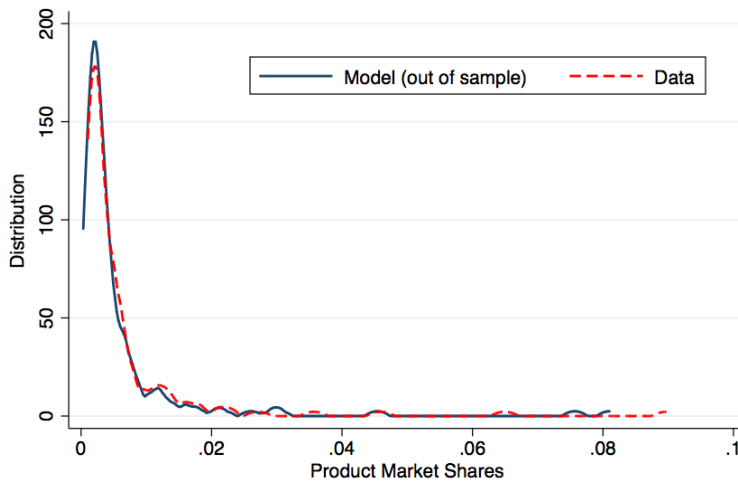
Appendix B Fit: Additional Material

Figure B.1: Model Fit

PANEL A: Training Sample (25% random sample)

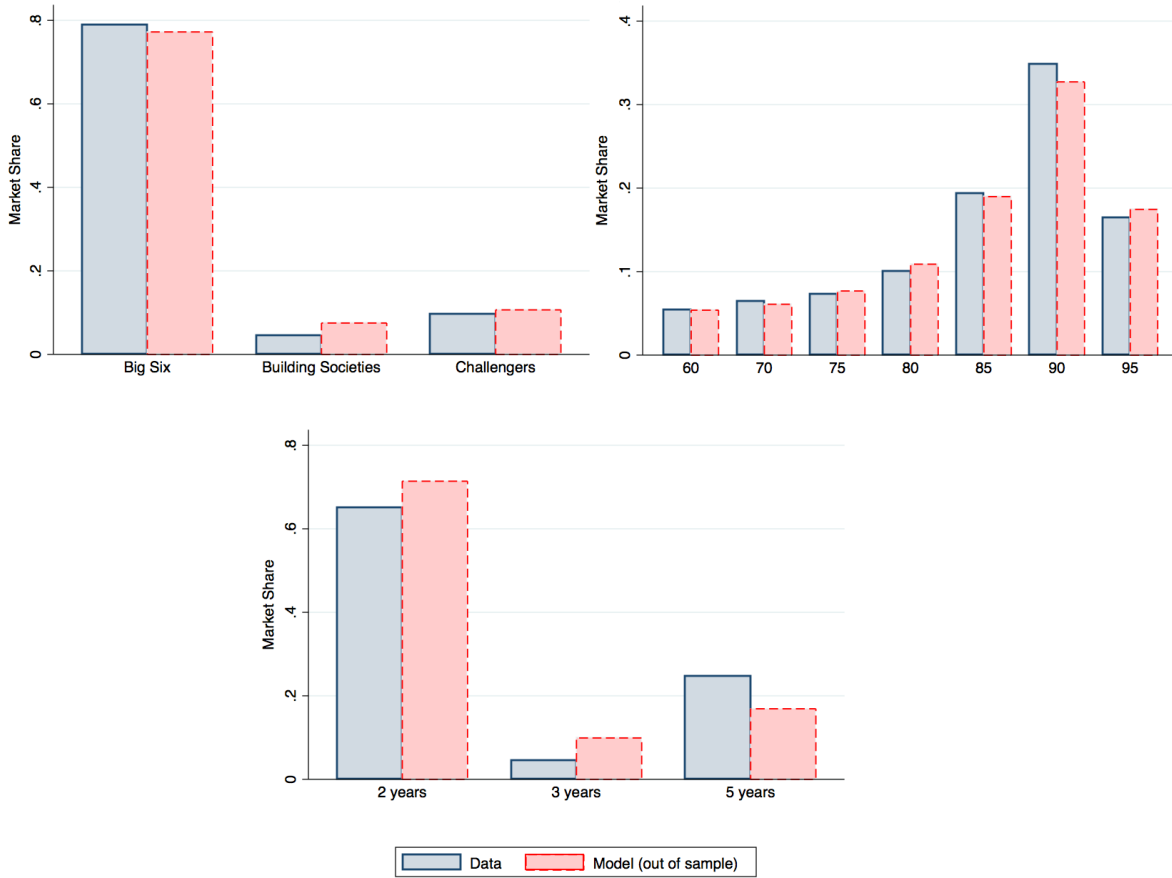


PANEL B: Cross-Validation Sample (Out-of-Sample Fit)



Note: The figures compare model predictions and observed market share distributions. Panel A uses a 25% random sample, while Panel B is based on the remaining 75% that was not used in the estimation. The red solid lines are the observed market shares in the data. Market shares are computed as the sum of originations for each product in each market divided by the total number of households. The blue dashed lines represent the estimated market shares from the model calculated as the sum of the individual predicted probabilities.

Figure B.2: Out-of-Sample Fit: Product Characteristics

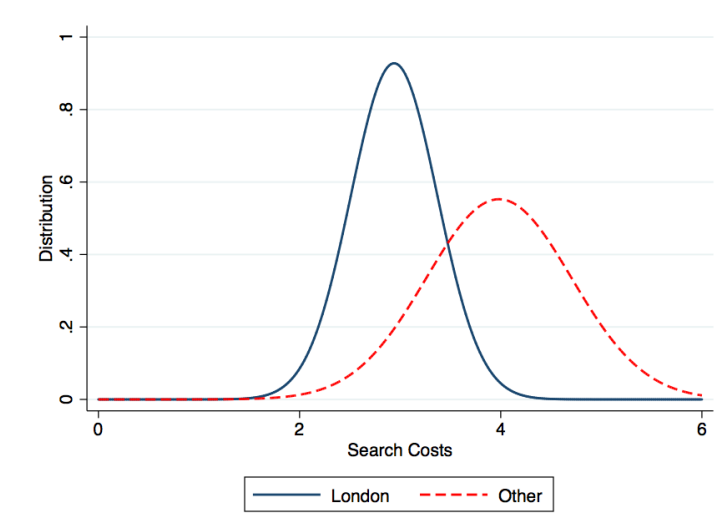


Note: The figures compare observed (solid line) and predicted (dashed line) market shares across different product characteristics. For observed market shares, I only use out-of-sample data. The upper left panel shows market shares for the Big Six, Building Societies and Challenger Banks. The upper right panel plots market shares across loan-to-value bands. Finally, the lower panel plots market shares across initial period deals.

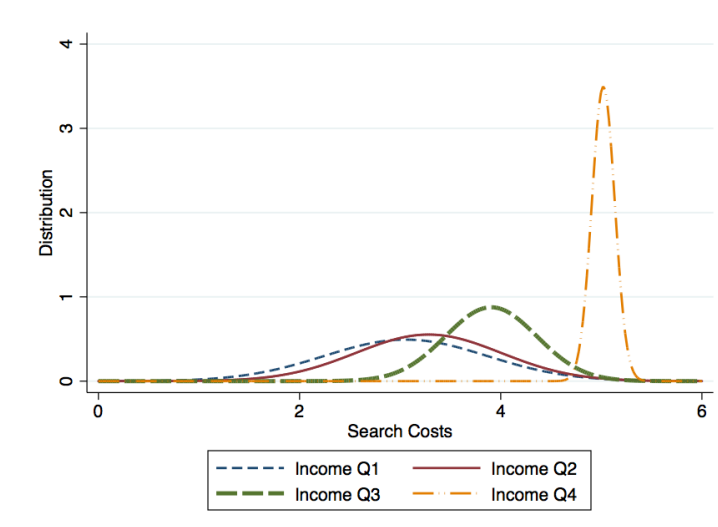
Appendix C Estimates: Additional Material

Figure C.1: Shopping Costs Distributions Across Subpopulations

PANEL A: Geographical Variation

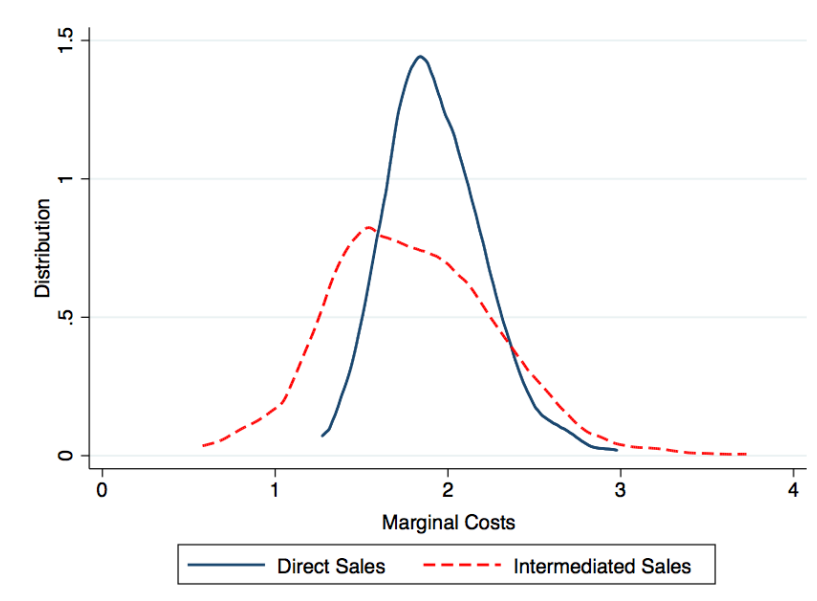


PANEL B: Income Variation



Note: Panel A plots the distribution of shopping costs for mortgages originated in London (solid line) and the rest of the country (dashed line). Panel B plots the distribution of shopping costs for mortgages originated by borrowers across income quartiles.

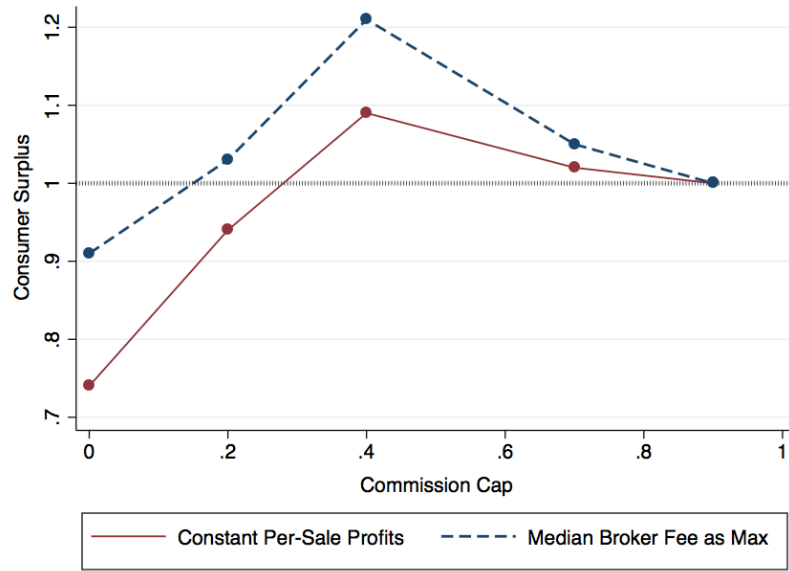
Figure C.2: Marginal Cost Estimates



Note: The figure plots lenders' marginal cost distribution for direct (solid line) and broker (dashed line) sales. These distributions result from marginal cost estimates from the model.

Appendix D Counterfactuals: Additional Material

Figure D.1: Alternative Pass-Through for Broker Fees



Note: The figure plots changes in consumer surplus under alternative broker fee pass-through. The solid line allows broker fees to increase such that profits for each mortgage sale remain the same as in the baseline with no restrictions for each broker. The dashed line allows broker fees to increase such that they are equal to the median (conditional on being positive) broker fee in the baseline.