The Role of Mortgage Brokers in the Subprime Crisis*

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Abstract

We study the role of mortgage brokers in the subprime crisis using a detailed sample of loans originated by, formerly, one of the largest subprime loan originators, New Century Financial Corporation. Prior to the subprime crisis, mortgage brokerage firms originated about 65% of all subprime mortgages and yet little is known about their behavior and contribution to the subprime crisis. Is there empirical support for the allegation that lenders like New Century compensated brokers in a fashion that encouraged them to originate higher cost loans? Did the incentive scheme change as New Century's loan volume surged? How did the mortgage brokers respond to the incentive scheme? How did the lender-broker relationships and broker competition interact with broker compensation? We decompose the broker revenues into a cost and profit component and find evidence consistent with broker market power that is greater for more complex mortgages and for borrower who may be less informed. We relate the broker profits to the subsequent performance of the loans. A probit model for loan performance shows that the increased broker profits lead to worse loan performance suggesting that brokers earned high profits on loans that turned out to be riskier ex post.

JEL Classifications: G12, G18, G21, G32

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1. Introduction

Over the decade leading up to the subprime crisis of 2007, mortgage lending has evolved from a relationship model to a largely transaction oriented model. The primary reason for the shift is the tremendous growth in mortgage securitization: The volume of outstanding agency mortgage-backed securities doubled from about $3 trillion in 1999 to nearly $6 trillion in 2007. The presence of the secondary market transforms mortgage lending to an originate-to-distribute model, where lenders can originate loans, earn their fees, and then distribute the loans to third-party investors. The securitized share of subprime mortgages, that is, mortgages passed on to third-party investors via mortgage-backed securities, increased from 54% of all mortgages originated in 2001 to 75% of all mortgages originated in 2006.

Lenders can originate mortgages either themselves as retail loans or through a mortgage broker. A mortgage broker is a financial intermediary who brings a borrower and a lender together to obtain a mortgage loan. The broker takes the borrower's application, performs a financial and credit evaluation, gives the borrower information about available loan options, and once a loan has been selected produces documents and closes the loan. The lender then underwrites, funds, and may service the loan. Typically the broker charges a direct fee to the borrower and earns an indirect fee—known as the yield spread premium—from the lender. Mortgage brokers play a major role in the mortgage market. Prior to the subprime crisis, mortgage brokerage firms originated about 65% of all subprime mortgages.[1]

Despite the mortgage brokers' central role in the subprime market we know relatively little about their behavior, incentives, or profits. What were the explicit and implicit

[1]Detailed information is available at the National Association of Mortgage Brokers website at www.namb.org.

incentives for mortgage brokers to match borrowers with different types of mortgages? Did these incentives change during the run up to the crisis?

Obtaining a mortgage is often one of the biggest financial decisions that a household makes, and it is a decision that is made relatively infrequently. Research on refinancing decisions suggest that many households may make suboptimal decisions, see, for example, Campbell (2006). The mortgage decision is perhaps even more challenging for subprime borrowers who often need to select between adjustable rates loans, hybrid rate loans, interest only loans, non-amortizing loans, loans with prepayment penalties, and loans with balloon payments. These attributes may help subprime borrowers–who would not have qualified for a prime mortgage–to obtain financing, but the attributes may also make the mortgage harder for the borrower to evaluate. Subprime borrowers may therefore be more reliant than prime borrowers on the information obtained from the mortgage broker. Added complexity may generate price dispersion, as argued by Carlin (2009), and may not be eliminated by competition as shown by Gabaix and Laibson (2006).

Part of the mortgage brokers' compensation comes directly from the lender in the form of a yield spread premium. By selecting different schedules for the yield spread premium the lender provides the mortgage broker with a set of implicit incentives. For example, a lender who finds that mortgages with certain attributes are more appealing to the ultimate buyers may change the yield spread premium to reward mortgage brokers for originating such loans.

The mortgage broker is likely to trade off the potential benefits of finding the best loan product for the borrower—which may help the broker win future business—against originating a loan product that may generate the highest revenues for the broker from the current loan. We develop a simple framework that allows us to empirically examine these trade offs for a large sample of subprime mortgages. The questions we seek to address are:

What were the explicit and implicit incentives for mortgage brokers to originate different types of mortgages? Did the incentives change over time and if so did the composition of originated loans change as well? Is there evidence that mortgage brokers extract rents from the transactions? Is there evidence that the mortgage brokers had incentives to originate loans that were riskier to the borrowers?

We study these questions using an extensive sample of mortgages originated by, formerly, one of the largest subprime loan originators, New Century Financial Corporation. The sample contains detailed information on the credit worthiness of the borrower, the purpose of the loan, the appraised property value, the location and type of property, the type and terms of loans originated, loan servicing records, and information on whether or not a mortgage broker was involved in the loan. The sample also reports the fees and yield spread earned by the brokers for each funded mortgage. Using that information, we can compute the revenues the brokers earn on each funded mortgage.

Our empirical framework is based on the idea that in order for a mortgage to be funded it must be acceptable to the borrower, broker, and the lender given the information they observe. To capture this we model the interaction between the borrower and the broker as a bargaining game over the loan terms and type subject to the constraint that the lender will fund the loan. From the broker's perspective the framework decomposes the total revenues charged by the broker into a cost of facilitating the match and a component that reflects the broker's bargaining power. The lender's surplus is the net present value to the lender from funding the loan gross of the yield spread paid to the mortgage broker. The lender effects the broker's behavior indirectly via the yield spread schedule and directly via the decision to fund a loan. The borrower's surplus depends on the benefit that the borrower receives from the loan which in turn depends on the value that the borrower assigns to owning the property and the valuation of various mortgage attributes.

We estimate a stochastic frontier model that decomposes the broker's revenues into a cost component and a profit component. The decomposition rests on the idea that when the borrower uses the broker, the broker will only propose loans with non-negative broker profit. Empirically the decomposition works because of the observed skewness in the total broker revenues. Our specification allows for the broker costs to vary across time and region, but does not allow the cost to depend on borrower characteristics or the loan type. The results are relatively insensitive to the choice of variables in the broker cost function, however, Our estimates are consistent with brokers having market power. Our estimates of the broker profits are higher for hybrid mortgages and for mortgages with prepayment penalties; the brokers' bargaining power being greater for such mortgages. Profits are also higher for mortgages with stated or limited documentation and for mortgages obtained to refinance an existing mortgage with cash-out refinancing being the most profitable. These effects are consistent with greater bargaining power when borrowers may be less informed or less sensitive to higher costs.

In order to investigate how the incentives that New Century provides to the brokers relates to the riskiness of the mortgages, we relate the broker profits to the delinquency of the loans. A probit model for loan delinquency shows that the marginal effect of broker profits is positive for future delinquency once we condition on the loan and borrower characteristics, suggesting that brokers earned high profits on loans that turned out to be riskier ex post. In this sense then, New Century provides the brokers with incentives that lead to riskier loans.

Demyanyk and Hemert (2009), as well as Mian and Sufi (2009), analyze the quality of securitized subprime mortgage loans. Keys, Mukherjee, Seru, and Vig (2008) and Purnanandam (2009) argues that the lack of screening incentives for originators and excessive risk-taking contributed to the subprime crisis. Despite the prominence of brokers in the

subprime mortgage market, little is known about their behavior and contribution to the subprime crisis. El-Anshasy, Elliehausen, and Shimazaki (2006) and LaCour-Little (2006) compare the rates on subprime mortgages originated by lenders through the retail channel and through mortgage brokers. LaCour-Little (2006) show that loans originated by brokers cost borrowers more than retail loans, while the El-Anshasy, Elliehausen, and Shimazaki (2006) do not find support for that claim.

Woodward and Hall (2009) examine the total revenues paid by borrowers to mortgage brokers for a sample of FHA loans and show that a substantial portion can be attributed to broker profits and that these profits vary with borrower characteristics consistent with the brokers' profits stemming from lack of information among borrowers. Our approach is similar to the one taken by Woodward and Hall (2009) in that we use stochastic frontier analysis to decompose the broker revenues charged into a cost and a profit component. Garmaise (2009) studies the length and intensity of the broker-lender relationship and finds that the quality of loans originated actually declines in the number of interactions between the broker and the lender.

2. New Century Financial Corporation

Our sample contains all loans originated by New Century Financial Corporation (New Century) between 1997 and March 2007.

2.1. Company Background

New Century made its first loan to a borrower in Los Angeles, California in February 1996. Ten years later New Century had more than 7,100 employees and 222 sales offices nationwide, and was one of the largest subprime mortgage originators in the United States.

New Century originated, retained, sold and serviced home mortgage loans designed for subprime borrowers. In 1996, the company originated over $350 million in loans. In 1997, New Century went public and was listed on NASDAQ. In 2001, the company's subprime loan origination volume exceeded $6 billion. Volume continued to grow rapidly, and volume increased tenfold to over $60 billion in 2006. The company grew its product offerings so that by 2006, New Century provided fixed rate mortgages, provided hybrid rate mortgages which are adjustable rate mortgages that convert to fixed rate mortgages after a number of months, and provided balloon mortgages. In 2004, New Century restructured into a real estate investment trust (REIT) and began trading on the NYSE.[2] New Century filed for Chapter 11 bankruptcy protection on April 2, 2007. Below is a summary of New Century's loan origination process.[3]

New Century's Loan Origination Process

1. Independent brokers or New Century brokers identify potential borrowers and complete loan applications. These are submitted either to a New Century account executive or through its web-based loan underwriting process called FastQual.

2. Account executives submit loan applications to New Century account managers, who review the applications to ensure all documentation are in place.

3. If applications and documentation are in place, account managers sends loans to New Century underwriters. Underwriters review loans for compliance to New Century's underwriting standards and decide whether to approve or deny the loans.

[2]REITs are entities that invest in different kinds of real estate or real estate assets. Mortgage REITs lend money to property owners and developers or invest in financial instruments secured by mortgages. According to the Internal Revenue Code, REITs are required to pay out at least 90% of their income before taxes to shareholders. Source: U.S. Securities and Exchange Commission at http://www.sec.gov/answers/reits.htm, accessed June 2, 2008.

[3]See Palepu, Srinivasan, and Sesia Jr. (2008) for more institutional details.

Underwriters set the interest rate and the terms of the loan. The company's underwriting guidelines required a credit report on all applicants from a credit reporting company. The company also reviewed all of the applicant's prior mortgage payment histories. During the underwriting process, the home was appraised.

4. If the loan is approved, the underwriter sends the loan to a closing agent for execution.

5. After loan documents are sent, the closing agent sends the documents to a New Century funding officer, who contacts the accounting department and requests the funds to be wired to the funding officers.

2.2. Origination Data

Our sample contains detailed information on the credit worthiness of the borrower, the purpose of the loan (purchase vs. refinance), appraised value, location and type of property, the type and terms of loans originated, originated fees, yield spread premium, loan servicing records, and information on whether or not a mortgage broker was involved. These data provide enough detail to allow us to study the lender/broker relationship, the matching of borrowers with loan types, and the relationship between loan types and revenues paid and received. The sample covers a ten-year period that ends in March 2007. The sample contains information on approximately 3 million loan records and 1.25 million funded loans across a diverse geographical area. Figure 1 plots the total amount of loans originated by New Century between 1997 and 2006 and the split between loans originated through the broker and retail channels. New Century's loan volume grew approximately tenfold between 2000 and 2005 and much of that growth stemmed from broker originated loans.

Figure 2 plots the percentage of loans 60 days or more delinquent as a function of

the number of months from origination by the year of origination. The plot is consistent with the evidence reported in Demyanyk and Hemert (2009) that the quality of the loans originated deteriorates with time. In particular, loans of 2004 and 2005 vintages are worse quality than loans originated earlier.

Table 2 shows the descriptive statistics for our origination database, covering the years 1997 to 2006. The first panel shows that the number of loans funded by New Century increased from below 20,000 in 1997 to almost 330,000 in 2006. Interestingly, only 40-50% of the proposed loans were actually funded by New Century, with a roughly equally fraction withdrawn by the borrower and the remaining 10-20% of the proposed loans declined by the lender.

The second panel shows a breakdown of the origination channel for the funded loans and shows how the role of the retail channel steadily decreased as New Century's loan volume increased. The change was accompanied by a steady increase in the number of brokers that New Century did business with. The next panel shows a breakdown of the loan types into fixed-rate mortgages (FRM), hybrid loans, balloon loans, and agency loans. For the whole sample period, hybrid loans were the most common ones followed by fixed-rate loans. The fifth panel reports the purpose of the loan. The purpose of more than half of the mortgages was to finance the purchase of a house. In 1997, about 58% percent of the funded broker loans were originated to extract cash by refinancing an existing loan into a larger new mortgage. That percentage stayed fairly flat until 2003, but afterwards decreased somewhat to about 37% in 2006.

New Century had three levels of income documentation: full, limited, and stated. For a full documentation loan, the applicant was required to submit two written forms of income verification showing stable income for at least twelve months. With limited documentation, the prospective borrower was generally required to submit six months

of bank statements. For stated docs, verification of the amount of monthly income the applicant stated on the loan application was not required. Palepu, Srinivasan, and Sesia Jr. (2008) note that in all cases, the applicant's employment status was verified by phone (salaried employees). Stated documentation mortgages were often referred to as "liar loans." While there are some fluctuations year-to-year, the general trend for our sample period is to have fewer full documentation loans and more limited or stated documentation loans. The last panel shows mean values for some additional loan and borrower characteristics in our sample.

2.3. Broker Compensation

Brokers are compensated for their services in two ways. On the one hand they receive fees paid directly by the borrower. These include the loan origination fee, credit fee, etc. In addition, the broker is paid a yield spread premium (YSP) by the lender. Lenders such as New Century usually distribute a wholesale rate sheet to mortgage brokers that sets the minimum mortgage rate based on a number of loan and borrower characteristics. Brokers may then earn a higher fee for originating higher rate loans, all else equal. Yield spread premia therefore are an indirect way for the lender to influence the brokers' origination activity. It is important to note that brokers need not disclose the YSP to borrowers until closing statements are signed.[4]

Table 2 shows a negative trend in percentage revenues earned by mortgage brokers over our sample period. One interpretation of this is that it reflects increased competition between brokers doing business with New Century. The various panels show how the revenues break down across different loan products like fixed-rate or hybrid mortgages with full versus stated documentation. In general, the between product variation is smaller than the variation across time.

[4]The yield spread premium is reported on lines 80–81 of the HUD-1 statement.

Figure 3 reports the unconditional distribution of the broker revenues in its components, all measured in dollars. Panel a reports the fixed fee portion of the revenues, Panel b reports the yield spread, and Panel c reports the total broker fees. All distributions are quite skewed—there are some extremely large fees and yield spreads paid out to the brokers. The average broker revenues are on the order of $7,000 per loan. The yield spread distribution is more concentrated than the fee distribution, and the fees average about 65% of the total revenues.

Figure 4 provides graphical evidence on how the documentation type effects the distribution of broker revenues. Panel a provides the unconditional distribution of the revenues, Panel b provides the distribution of revenues for the loans with full documentation, Panel c the distribution of loans with limited documentation, and Panel d the distribution of stated documentation loans. The average and median levels of revenues are higher for limited and stated documentation loans relative to full documentation loans, and the right tail of the distribution is higher for limited and stated documentation loans relative to full documentation loans. Our empirical model uses such variation to identify variation in broker profitability across the different loan categories.

3. Framework

We model the underwriting process as follows. The borrower arrives to the broker requesting a mortgage loan. The broker evaluates the borrower's characteristics including the borrower's credit quality and willingness to pay, and based on that information the broker provides the borrower with financing options. The broker submits funding requests to one or more lenders, and the lenders respond with a decision to fund the loan or not. Funding requests are submitted until the borrower and broker and lender find an acceptable loan. At that point, the mortgage is written. If no acceptable loan is found,

then no mortgage is written.

We use P to denote the loan principal, l the loan type—fixed, floating, does the loan have a prepayment penalty, maturity, and so on—and r be the loan's interest rates so that (P, l, r) denotes the loan. We use the subscript i to denote the borrower and the subscript j to denote the mortgage broker. Define the vector of characteristics X_{ij} as

$$X_{ij} \equiv (X_i^B, X_j^{MB}, X^M). \tag{1}$$

Here X_i^B is the vector of characteristics for borrower i such as borrower FICO score, borrower income, borrower age, X_j^{MB} is a vector of mortgage broker characteristics such as the broker's underwriting history, and market share, and X^M is a vector of overall market conditions such as the calendar time, the overall size of the market, and so on. All payoffs and decisions are conditional on these characteristics; we drop the conditioning variable X_{ij} from the notation at this point to simplify the notation. Our empirical work conditions on X_{ij}.

Let f denote the total fees that the broker charges the lender for originating the loan, including the origination fee and the credit fee. Define $\nu(P, l, r)$ as the borrower's dollar valuation for the loan as a function of the loan amount, the terms of the loan, and loan rates. The function $\nu(P, l, r)$ measures the wealth equivalent benefits that the borrower receives from the loan—for expositional purposes we assume that ν is differentiable with respect to its arguments and strictly concave, and we also assume that ν is decreasing in r. Using ν, and assuming that the borrower is risk-neutral, the borrower's total surplus from receiving a funded loan (P, l, r), and paying fees of f is

$$\nu(P, l, r) - f. \tag{2}$$

The lender pays the broker a yield spread of $y(P, l, r)$ for originating the loan. We use C to denote the broker's costs of origination the loan. Here, C includes the broker's time costs of dealing with the borrower, as well as any administrative costs paid by the broker for intermediating the mortgage. Assuming that the broker is risk neutral, the broker's surplus from originating a funded loan (P, l, r), receiving fees of f and a yield spread of $y(P, l, r)$, and paying costs of C is

$$f + y(P, l, r) - C. \tag{3}$$

We assume that the terms of the mortgage loan can be described by a generalized Nash bargain between the broker and the borrower, subject to the constraint that the lender will fund the loan. Let F denote the set of loans that will be funded by the lender:

$$F(X_{ij}) = \{(P, l, r) | \text{lender will fund loan type } (P, l, r), X_{ij}\}. \tag{4}$$

Here F depends on the vector of characteristics X_{ij} because the lender's decision depends on characteristics of the borrower, broker, and overall market conditions. We drop the conditioning variable to simplify notation.

We use $\rho \in [0, 1]$ to denote the bargaining power of the broker relative to the bargaining power of the borrower. If $\rho = 0$ then the borrower has all the bargaining power, and if $\rho = 1$ the mortgage broker has all the bargaining power. The funded loan contract maximizes the generalized Nash product

$$\max_{\{l,r\} \in F} (f + y(P, l, r) - C)^{\rho} (\nu(P, l, r) - f)^{1-\rho}, \tag{5}$$

subject to the participation constraints:

$$\nu(P,l,r) - f \geq 0, \tag{6}$$

$$f + y(P,l,r) - C \geq 0. \tag{7}$$

Condition (6) requires that the fees be less than the borrower's surplus and condition (7) requires that the fees plus the yield spread are greater than the broker's cost. The participation constraints can only be satisfied if the gains to trade are positive:

$$\nu(P,l,r) + y(P,l,r) - C \geq 0, \text{ for some } (P,l,r) \in F. \tag{8}$$

If the gains from trade are not positive, the bargaining ends and no mortgage is funded.

When the gains from trade are positive and the terms of the loan are in the interior of F, the first-order-conditions imply

$$\frac{\partial \nu(P,l,r)}{\partial l} = \frac{\partial y(P,l,r)}{\partial l}, \tag{9}$$

$$\frac{\partial \nu(P,l,r)}{\partial r} = \frac{\partial y(P,l,r)}{\partial r}, \tag{10}$$

and

$$(1-\rho)\left(f + y(P,l,r) - C\right) = \rho\left(\nu(P,l,r) - f\right). \tag{11}$$

Conditions (9) and (10) are efficiency conditions: the marginal benefits to the borrower for the terms of the loan are equated to the marginal revenues to the broker for the terms of the loan. We have assumed that the borrower and mortgage broker do not bargain over the loan size P. If we relaxed that assumption and allowed the loan size

to be part of the bargaining, then efficiency conditions similar (9) and (10) would also hold: the loan size would equate the marginal benefits and costs between the borrower and mortgage broker.

Since the lender sets the yield spread, equations (9) and (10) show how that yield spread function effects the loan choice. The lender also effects the loan choice directly though the set of loans that will be funded, F.

Condition (11) is the direct condition for setting the fees: the fees are set so that the total surplus is split according to the relative bargaining power of the broker and the borrower. Using condition (11) to solve for the fees,

$$f = \rho\nu(P, l, r) + (1 - \rho)(C - y(P, l, r)). \tag{12}$$

If the borrower has all the bargaining power, then $\rho = 0$ and

$$f = C - y(P, l, r)$$

so that all the surplus flows to the borrower. If the broker has all the bargaining power, then $\rho = 1$ and

$$f = \nu(P, l, r)$$

so that all the surplus flows to the broker.

The lender chooses which submitted loans will be funded and the yield spread that is paid to the broker. Let $u(P, l, r)$ denote the lender's expected payoff from financing a mortgage of type (P, l, r). Here, $u(P, l, r)$ represents the net present value to the lender from funding the loan gross of the yield spread paid to the mortgage broker. If the lender securitizes the loan, $u(P, l, r)$ is the difference between the price paid by the mortgage

securitizer for the loan and the amount lent to the borrower. If the lender does not securitized the loan, $u(P, l, r)$ is the difference between the lender's expected present value of the payments received from the borrower and the amount lent to borrower.

Since the lender pays the yield spread $y(P, l, r)$ to the broker, the lender's surplus from funding the mortgage loan is

$$u(P, l, r) - y(P, l, r). \tag{13}$$

The lender will only fund the loan if that payoff is positive, or

$$u(P, l, r) - y(P, l, r) \geq 0. \tag{14}$$

The lender's decisions effect the terms of the loan underwriting process though two channels. First, the lender determines the yield spread function, which determines which loans will be submitted because the yield spread function directly determines the broker's participation constraint in equation (7) and efficiency conditions (9) and (10). Since the broker's surplus directly depends on the yield spread, condition (11) implies that the fees themselves depend on the yield spread. Second, the lender's decision on which loans to fund determines which loans will be offered directly though the effects of the constraints in F on the generalized Nash solution.

To summarize, the loan will be originated if the lender's surplus is positive so that the lender agrees to the funding, if the gains from trade between the borrower and the broker are positive, and the fees will be set so that the surplus is split between the borrower and broker in proportion to their bargaining power.

4. Empirical Analysis

4.1. Estimating the Broker's Profits

For the funded loans in our sample, we observe the broker's revenue equal to $f + y(P, l, r)$. Substituting in the equilibrium fees from equation (12)

$$f + y(P, l, r) = C + \rho\left(\nu(P, l, r) + y(P, l, r) - C\right) : \tag{15}$$

the broker's revenue equals the costs of the intermediating the loan plus the fraction of the total gains from trade that the broker is able to capture. If the broker has all the bargain power so that $\rho = 1$ the broker receives all the gains from trade and if the borrower has all the bargain power $\rho = 0$ and the broker revenues is equal to the costs of intermediating the trade.

We are interested in empirically decomposing the observed revenues into a cost component and the grains from trade captured by the broker. To do so, we parameterize the broker's cost function as

$$C = C(X_{ij}) + \epsilon_{ij}, \tag{16}$$

where $C(X_{ij})$ is the cost function conditional on lender and mortgage broker characteristics, X_{ij} and ϵ_{ij} is zero mean error. Letting ξ_{ij} be the broker's profit,

$$\begin{aligned} f + y(P, l, r) &= C(X_{ij}) + \epsilon_{ij} + \rho\left(\nu(P, l, r) + y(P, l, r) - C\right) \\ &\equiv C(X_{ij}) + \epsilon_{ij} + \xi_{ij}, \end{aligned} \tag{17}$$

where ξ_{ij} is non-negative. Here ϵ_{ij} represents unobserved heterogeneity in the brokers' costs. Conversations with a market participant indicated that the broker's cost function

is likely to be unaffected by the loan amount, the loan type, or loan rates. We also report parameter estimates from a specification that allows the cost function to depend on the loan type, the prepayment penalty, and whether or not the loan is a refinance or not. Our main results carry through to such a specification.

The model in equation (17) fits naturally into a specification than can be estimated using stochastic frontier analysis. Greene (2002) and Kumbhakar and Lovell (2000) provide textbook references to stochastic frontier models. Frontier models are used to estimate cost or profit functions that are viewed as the most efficient outcomes possible. Individual observations deviate from the efficient outcomes by a symmetric mean zero error and a one-sided error that measures that observation's inefficiency. Such models have been applied in financial economics by Hunt-McCool, Koh, and Francis (1996) and Koop and Li (2001) to study IPO underpricing, by Altunbas, Gardener, Molyneux, and Moore (2001) and Berger and Mester (1997) to study efficiency in the banking industry, by Green, Hollifield, and Schürhoff (2007) to study dealers' profits in intermediating municipal bonds, and by Woodward and Hall (2009) in studying broker profits in the mortgage industry.

In our application, the broker's costs for underwriting the loan take the place of the most efficient broker revenue, and the efficiency term is a measure of the broker's profits. If the borrowers have enough bargaining power, then the broker's revenues would be driven down to their costs, and the one-sided error would be zero. Measures of the relative importance and determinants of the distribution of the one-sided error therefore provide useful information about the brokers' ability to earn profits by underwriting loans. In particular, the distribution of the one-sided error across different loan characteristics provides estimates of the relative profitability of different types of loans.

We note here that both the borrower's and the lender's participation constraints can

also be estimated using stochastic frontier analysis. The borrower's participation constraint is that the fees f are less than or equal to the borrower's valuation for the loan $\nu(P, l, r)$, so that fees must equal the borrower's valuation plus a non-negative term equal to the borrower's surplus from the loan. If we parameterize the borrower' valuation and the stochastic distribution of borrower's surplus, then we can econometrically estimate the borrower's valuation function and the conditional distribution of the borrower's surplus. Similarly, the lender's participation constraint is that the yield spread $y(P, l, r)$ is less than the lender's valuation the loan $u(P, l, r)$ so that the yield spread is equal to the lender's valuation minus a non-negative term. With parametric assumptions, we can therefore estimate the lender's valuation function and the conditional distribution of the lender's surplus.

To arrive at an econometric specification to the model, we impose parametric structure on the distribution of the symmetric error ϵ_{ij} and on the broker's profits ξ_{ij} We parameterize $\epsilon_{ij} \sim \mathcal{N}(0, \sigma_C^2)$, and we parameterize ξ_{ij} as an exponential with mean parameter $1/\lambda(X_{ij})$. The first two moments of ξ_{ij} are

$$E\left[\xi_{ij} \middle| X_{ij}\right] = 1/\lambda(X_{ij}) \tag{18}$$

$$\text{Std. Dev.}\left[\xi_{ij} \middle| X_{ij}\right] = 1/\lambda(X_{ij}) \tag{19}$$

We estimate specifications in which the exponential term has parameter $1/\lambda_{ij}$ a log-linear function our our explanatory variables X_{ij}. With K conditioning variables,

$$1/\lambda(X_{ij}) = \beta_0 \prod_{k=1}^{K} e^{X_{ij,k}\beta_k}. \tag{20}$$

If the parameter $\beta_0 = 0$, then the cost function is zero; the borrowers have all the

bargaining power and there is no asymmetric term. If the constant is non-zero, then the brokers have bargaining power and so earn positive profits, on average. Variables that increase $\lambda(X_{ij})$ suggest high broker bargaining power and therefore higher profits for the brokers. Because of the log-linear functional form, the coefficients on the conditioning variables measure the percentage change in profits per unit change in the conditioning variable.

The explanatory variables include the dummies for the year, and the geographical region, the documentation type–full documentation, low documentation or stated documentation, the type of the loan such fixed, hybrid, if the loan is a refinance or not, if there is cash taken out or not, information about the borrower credit history such as the FICO score, age, the loan to value ratio, and measures of the broker's experience and previous relationship with New Century.

We parameterize the broker's cost as a function of dummies for the year and the geographic location. We chose not to allow the cost function to depend on the loan characteristics as it is unclear what the economic rationale for the costs for different loan types to be different. We also report the results for a general specification in which the cost function can depend on the characteristics of the loan type. Our main results continue to hold in such a specification.

Let $\{Z_{ij,l}\} \in X_{ij}$ for l=1,...,L denote the dummy variables used for the cost function, we assume

$$C(X_{ij}) = \gamma_0 + \sum_{l=1}^{L} Z_{ij,l}\gamma_l. \tag{21}$$

The empirical analysis uses a cleaned sample of all funded broker-originated stand-alone first lien loans. The overall NCEN data base contains 3,241,537 records, out of

which 1,360,348 are for funded loans. 713,916 of these funded loans are broker-originated stand-alone first lien loans. For loan records to be considered in our empirical analysis, we further require that broker fees, yield spread premia, loan type, purpose, amount and fund date, rate, fico score, combined loan to value ratio, documentation level, the borrower's age and marital status are available. These leaves us with a final set of 385,984 records. Table 4 reports the summary statistics for the sub-sample used in the estimation.

Table 3 describes the variables using for our empirical analysis and Table 5 reports the point estimates and associated standard errors for the stochastic frontier model applied to the broker revenues for first lien loans funded by New Century in our sample.

The coefficients in the frontier model are estimated precisely. We only include first lien loans that do not appear to match with any second lien loans in our sample. We refer to such first lien loans as stand-alone first lien loans. The specification allows the cost to vary across the years and and geographic location. The estimate for the constant is approximately \$3,000. The estimates for the geographic location dummies suggests that costs in California, which is our benchmark, approximately \$1,000 higher than in the other western states, Florida and the Northeast, and approximately \$1,300-\$1,500 higher than the costs in Southern States, Texas, and the Midwest. The estimates for the year dummies show evidence of higher costs in 2001 to 2005 with other years showing smaller deviations from the benchmark level in 1997.

The second column of Table 5 reports the estimates for the broker profit function. The constant is positive and significantly different from zero providing evidence of broker market power. The estimates for the coefficients on loan characteristics show that the broker profit increases in the loan amount and the interest rate on the loan. Other attributes of the loan also matter for the broker profits. A hybrid loan implies a 28% increase in the broker profit. Likewise loans with limited documentation or stated doc-

umentation increase the profit estimates by 33% and 18% with the strongest effects for smaller size loans. Loans with prepayment penalties also generate higher estimates for broker profits with a marginal effect of 29%. Similarly, the refinancing generates greater profits, with estimated marginal effects of approximately 16%. The effect on profits is almost doubled when the refinancing takes cash out.

The cumulative loan to value ratio and the FICO score have economically small effects on the estimated broker profits. Likewise other borrower characteristics have relatively small impact. Interestingly, brokers with a longer history of originating loans for New Century are able to earn higher profits. The evidence is consistent with the strength of the broker–lender relationship affecting broker profits and that more experienced brokers have higher bargaining power with the borrowers.

The positive and economically significant marginal effects of many mortgage attributes are consistent with the brokers having greater bargaining power for more complex mortgages. The greater profits for limited and stated documentation loans may also be interpreted as evidence that brokers have greater bargaining power when interacting with less informed borrowers.

Tabule 6 reports parameter estimates for a stochastic frontier model in which we allow the cost function to depend on location and time dummies, as well as the type of rates:fixed or hybrid, the documentation type, if the loan has a penalty for early refinancing, and if the loan is a refinance or not. While the coefficients on the additional variables economically large and estimated precisely, the general pattern of the coefficients in the one-sided error is similar to results reports in Table 5, except the refinancing penalty has a lower impact on the profits than in the more restrictive model.

In order to further understand the results,Table 7 reports statistics for the fitted values based on the estimates reported in Table 5. The results are broken down by loan

type—fixed-rate versus hybrid loans—and by state—California, Florida, and Texas. By comparing the median values of the profits we observe that hybrid loans produce higher profits in all three states and the effects are economically significant. We also observe that the median fraction of broker revenues from broker fees is fairly stable across loans with high broker profits and loans with low broker profits. The finding suggests that the brokers who are able to extract high profits are usually able to to obtain both higher fees from the borrower and also higher yield spread premia from the lender.

Table 8 provides further details on broker revenues and estimated broker profits. For mortgages originated in California, it shows that both median broker revenues and broker profits are higher for loans with low documentation (limited and stated docs) and lower for loans with full documentation. Mortgages to finance the purchase of a home produce lower profits than those obtained to refinance an existing mortgage, with cash-out refinancing being the most profitable. We also show that loans with a prepayment penalty are more profitable than those without.

4.2. Issues of Identification

The stochastic frontier model is estimated from the right tail of the revenue distribution. Appendix A reports the moment conditions used in the model. We will have difficulty in fitting the one-sided error term if the distribution of the revenues is a symmetric distribution. Empirically, the distribution is far for symmetric; see Figure 3 for a graphical illustration of the fact. The coefficients in the one-sided error distribution are identified by the way in which the right tail of the conditional distribution changes with the conditioning variable. Figure 4 provides graphical evidence that the shape of right tail changes with documentation type. Our empirical estimates of the model indicate that the conditional right tail changes with all our conditioning variables.

4.3. The Effects of Broker Profits on Loan Performance

The effects of broker profits on loan performance are illustrated by Figure 6 which plots, for hybrid loans originated in California, the delinquency rate as a function of months from origination by year of origination for full documentation and stated documentation loans. The subplots on the left show the delinquency rates for low broker profit loans and the subplots on the right show corresponding rates for high broker profits loans. The overall effect is that the delinquency rate tends to be higher for higher broker profit loans, once we condition on loan type.

Our earlier results show that many of the conditioning variables are important the broker profits. To deal with the effect of the conditioning variables, Table 9 reports parameter estimates and marginal effects for a probit model that relates loan delinquency within 12 months of origination to loan, borrower, and broker characteristics and includes the estimated broker profits. The marginal effects are positive for broker profits, suggesting that brokers earned high profits on loans that turned out to be riskier ex post. During the 2002-2005 period, an increase in broker profits by $1000 was associated with a 22 basis point increase in 12-month delinquency rates, all else equal. Loans with limited or stated documentation also have positive marginal effects consistent with the findings of Jiang, Nelson, and Vytlacil (2009). Hybrid loans and loans with prepayment penalties also have positive marginal effects.

5. Conclusion

We study the role of mortgage brokers in the subprime crisis using an extensive sample of loans originated by, formerly, one of the largest subprime loan originators, New Century Financial Corporation. While mortgage brokerage firms originated about 65% of all

subprime loans prior to the crisis, the empirical evidence regarding their incentives and contribution to the subprime crisis remains sparse.

Our work sheds light on the incentive structure for mortgage broker by decomposing broker revenue into a cost and profit component. We find evidence consistent with broker market power that is greater for more complex mortgages and for borrowers who may be less informed. We relate the estimated broker profits to future loan delinquency and find that after controlling for other factors, loans associated with higher broker profits have a greater risk of future delinquency. The establishes a link between broker incentives and delinquency risk in the mortgage market.

Prior to the crisis, mortgage brokers were lightly regulated with some states having no regulation at all.[5] In future work, we plan to exploit differences in regulation of mortgage brokers across states during our sample period to address questions about the likely impact of regulation on the brokers' behavior.

[5]One of the recommendations of the Presidents Working Group on Financial Markets (Progress Update on March Policy Statement on Financial Market Developments, October 2008) was a reform of the mortgage origination process. New legislation sets minimum standards for licensing of mortgage brokers for all states.

References

Altunbas, Y., E. P. M. Gardener, P. Molyneux, B. Moore, 2001. Efficiency in European Banking. European Economic Review 45, 19311955.

Berger, A., L. J. Mester, 1997. Inside the Black Box: What Explains Differences in the Efficiencies of Financial Institutions. Journal of Banking and Finance 21, 895947.

Campbell, J., 2006. Household Finance. Journal of Finance 61, 1553–1604.

Carlin, B., 2009. Strategic Price Complexity in Retail Financial Markets. Journal of Financial Economics 91, 278–287.

Demyanyk, Y., O. V. Hemert, 2009. Understanding the subprime mortgage crisis. forthcoming, Review of Financial Studies.

El-Anshasy, A., G. Elliehausen, Y. Shimazaki, 2006. The pricing of subprime mortgages by mortgage brokers and lenders. George Washington University WP.

Gabaix, X., D. Laibson, 2006. Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets. Quarterly Journal of Economics 121, 505–540.

Garmaise, M., 2009. After the Honeymoon: Relationship Dynamics Between Morgage Brokers and Banks. UCLA, WP.

Green, R. C., B. Hollifield, N. Schürhoff, 2007. Financial Intermediation and the Costs of Trading in an Opaque Market. Review of Financial Studies 20, 275–314.

Greene, W. E., 2002. Econometric Analysis. Prentice Hall, Upper Saddle River, NJ.

Hunt-McCool, J., S. C. Koh, B. Francis, 1996. Testing for Deliberate Underpricing in the IPO Premarket: A Stochastic Frontier Approach. Review of Financial Studies 9, 12511269.

Jiang, W., A. Nelson, E. Vytlacil, 2009. Liar Loans? Effects of Loan Origination and Loan Sale on Delinquency. Columbia Business School, WP.

Keys, B. J., T. Mukherjee, A. Seru, V. Vig, 2008. Did securitization lead to lax screening: evidence from subprime loans. University of Michigan WP.

Koop, G., K. Li, 2001. The Valuation of IPO and SEO Firms. Journal of Empirical Finance 8, 375401.

Kumbhakar, S., K. Lovell, 2000. Stochastic Frontier Analysis. Cambridge University Press, New York, NY.

LaCour-Little, M., 2006. The Pricing of Mortgages by Brokers: An Agency Problem?. California State University at Fullerton WP.

Mian, A., A. Sufi, 2009. The consequences of mortgage credit expansion: Evidence from the U.S. mortgage default crisis. University of Chicago WP.

Palepu, K., S. Srinivasan, A. Sesia Jr., 2008. New Century Financial Corporation. Harvard Business School Review.

Purnanandam, A., 2009. Originate-to-distribute model and the subprime mortgage crisis. University of Michigan WP.

Woodward, S., R. Hall, 2009. The Equilibrium Distribution of prices Paid by Imperfectly Informed Customers: theory, and Evidence from the Mortgage Market. Stanford University WP.

A. Moment Conditions for the Stochastic Frontier Model

The model is:

$$f_{ij} + y_{ij} \equiv w_{ij} = z'_{ij}\gamma + \epsilon_{ij} + \xi_{ij}, \tag{A1}$$

with ϵ_{ij} normally distributed with standard deviation σ and ξ_{ij} exponentially distributed with parameter

$$1/\lambda_{iw_{ij}j} = e^{X'_{ij}\beta}, \tag{A2}$$

with both random variables independent of each other:$\epsilon_{ij} \sim \mathcal{N}(0, \sigma^2)$, and $\xi_{ij} \sim \lambda_{ij}e^{-\lambda_{ij}}$.

Define $q_{ij} = \epsilon_{ij} + \xi_{ij}$, we need the density of q_{ij} to compute the log-likelihood function. Using the formula for the cumulative distribution function for sums of independent random variables,

$$\Pr(q_{ij} \leq q) = \int_0^\infty \Phi\left(\frac{q-s}{\sigma}\right) \lambda_{ij}e^{-\lambda_{ij}s}ds, \tag{A3}$$

with Φ the standard normal cdf. Letting ϕ be the standard normal density, the density

function for q_{ij} is:

$$\begin{aligned}
\frac{1}{\sigma}\int_0^\infty \phi\left(\frac{q-s}{\sigma}\right)\lambda_{ij}e^{-\lambda_{ij}s}ds. &= \int_0^\infty \frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{(q-s)^2}{2\sigma^2}}\lambda_{ij}e^{-\lambda_{ij}s}ds \\
&= \int_0^\infty \frac{1}{\sqrt{2\pi}\sigma}\lambda_{ij}e^{-\frac{q^2+s^2-2qs+2\sigma^2\lambda_{ij}}{2\sigma^2}}ds \\
&= \int_0^\infty \frac{1}{\sqrt{2\pi}\sigma}\lambda_{ij}e^{-\frac{(s-(q-\sigma^2\lambda_{ij}))^2}{2\sigma^2}-\lambda_{ij}q+\frac{1}{2}\sigma^2\lambda_{ij}^2}ds \\
&= \left(1-\Phi\left(-\frac{q}{\sigma}+\sigma\lambda_{ij}\right)\right)\lambda_{ij}e^{-\lambda_{ij}q+\frac{1}{2}\sigma^2\lambda_{ij}^2} \\
&= \Phi\left(\frac{q}{\sigma}-\sigma\lambda_{ij}\right)\lambda_{ij}e^{-\lambda_{ij}q+\frac{1}{2}\sigma^2\lambda_{ij}^2}. \qquad \text{(A4)}
\end{aligned}$$

The third line follows from completing the square, the fourth line from the definition of the normal cdf, and the final line from the symmetry of the normal cdf.

Using the functional form for λ_{ij}, the contribution to the log-likelihood for one observation therefore is

$$\begin{aligned}
\mathcal{L}_{ij}\left(\gamma,\sigma,\beta;w_{ij},X_{ij},Z_{ij}\right) = \ln&\left(\Phi\left(\frac{w_{ij}-Z_{ij}\gamma}{\sigma}-\sigma e^{-X_{ij}\beta}\right)\right) \\
&+\ln\left(e^{-X_{ij}\beta}\right)-e^{-X_{ij}\beta}(w_{ij}-Z_{ij}\gamma)+\frac{1}{2}\sigma^2\left(e^{-X_{ij}\beta}\right)^2. \qquad \text{(A5)}
\end{aligned}$$

Let $(\hat{\gamma},\hat{\sigma},\hat{\beta})$ be the Maximum Likelihood estimates and let $\hat{q}_{ij}$ be the empirical residuals for the model,

$$\hat{q}_{ij} = w_{ij} - Z_{ij}\hat{\gamma}. \qquad \text{(A6)}$$

Differentiating the log-likelihood with respect to the parameters to arrive at the mo-

ment conditions for the model:

$$\frac{\partial \mathcal{L}}{\partial \gamma}: \quad \sum_{ij}\left(\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}(-1/\hat{\sigma})+e^{-X_{ij}\hat{\beta}}\right)Z_{ij}=0 \tag{A7}$$

$$\frac{\partial \mathcal{L}}{\partial \sigma}: \quad \sum_{ij}\left(\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}\left(-\frac{\hat{q}_{ij}}{\hat{\sigma}^2}-e^{-X_{ij}\hat{\beta}}\right)+\hat{\sigma}(e^{-X_{ij}\hat{\beta}})^2\right)=0 \tag{A8}$$

$$\frac{\partial \mathcal{L}}{\partial \beta}: \quad \sum_{ij}\left(\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}\hat{\sigma}-e^{X_{ij}\hat{\beta}}+\hat{q}_{ij}-\hat{\sigma}^2e^{-X_{ij}\hat{\beta}}\right)e^{-X_{ij}\hat{\beta}}X_{ij}=0. \tag{A9}$$

From the properties of the exponential distribution for ξ_{ij},

$$E[q_{ij}|X_{ij}]=e^{X_{ij}\beta}, \tag{A10}$$

and the joint distribution of ϵ_{ij} and ξ_{ij}

$$E[\epsilon_{ij}|q_{ij}]=\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}q_{ij}. \tag{A11}$$

We can interpret

$$\left(\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}(-1/\hat{\sigma})+e^{-X_{ij}\hat{\beta}}\right)$$

and

$$\left(\frac{\phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}{\Phi\left(\frac{\hat{q}_{ij}}{\hat{\sigma}}-\hat{\sigma}e^{-X_{ij}\hat{\beta}}\right)}\hat{\sigma}-e^{X_{ij}\hat{\beta}}+\hat{q}_{ij}-\hat{\sigma}^2e^{-X_{ij}\hat{\beta}}\right)$$

as generalized residuals for the model, which must be orthogonal to the conditioning information.

Table 1: **Loan Characteristics at Origination by Vintage Year** The table reports descriptive statistics for the New Century loan sample, covering the period from 1997 to 2006.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
					Number of loans (×1000)					
Funded	19	35	40	38	45	94	164	243	306	327
Declined	10	40	47	43	25	20	81	62	55	65
Withdrawn	21	44	28	14	21	56	105	309	403	278
					Origination channel (Percentage of funded loans)					
Retail	35	32	30	30	24	16	11	12	15	19
Correspondent	12	14	11	9	5	6	9	12	14	13
Broker	53	54	59	61	71	78	79	76	71	68
					Number of brokers with loans originated for NCEN (×1000)					
Number of brokers	1.7	3.2	4.9	5.3	5.9	9.8	15.3	21.3	26.7	29.4
					Loan program (Percentage of funded broker loans)					
FRM	26	39	35	27	20	29	36	42	41	31
Hybrid	74	61	65	73	80	71	64	58	57	62
Balloon	0	0	0	0	0	0	0	0	1	3
FHA/FNMA/FHLMC	0	0	0	0	0	0	0	0	1	4
					Loan purpose (Percentage of funded broker loans)					
Purchase	19	32	24	23	22	21	30	46	53	53
Refinancing (cash out)	58	51	58	60	60	62	59	49	38	37
Refinancing (no cash)	23	17	17	17	18	17	11	5	8	9
					Documentation type (Percentage of funded broker loans)					
Full docs	69	63	65	66	60	61	60	52	55	58
Limited docs	0	0	0	5	8	5	4	4	2	1
Stated docs	31	37	35	29	32	34	36	44	43	41
					Average characteristics for funded broker loans					
Loan amt (×1000)	108	100	108	115	147	156	169	175	184	191
FICO	606	602	596	584	582	592	608	627	633	630
LTV (%)	71	73	72	70	76	77	76	70	66	67
D/I ratio (%)	27	26	27	29	28	28	28	30	31	30
Prepay penalty (%)	63	71	76	83	83	80	79	76	69	64
APR (%)	12.3	11.6	12.0	12.7	10.6	9.2	8.2	8.3	9.3	10.6
Mortgage rate (%)	9.9	10.1	10.3	11.1	9.7	8.5	7.7	7.6	8.0	8.9

Table 2: **Broker Compensation by Vintage Year** The table reports the average yield spread premium, total broker fees, and broker revenues as a percentage of the funded loan amount by origination year. We also report the number of of brokers doing business with New Century. The sample includes all broker-originated loans funded by New Century, and covers the time period 1997–2006. The first panel reports results for all broker-originated loans, and the next panels condition on loan type and documentation level.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
					All funded broker loans					
YSP	2.1	1.8	1.6	1.6	1.4	1.3	1.3	1.3	1.1	1.1
Total fees	2.9	2.9	2.9	2.7	2.4	2.2	1.9	1.7	1.4	1.4
Broker revenue	5.1	4.7	4.5	4.3	3.8	3.5	3.2	3.0	2.5	2.5
# brokers (× 1000)	1.7	3.2	4.9	5.3	5.9	9.8	15.3	21.3	26.7	29.4
					FRMs with full docs					
YSP	1.9	1.8	1.6	1.6	1.4	1.3	1.2	1.1	1.0	1.0
Total fees	3.5	3.4	3.6	3.3	2.9	2.5	2.2	2.0	1.7	1.7
Broker revenue	5.4	5.2	5.2	4.9	4.3	3.8	3.4	3.1	2.7	2.7
# brokers (× 1000)	0.6	1.4	2.0	1.7	1.7	4.2	8.4	11.3	13.8	13.5
					FRMs with stated docs					
YSP	1.8	1.8	1.6	1.6	1.4	1.2	1.2	1.1	0.9	1.0
Total fees	3.5	3.2	3.1	3.0	2.6	2.4	2.2	1.9	1.6	1.7
Broker revenue	5.3	5.0	4.7	4.6	4.0	3.6	3.4	3.0	2.5	2.7
# brokers (× 1000)	0.3	1.0	1.2	0.8	0.9	2.3	5.0	8.9	11.4	10.6
					Hybrid loans with full docs					
YSP	2.2	1.8	1.6	1.6	1.4	1.4	1.4	1.5	1.2	1.1
Total fees	2.7	2.7	2.7	2.7	2.5	2.2	1.9	1.8	1.5	1.4
Broker revenue	5.0	4.5	4.3	4.3	3.8	3.6	3.3	3.2	2.7	2.5
# brokers (× 1000)	1.3	2.0	3.3	3.7	4.1	6.8	10.7	13.2	16.4	19.3
					Hybrid loans with stated docs					
YSP	2.1	1.8	1.5	1.6	1.3	1.3	1.3	1.4	1.1	1.1
Total fees	2.8	2.7	2.5	2.4	2.2	2.0	1.8	1.6	1.3	1.3
Broker revenue	4.9	4.5	4.1	4.0	3.6	3.3	3.1	3.0	2.4	2.4
# brokers (× 1000)	0.8	1.5	2.3	2.5	3.1	5.5	9.4	13.3	15.7	18.0

Table 3: **List of Variables** The table provides the definition of the conditioning variables used to estimate the stochastic frontier model.

Variable	Description
	Location Indicators
FL	Loans originated in Florida
TX	Loans originated in Texas
West w/o CA	Loans originated in the West outside CA
South w/o FL, TX	Loans originated in South outside FL and TX
MidWest	Loans originated in Midwest
NorthEast	Loans originated in Northeast
Year dummies for loans originated in 1998—2006 with 1997 as the baseline	
	Loan Characteristics
Loan amt	Loan Amount in dollars
Rate	Loan Interest Rate
Hybrid	Indicator for Hybrid Loans
Limited doc	Indicator for Limited Documentation
Stated doc	Indicator for Stated Documentation
Prepay penalty dummy	Indicator for loans with Prepayment Penalty
Refi	Indicator for refinancing
Refi w/ cash out	Indicator for cash-out refinancing
CLTV	Cumulative Loan to Value Ratio
	Borrower Characteristics
FICO	FICO Score
Borr age	Borrower's Age
Borr separated	Indicator for separated borrower
Borr not married	Indicator for unmarried borrower
	Broker Characteristics
Brk experience	Indicator for Broker with history of 6+ months w/ New Century

Table 4: **Loan Characteristics at Origination by Vintage Year for the Cleaned Sample** The table reports descriptive statistics for the cleaned New Century loan sample, covering the period from 1997 to 2006.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
					Loan program					
FRM	0.16	0.31	0.25	0.15	0.14	0.23	0.26	0.23	0.26	0.24
Hybrid	0.84	0.69	0.75	0.85	0.86	0.77	0.74	0.77	0.74	0.76
					Loan purpose					
Purchase	0.23	0.37	0.29	0.27	0.24	0.22	0.28	0.32	0.3	0.39
Refi (cash out)	0.55	0.46	0.54	0.55	0.59	0.62	0.61	0.62	0.62	0.53
Refi (no cash out)	0.22	0.17	0.17	0.18	0.17	0.16	0.11	0.06	0.08	0.08
					Documentation type					
Full	0.7	0.62	0.65	0.65	0.6	0.6	0.6	0.54	0.61	0.62
Limited	0	0	0	0.05	0.08	0.05	0.04	0.04	0.02	0.01
Stated	0.3	0.38	0.35	0.3	0.32	0.34	0.36	0.42	0.37	0.37
					Fraction of loans seviced by NCEN/OCWEN					
	0.00	0.00	1.00	1.00	0.45	0.30	1.00	1.00	1.00	1.00
					Average loan characteristics					
Loan amt ($\times$ 1000)	99	94	107	118	141	154	173	183	183	161
FICO	598	596	590	578	578	586	600	609	603	599
CLTV (%)	74	79	78	77	78	79	82	82	80	83
D/I ratio (%)	26	25	26	28	28	28	28	29	28	28
Prepay penalty	0.55	0.69	0.75	0.86	0.83	0.81	0.81	0.75	0.70	0.64
APR (%)	12.5	11.8	12.2	12.7	10.8	9.3	8.2	8.1	9.1	10.8
Mortgage rate (%)	10.2	10.3	10.6	11.3	10.0	8.7	7.8	7.5	7.9	9.1

Table 5: **Broker profits** The table reports parameter estimates for the stochastic frontier model developed in Section 3 and equations 16 and 17. The dependent variable is broker revenue, computed as the sum of total broker fees plus yield spread premium. The estimates for the cost function are reported in the first two columns. The average cost is $2864.1. The last two columns show the estimated specification of broker profits. The sample includes all stand-alone broker-originated first liens, and covers the from 1997 to 2006. The benchmark set contains all CA fixed-rate mortgage originated in 1997.

	cost		profit	
	estimate	std. err.	estimate	std. err.
constant	3651	(37.93)	136.1150	(7.6905)
FL	-1078	(13.18)	0.3195	(0.0096)
TX	-1470	(13.08)	0.3410	(0.0119)
West w/o CA	-958.5	(12.44)	0.1685	(0.0088)
South w/o FL, TX	-1398	(11.86)	0.3685	(0.0089)
MidWest	-1293	(10.45)	0.1770	(0.0082)
NorthEast	-965.4	(12.25)	0.3020	(0.0080)
1998	-199.4	(41.16)	-0.0985	(0.0328)
1999	-86.11	(40.54)	-0.1875	(0.0319)
2000	70.92	(40.81)	-0.3130	(0.0319)
2001	256.3	(39.42)	-0.3415	(0.0308)
2002	417.3	(37.94)	-0.3355	(0.0299)
2003	461.5	(37.56)	-0.3945	(0.0300)
2004	581.9	(37.54)	-0.4190	(0.0300)
2005	416.2	(37.65)	-0.4385	(0.0300)
2006	283.9	(38.01)	-0.5570	(0.0301)
loan amt			0.8745	(0.0035)
rate			0.0775	(0.0022)
hybrid			0.2800	(0.0051)
limited doc			0.3260	(0.0236)
stated doc			0.1795	(0.0092)
loan amt × limited doc			-0.1900	(0.0101)
loan amt × stated doc			-0.1035	(0.0043)
Prepay penalty dummy			0.2875	(0.0052)
Refi			0.1640	(0.0075)
Refi w/ cash out			0.1520	(0.0066)
CLTV			0.0019	(0.0002)
FICO			-0.0008	(0.0001)
FICO $\geq$ 620			0.0019	(0.0068)
Borr age			0.0050	(0.0002)
Borr separated			-0.0495	(0.0223)
Borr not married			-0.0122	(0.0040)
Brk experience			0.0498	(0.0042)
$\log(\sigma_C^2)$	13.88	(0.00566)		
Observations	385,984		385,984	

Table 6: **Broker profits-alternative specification of the cost function** The table reports parameter estimates for the stochastic frontier model developed in Section 3 and equations 16 and 17. The dependent variable is broker revenue, computed as the sum of total broker fees plus yield spread premium. The estimates for the cost function are reported in the first two columns. The last two columns show the estimated specification of broker profits. The sample includes all stand-alone broker-originated first liens, and covers the from 1997 to 2006. The benchmark set contains all CA fixed-rate mortgage originated in 1997.

	cost		profit	
	estimate	std. err.	estimate	std. err.
constant	2923	(39.12)	196.3699	(11.1931)
FL	-1021	(-13.09)	0.2905	(0.0096)
TX	-1258	(-13.98)	0.2380	(0.0121)
West w/o CA	-914.5	(-12.42)	0.1485	(0.0088)
South w/o FL, TX	-1268	(-12.07)	0.3125	(0.0090)
MidWest	-1256	(-10.6)	0.1560	(0.0083)
NorthEast	-855.5	(-12.47)	0.2435	(0.0082)
1998	-137	(-40.89)	-0.1270	(0.0327)
1999	-103.2	(-40.27)	-0.1770	(0.0318)
2000	-9.318	(-40.58)	-0.2770	(0.0319)
2001	181.7	(39.2)	-0.3060	(0.0308)
2002	364.4	(37.7)	-0.3115	(0.0299)
2003	436.1	(37.33)	-0.3840	(0.0300)
2004	559.5	(37.31)	-0.4085	(0.0300)
2005	409.3	(37.4)	-0.4340	(0.0300)
2006	290.5	(37.77)	-0.5610	(0.0301)
loan amt			0.8770	(0.0036)
rate			0.0780	(0.0022)
hybrid	369	(7.482)	0.1005	(0.0063)
limited doc	-1.369	(19.61)	0.3295	(0.0273)
stated doc	13.67	(7.071)	0.1780	(0.0107)
loan amt $\times$ limited doc			-0.1915	(0.0105)
loan amt $\times$ stated doc			-0.1055	(0.0045)
Prepay penalty dummy	199.6	(7.784)	0.1930	(0.0064)
Refi	268.1	(11.05)	0.0395	(0.0093)
Refi w/ cash out	142.7	(10.28)	0.0915	(0.0084)
CLTV			0.0020	(0.0002)
FICO			-0.0008	(0.0001)
FICO $\geq$ 620			0.0009	(0.0068)
Borr age			0.0051	(0.0002)
Borr separated			-0.0484	(0.0223)
Borr not married			-0.0147	(0.0040)
Brk experience			0.0500	(0.0042)
$\log(\sigma_c^2)$	13.87	(0.00569)		
Observations	385984			

Table 7: **Broker profits** The table reports summary statistics on broker revenues, total fees and yield spread premia (rows one through three), and broker costs and profits all measured in $ as estimated in Table 4 (rows four and five). The last two rows report descriptive statistics for total broker fees, as a fraction of broker revenue, for loans with low broker profits (bottom profit quartile) and high broker profits (top profit quartile). Results are reported for California, Florida, and Texas, and cover the sample period 1997 to 2006.

	FIX							HYBRID						
	mean	std dev	1%	25%	median	75%	99%	mean	std dev	1%	25%	median	75%	99%
							California							
Brk revenue	6385	3003	1594	4300	5850	7889	16150	7481	3471	1955	3714	6860	9256	18695
Fees	4341	2472	411	2716	3965	5520	12656	4658	2657	405	2895	4255	5950	13385
YSP	2044	1471	0	1024	1720	2750	6975	2823	1769	0	1581	2453	3680	8740
Brk costs	4088	152	3451	4067	4112	4233	4233	4073	156	3451	4067	4112	4112	4233
Brk profits	2370	2580	215	584	1342	3300	11910	3386	3199	270	942	2344	4854	14551
				Low profits							Low profits			
Brk fees/rev	0.67	0.2	0.1	0.57	0.71	0.79	1	0.58	0.21	0.07	0.49	0.62	0.73	1
				High profits							High profits			
Brk fees/rev	0.68	0.18	0.12	0.57	0.7	0.79	1	0.63	0.15	0.15	0.54	0.63	0.74	1
							Florida							
Brk revenue	4396	2208	1200	2923	3960	5323	12165	5203	2784	1315	3310	4600	6376	15179
Fees	3111	1757	295	1925	2829	3995	8910	3226	2088	83	1835	2859	4175	10437
YSP	1285	1051	0	650	1050	1620	5320	1977	1414	0	1050	1634	2511	7200
Brk costs	2954	189	2373	2989	2989	3034	3154	2973	157	2373	2989	3034	3155	3155
Brk profits	1466	1786	266	492	802	1642	8851	2221	2456	309	659	1250	2858	12109
				Low profits							Low profits			
Brk fees/rev	0.67	0.2	0.05	0.57	0.7	0.81	1	0.57	0.22	0	0.43	0.6	0.72	1
				High profits							High profits			
Brk fees/rev	0.71	0.17	0.14	0.61	0.73	0.82	1	0.62	0.18	0.07	0.53	0.64	0.74	1
							Texas							
Brk revenue	3471	1722	1051	2412	3113	4100	9745	4338	2587	1051	2760	3724	5081	14940
Fees	2177	1195	119	1463	1955	2670	6252	2476	1670	25	1500	2150	3024	8885
YSP	1294	872	0	770	1120	1600	4606	1862	1323	0	1054	1552	2240	7225
Brk costs	2573	165	1981	2464	2598	2642	2762	2551	185	1981	2464	2597	2642	2762
Brk profits	955	1303	269	405	550	907	6738	1730	2311	317	557	871	1811	12229
				Low profits							Low profits			
Brk fees/rev	0.62	0.19	0	0.54	0.6	0.74	1	0.55	0.2	0	0.45	0.58	0.67	1
				High profits							High profits			
Brk fees/rev	0.62	0.15	0.14	0.55	0.6	0.72	1	0.56	0.15	0.07	0.48	0.58	0.65	0.88

Table 8: **Broker Revenues and Estimated Profits in California for Different Loan Types** This table reports the broker revenues and estimated broker profits as estimated in Table 4 for different types of loans originated in California during the sample period from 1997 to 2006. The revenues and profits are measure in dollars.

	Mean	Std. Dev.	5%	25%	Median	75%	95%
All Mortgages							
Revenue	7228.86	3400.15	2895.80	4832.00	6613.40	8950.00	13702.50
Profits	3152.17	3097.56	355.19	824.07	2070.44	4513.90	9457.39
Fixed Rate							
Revenue	6385.03	3003.22	2520.00	4300.00	5850.00	7888.75	11979.50
Profits	2370.18	2580.25	289.88	584.22	1341.79	3300.43	7642.95
Hybrid Rate							
Revenue	7481.43	3470.60	3055.00	5022.00	6860.00	9256.25	14120.00
Profits	3386.22	3199.42	389.01	941.70	2344.40	4853.85	9881.73
Full Doc							
Revenue	7030.38	3272.90	2860.00	4725.95	6425.00	8677.21	13250.00
Profits	2967.55	2961.58	344.19	776.23	1892.14	4224.10	8994.19
Limited Documentation							
Revenue	7430.10	3511.13	2945.00	4951.00	6819.75	9221.50	14109.00
Profits	3338.83	3215.37	367.19	887.37	2274.59	4799.66	9851.77
Stated Documentation							
Revenue	7750.56	3677.64	3007.50	5089.50	7147.50	9678.00	14907.75
Profits	3641.22	3406.43	401.63	977.80	2627.68	5259.93	10541.82
Purchase							
Revenue	6751.14	3333.49	2550.00	4374.00	6110.00	8410.00	13120.50
Profit	2772.02	2936.56	308.22	651.47	1598.35	3970.74	8837.44
No Cash Out Refinancing							
Revenue	6886.43	3344.71	2773.00	4530.00	6202.13	8500.00	13169.00
Profit	2898.62	3024.85	338.99	709.90	1733.57	4081.55	9006.82
Cash Out Refinancing							
Revenue	7419.52	3409.47	3069.00	5020.00	6817.50	9135.00	13932.96
Profit	3301.71	3143.01	380.57	914.86	2269.20	4701.61	9679.05
No Prepayment Penalty							
Revenue	6806.25	3639.60	2307.50	4222.75	6062.50	8592.21	13711.50
Profit	2958.68	3218.92	301.92	652.80	1675.48	4215.34	9541.55
Prepayment Penalty							
Revenue	7244.70	3389.85	2928.00	4850.00	6630.00	8960.00	13702.50
Profit	3159.42	3092.70	357.54	832.66	2084.20	4525.66	9457.05

Table 9: **Broker Profits and Loan Performance** Parameter estimates and marginal effects for a probit model using loan delinquency within 12 months of loan origination as the dependent variable and broker profits, and loan, borrower, and broker characteristics as independent variables. The sample includes all stand-alone broker-originated first liens, and covers the from 2002 to 2005. The benchmark set contains all CA fixed-rate mortgage originated in 2002.

	Coefficient	Std. err.	Marginal effect	Std. err.
Constant	2.779	(0.181)		
FL	-0.0156	(0.022)	-0.0008	(0.00114)
TX	0.161	(0.025)	0.0098	(0.00175)
West w/o CA	0.0708	(0.021)	0.0040	(0.00123)
South w/o FL, TX	0.157	(0.021)	0.0094	(0.00140)
MidWest	0.211	(0.019)	0.0127	(0.00131)
NorthEast	0.133	(0.019)	0.0077	(0.00122)
2003	-0.279	(0.025)	-0.0135	(0.00111)
2004	0.180	(0.024)	0.0101	(0.00143)
2005	0.397	(0.024)	0.0253	(0.00181)
log loan amt	-0.205	(0.013)	-0.0108	(0.00071)
hybrid	0.163	(0.015)	0.0079	(0.00068)
limited doc	0.068	(0.032)	0.0038	(0.00185)
stated doc	0.246	(0.011)	0.0139	(0.00067)
Prepay penalty dummy	0.0261	(0.013)	0.0014	(0.00065)
Refi	-0.135	(0.021)	-0.0075	(0.00122)
Refi w/ cash out	-0.019	(0.019)	-0.0010	(0.00104)
CLTV	0.011	(0.0005)	0.0006	(0.00003)
FICO	-0.006	(0.0002)	-0.0003	(0.00001)
FICO $\geq$ 620	-0.014	(0.020)	-0.0008	(0.00102)
Borr age	-0.004	(0.0005)	-0.0002	(0.00003)
Borr separated	0.066	(0.058)	0.0037	(0.00347)
Borr not married	0.105	(0.010)	0.0057	(0.00060)
Brk experience	-0.002	(0.011)	-0.0001	(0.00060)
Brk profits (in $1000)	0.042	(0.002)	0.0022	(0.00013)
Log likelihood	-34562.206			
Observations	250,569			

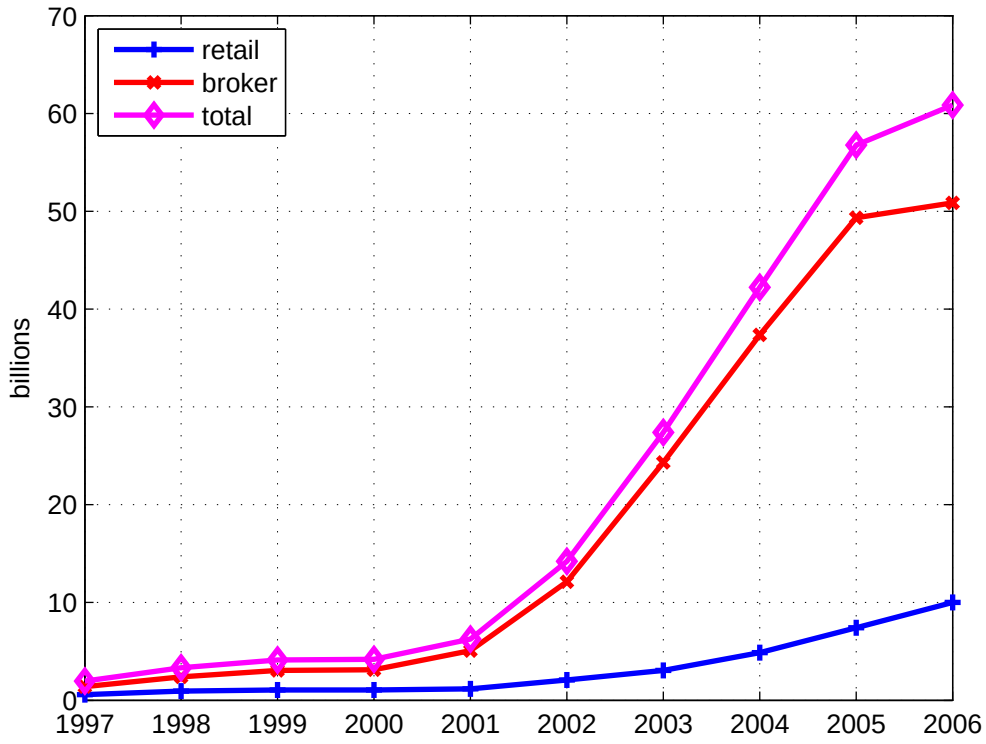


Figure 1: **Origination volume.** Annual loan amount funded by New Century from 1997 to 2006.

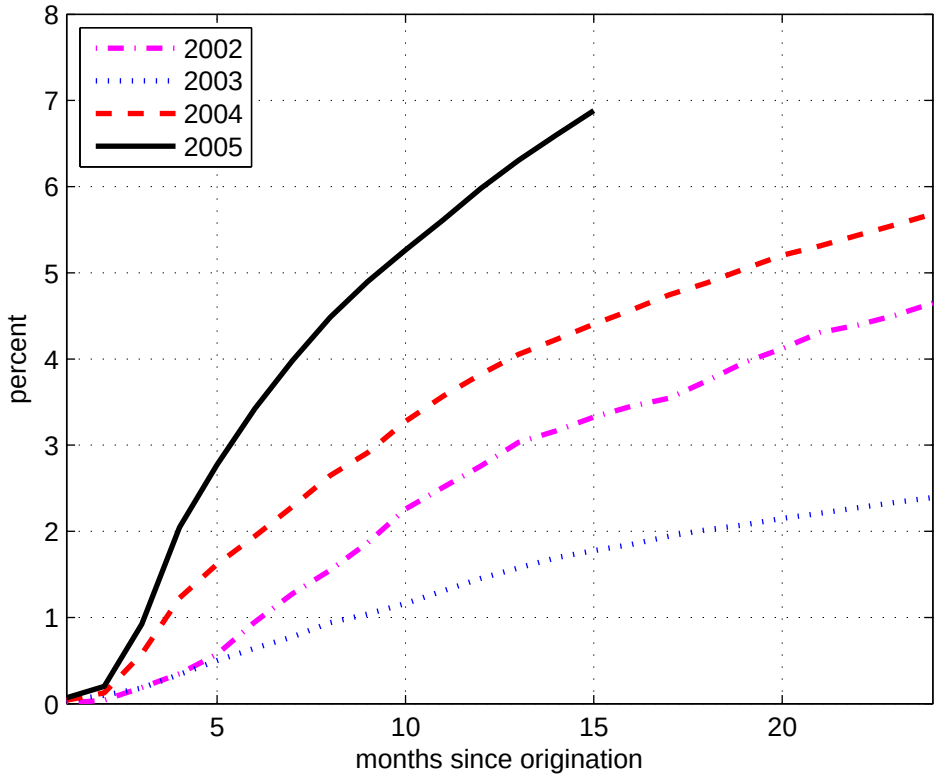
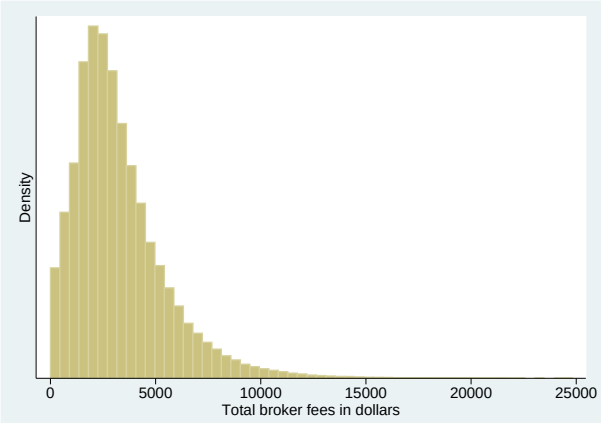
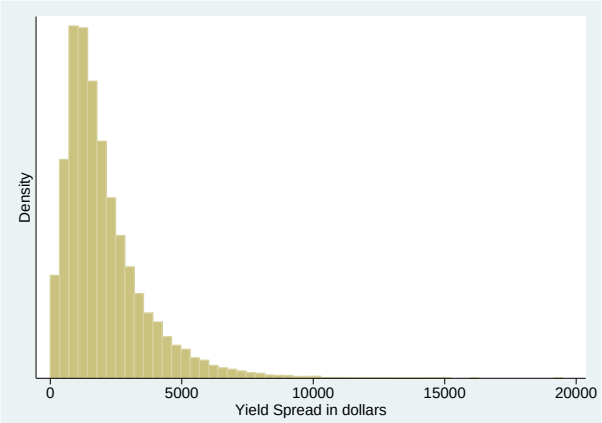


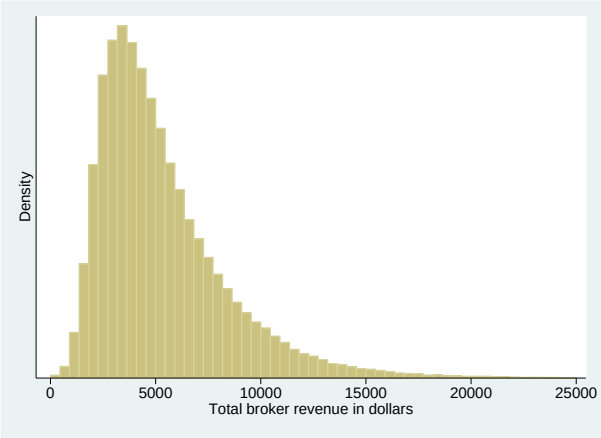
Figure 2: **Delinquency.** Percent of loans delinquent as a function of months from origination by year of origination.



Panel a: Fixed fees.

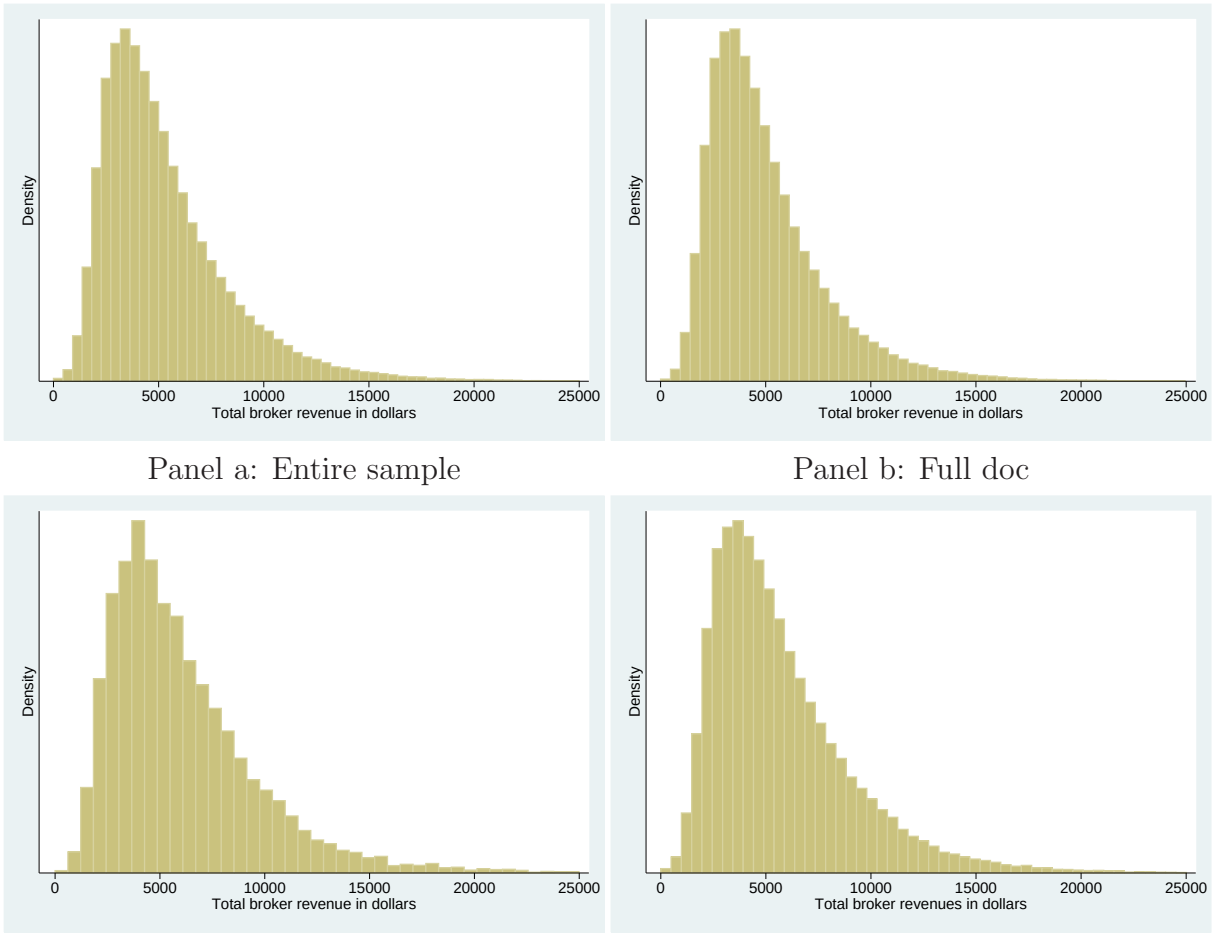


Panel b: Yield spread



Panel c: Brokers total revenues

Figure 3: **Broker revenues:** The figures report the unconditional distribution of broker fees, yields spreads, and the total broker revenues for unmatched first lien mortgages in our sample.



Panel a: Entire sample

Panel b: Full doc

Panel c: Limited documentation

Panel d: Stated documentation

Figure 4: **Broker revenues across document types** The figures report the unconditional distribution of broker revenues, and the distributions of the broker revenues conditional on the documentation type of the loan.

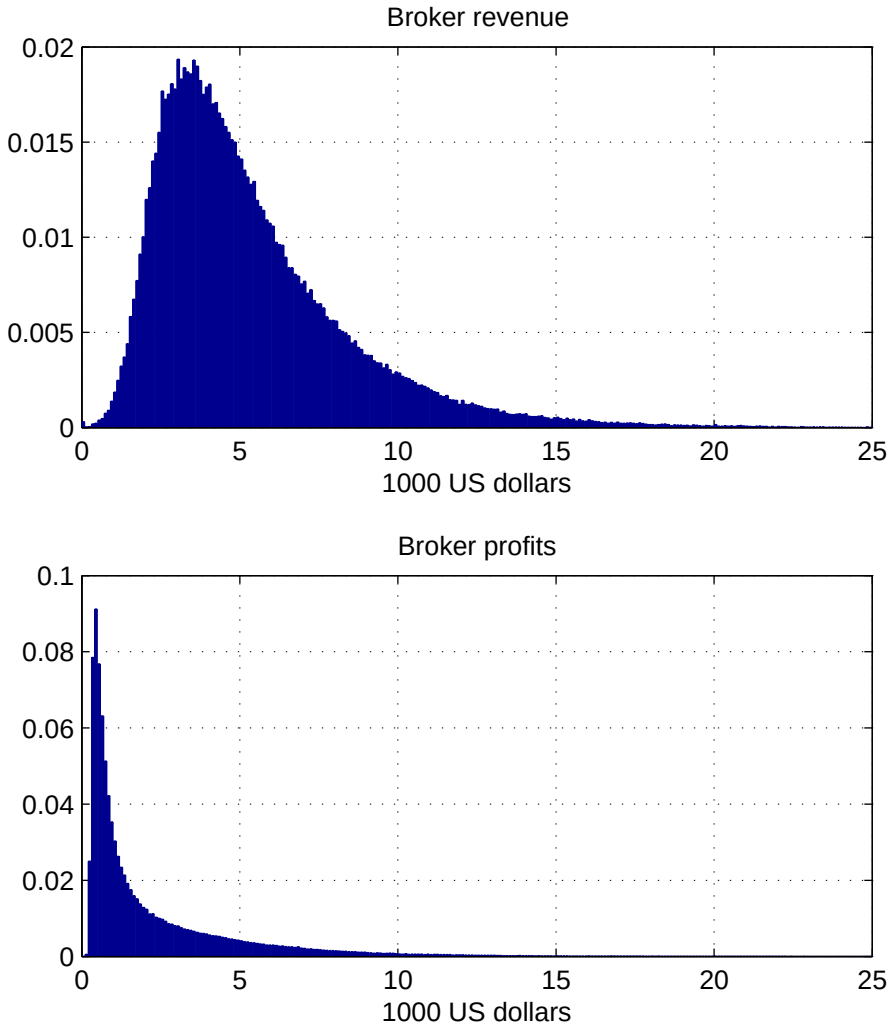


Figure 5: **Broker revenues and profits.** These results are for the estimation in Table 5.

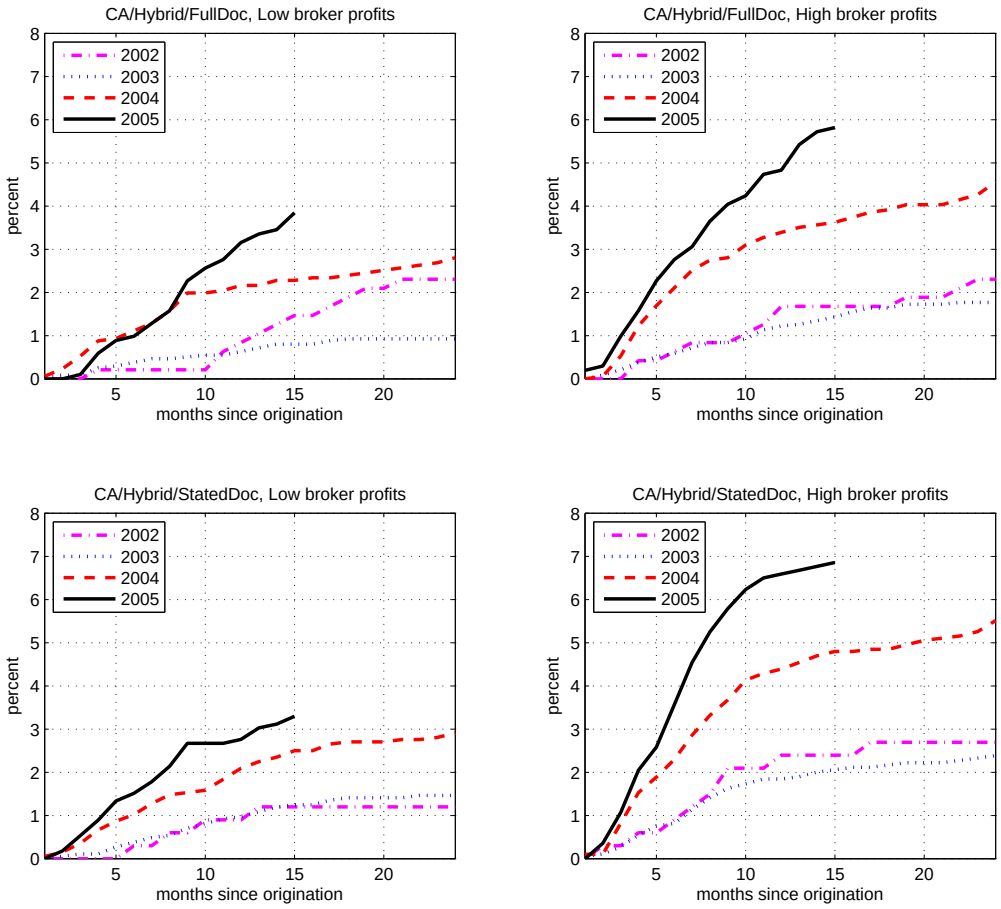


Figure 6: **Delinquency.** The delinquency rate are computed based on the results reported in Table 9 for loans originated in California. The top left plot shows the delinquency rates for loans with low broker profits and full documentation, the bottom left plots the rate for low broker profit loans with stated documentation. The plots on the right shows the corresponding rates for higher broker profits loans with either full or stated documentation.