Appendix to "Diagnosing Consumer Confusion and Sub-Optimal Shopping Effort: Theory and Mortgage-Market Evidence"

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I. Earlier Research

We review earlier research on mortgage origination charges, along with research on mortgage interest rates, non-real-estate consumer lending, and car-buying, that is relevant to this study. The auto and auto-lending markets are similar to the mortgage market in that transactions have large dollar values and prices are negotiated.

A. Research on mortgage costs

Susan E Woodward (2003) studied complete mortgage terms—loan rate plus lender/broker upfront charges, the YSP, and charges for other settlement services. She investigated the relation between the origination charges that borrowers pay directly and those they pay indirectly through the YSP, finding that a dollar of added YSP is associated with only a 55-cent decline in direct charges. This finding suggests that borrowers may not be aware that a higher mortgage interest rate puts cash in the broker's pocket that the borrower should be able to extract from the broker by insisting on a lower direct origination charge.

Another finding in Woodward's study was that borrowers who rolled all closing costs into the rate on their loan, by negotiating a direct charge of zero, paid total closing costs that were $1,500 lower than those of other borrowers, other things being equal. Borrowers who shop on rate alone may be financially more savvy than other borrowers, or may simply benefit from a shopping strategy that allows them to compare loans with only a single number, rate, and liberate themselves from attempting the rate-point trade-off.

Marsha Courchane and David Nickerson (1997) studied the interest rates and the charges labeled as points, but not other cash charges, on loans from retail bank lenders. Direct lenders have internal rate sheets. Some borrowers are quoted a standard rate, and some are quoted from other cells having higher interest rates on the rate sheet. When a borrower pays an interest rate higher than the standard rate, the difference is called an "overage." Overages are economically equivalent to yield-spread premiums. Courchane and Nickerson find that minorities on average

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pay more in overages than do other borrowers. Studying a different set of lenders, Harold A. Black, Thomas P. Boehm and Ramon P. DeGennaro (2003) also found that minorities pay higher overages. Neither of these studies has data on cash fees charged to borrowers, so they are not conclusive about loan terms for minorities. Woodward (2003), using data reporting both rate and closing fees, did find that minority borrowers pay more than other borrowers.

As we noted in the body of the paper, borrowers receive a disclosure form called a Good Faith Estimate (GFE) prior to committing to a mortgage. Mark D. Shroder (2007) compared GFEs to the HUD-1 settlement statements giving the actual terms for 146 FHA loans. He found that most GFEs overestimate borrowers' ultimate cash origination charges by a small amount, but that for a minority, the GFE underestimates by a large amount. He also finds that when lender/broker charges are higher, so are the charges for title services, a finding consistent with the findings in Susan E. Woodward (2008) and Woodward (2003). He hypothesizes that this is consistent with the "sheep-shearing" view of the market: borrowers vulnerable to over-charge in one category are vulnerable in others also. The sheep can be sheared on both sides.

Shroder gave special attention to whether transactions showed evidence of uproar (divorce or unusual delinquency in property taxes) in transactors' lives. Such uproar could raise transaction costs by increasing the complexity of the transaction, raising the time pressure to get the deal closed, or reducing the seller's or buyer's resistance to agent opportunism. He found that transactions with indications of trouble had total lender or broker and title cash fees that were higher by $1,050, other things equal, in a set where the average was $2,060. He finds it implausible that a divorce or delinquent property taxes could so inflate transaction costs. He concludes that the present disclosure rules do not sufficiently improve the negotiating position of buyers and sellers relative to service providers to prevent personal difficulties from influencing the fees they pay. His evidence is less than conclusive because he did not include the charges labeled as points in his measure of closing costs.

Subprime mortgages are intended for borrowers with higher default risks; their higher interest rates compensate the lender for that risk. Marsha Courchane, Brian Surette and Peter Zorn (2003) find that a significant fraction of borrowers eligible for prime loans actually take out more expensive subprime loans. The authors find that the standard predictors of default—credit scores, assets, and load-to-value ratio—explain much of the difference in what type of loan borrowers get, but other factors also matter, including shopping behavior (Do borrowers search for best rates and affordable monthly payments? Are they familiar with mortgage market terms?), adverse life events (divorce, illness, unemployment, large drop in income), channel (borrowers using brokers are more likely to get subprime loans than those who use lenders, other things equal), and age (older borrowers are more likely to have subprime loans, other things equal). After taking account of these factors, they found no meaningfully higher likelihood

that minorities would take out subprime loans.

Minority borrowers' loan applications are rejected more often than are the applications of white borrowers. Michael LaCour-Little (1999) reviews this literature. Higher rejection rates may be a factor in the reluctance of minority borrowers to shop aggressively for the best mortgage terms. Research on differences in rejection rates is inconclusive on the question of whether higher rates for minorities are the result of discrimination or a lower fraction of qualified borrowers among minority applicants for mortgages.

Mark A. Cohen (2008), for car loans, and Woodward (2003), for mortgages, find that African-American borrowers pay their loan brokers roughly $500 more than do other borrowers. The differential for car loans is, of course, a much larger fraction of the amount of the loan.

The race differences in broker origination charges result from some combination of taste-based pure racial discrimination, as described by Gary Becker (1957), differences in costs of serving customers not reflected in explanatory variables but correlated with race, and differences in shopping behavior, possibly the result of racial differences in the way that shoppers are treated by mortgage brokers and direct lenders. Less effective shopping and higher rejection rates may arise from related sources.

B. Findings from the auto-loan market

The institutional arrangements of the market for auto loans closely parallel those of the home mortgage market. Car buyers can get a loan from their local bank or credit union, or they can arrange financing at the point-of-sale with the auto dealer who sells them a car. The loan broker, usually a separate individual within a dealer's facility, operates with a rate sheet similar to the rate sheet of the mortgage broker, but simpler. Car lenders make finer distinctions on credit quality than do mortgage lenders. The car loan rate sheets generally have five credit-quality categories, with lower rates for better credit. As with the mortgage rate sheet, the lender pays the dealer more for making loans at higher rates, and this amount is exactly analogous to a yield-spread premium. Cohen (2008) reports that on average, minority car buyers/borrowers agree to higher rates that result in additional payment from the wholesale lender to the car dealer of about $500 per loan on new cars averaging $25,000 in value. One feature of the auto loan market not found in the mortgage market is that wholesale auto lenders put a ceiling on the upward adjustment of interest rate for the two highest credit-quality buckets, but not for the lower-quality buckets. Cohen found that to evade these caps, auto loan brokers sometimes moved borrowers to a lower quality credit bucket than they merited (based on their credit scores) so as to quote them higher rates, which were sometimes accepted by the car buyers.

C. Research outside of lending

Beyond mortgage lending there is considerable research that can help interpret the findings in this study. In particular, the research on the purchase terms for cars, which are sold in markets where price is negotiated, is relevant. The relevant facts and principles found in this work, discussed in more detail below, are:

1) Education, income, comparison shopping, and tolerance for engaging in negotiation all have a measurable relation to prices consumers pay in markets for large purchases such as autos.

2) Minorities and women pay more for cars than do other consumers. Much, but not all, of the difference is related to education, income, and the willingness to comparison shop and negotiate.

3) Consumers capture a smaller share of the potential gains from trade when they do not know the size of the potential surplus.

Ian Ayres and Peter Siegelman (1995) found that minorities and women pay more for new cars than do white men. Fiona Scott-Morton, Florian Zettelmeyer and Jorge Silva-Risso (2007) investigated the role of shopping strategy in these differentials. They find that success in shopping depends on knowledge of dealer invoice price, visits to additional dealers, patience, and taste or distaste for bargaining and shopping. The best deals arise from a combination of market knowledge and willingness to negotiate.

Fiona Scott-Morton, Florian Zettelmeyer and Jorge Silva-Risso (2003) examined auto purchases on and off the Internet. Offline, women pay 0.5 percent more and minorities an extra 2 percent ($500 again), compared to white men, for equivalent cars. Sixty percent of this price differential for in-person shopping is related to income, education, already having a car (making search costs lower) and taste for shopping. For online car purchases, where customers also negotiate price, there are no race or sex differences in car prices.

Mark Aguiar and Erik Hurst (2007) demonstrate the general importance of shopping and comparing prices, in markets with posted prices, in their study of expenditure, consumption, and time spent shopping. At retirement, households spend more time shopping and find better prices.

Ian Ayres (2001) explores four possible explanations for why minorities and women pay more for cars. The first two are Becker-type discrimination, involving a dislike of the buyer by the seller. Ayers leans against these sources of differential treatment because dealerships hire many minority salespeople and some dealerships are minority-owned, but nonetheless behave like other dealerships. He then considers the possibility that minority buyers might have more distaste for bargaining or be more inelastic demanders because they have less knowledge of market prices. The Scott-Morton *et al.* studies confirm both as sources of differential pricing.

Meghan Busse, Jorge Silva-Risso and Florian Zettelmeyer (2006) study two different types of auto sales promotions. In one, a car maker offered car buyers a \$1,000 cash rebate. In another, the car maker offered \$1,000 to dealers who sell such a car. Standard economic analysis suggests that the two different promotions should have identical impacts on price paid and the number of cars sold. In fact, they gave very different results. When the buyers collect the rebate, both buyer and car salesman know of the existence of the promotion. When the seller gets the bonus, only the sellers, not the car buyers, know of its existence. When car buyers get the rebate, consumers get 70 to 90 percent of the benefit of it—their total price net of the rebate is about \$800 lower than with no promotion. When car makers do a promotion to dealers, consumer benefit is only 30 to 40 percent of the surplus amount. The promotions direct to consumers were much more successful in selling additional cars than were the partially concealed promotions to salesmen only.

The parallel between the auto dealer promotions and the mortgage market is that the lender payments to brokers are well understood by the mortgage brokers, but perhaps not by consumers. The parallel is not perfect–an important difference is that the YSP is not a temporary promotion by lenders, but now a permanent part of how lenders distribute their wholesale terms to mortgage brokers. Despite the permanence of the wholesale arrangements, it seems that few consumers understand them.

II. Bargaining over the Terms of the Mortgage

In this appendix, we explore the simple view that the borrower and the mortgage broker make a bargain that maximizes their joint surplus. We let r be the coupon rate on the mortgage, $p(r)$ be the payment at annual rate for a 30-year amortized fixed-rate mortgage at coupon rate r, r_b be the borrower's personal discount rate, $Y(r)$ be the yield-spread premium available from wholesale lenders, per dollar of principal, L be the cash origination charge the borrowers pays to the broker, T^* be the time (in years) to paying off the mortgage in the mind of the borrower, $A(r,T)$ be the remaining principal on a 30-year mortgage at coupon rate r as of time T, $V(r,T)$ be the present value of a \$1 per year flow lasting for T years discounted at rate r, and $\tilde{V}(r,T)$ be the present value of \$1 T years from now.

The borrower's net benefit of the loan, per dollar of principal, is

$$1 - p(r)V(r_b, T^*) - A(r, T^*)\tilde{V}(r, T^*) - L. \tag{1}$$

The first term is the benefit of the principal supplied by the lender, the second is the present value of the loan payments, the third is the present value of the payoff of the principal at T^*, and the fourth is the cash closing payment to the broker.

The broker's benefit from originating the loan, per dollar of principal, is the

total origination charge less the broker's cost, k,

$$Y(r) + L - k. \tag{2}$$

The surplus is the sum of the borrower's and broker's benefits,

$$1 - p(r)V(r_b, T^*) - A(r, T^*)\tilde{V}(r, T^*) + Y(r) - k. \tag{3}$$

The cash origination charge, L, drops out of the sum, so it does not appear in the rest of the discussion. In terms of an Edgeworth-box analysis of this bargaining problem, the maximization of the surplus places the parties on their contract curve and the choice of L picks a point on the contract curve. Maximization of the surplus is a matter of choosing the coupon rate r or, equivalently, choosing the YSP, $Y(r)$.

Lenders solve a complicated problem in setting the rate sheets that determine the YSP as a function of the coupon rate, $Y(r)$. The central factor is that a higher coupon rate implies a higher present value of the payments, a benefit that the broker shares through the YSP. One important subsidiary factor is the likelihood of early payoff of the mortgage from the sale of the house or refinancing. Payoffs tend to occur earlier for high-rate mortgages, a factor the lender builds into the curvature of the YSP as a function of the coupon rate. Because the present value of the payments on lower-coupon loans falls short of the amount of the principal, the YSP will be negative below some coupon rate. Lenders also consider any market power they may have in the wholesale market, though we believe this factor is not very important—brokers know the quoted terms of numerous lenders every day for identical mortgages, so the wholesale market has close to perfect Bertrand competition. Lenders adjust their YSPs daily or even more often to modulate their lending flows and reflect changes in market rates.

Our best source of information about the YSP is a group of rate sheets from a dozen large lenders for May 31, 2000. Figure 1 gives averages for May 31, 2000, for a 30-day lock period, with a cost to the broker, $k = \$2500$, which we believe is reasonable. The error bars are one standard error—they become larger at both ends of the line because fewer lenders quoted premiums so far from the popular interest rates. The figure shows the benefit of the loan to a hypothetical borrower with a discount rate of 9 percent per year, from equation (1). The benefits are based on a time to payoff of $T^* = 7$ years, which we believe is typical.

Figure 1 shows how the joint surplus varies with the coupon interest rate. For the case shown, it is clear that the efficient loan would have the lowest interest rate the lender offers and thus the most negative YSP. The YSPs that lenders offer plainly under-compensates a borrower for the higher payment of a loan with a positive YSP, if the borrower's discount rate is not too much higher than the coupon rate. A borrower who had enough cash in an investment of equal risk to a mortgage, paying less than 10 percent per year, could use cash withdrawn from that account to induce a broker to originate a loan with a large negative YSP and

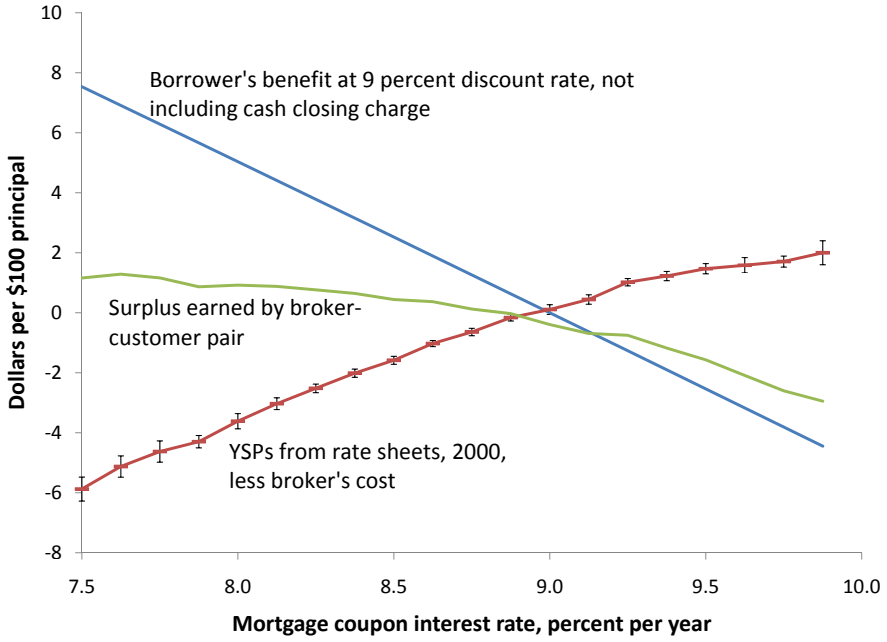

Figure 1. The Yield-Spread Premium on May 31, 2000, Borrower's Benefit, and the Joint Surplus

come out ahead—the interest rate implicit in the YSP, under the assumptions of these calculations, is higher than 10 percent. If the borrower expects to repay the loan in much less than seven years, the opposite conclusion follows; the maximum surplus occurs with a large YSP and no cash origination charge.

Figure 2 considers the relation between the coupon rate and the joint surplus for borrowers at three coupon rates, with expected time to payoff of 7 years. At the bottom is the same surplus as in Figure 1. This borrower gains relatively little from the loan transaction, given that the borrower's discount rate is close to the rate of a mortgage that has zero YSP. This borrower-broker pair is best off by choosing the lowest available coupon interest rate offered by the lender and using some of the resulting benefit to the borrower to pay the lender the corresponding negative YSP.

The middle line in Figure 2 shows the surplus to the pairing of a broker with a borrower whose discount rate is 10 percent. The surplus is substantial—because the discounted cost to the borrower of repaying the loan is less than the principal—but is essentially flat across the interest rates. Thus the provisions of the rate sheet achieve close to indifference in this case, with the loan expected to last for 7 years and the borrower's discount rate somewhat above the par rate. The top line in the figure shows that, when the borrower has a discount rate of 15 percent, the

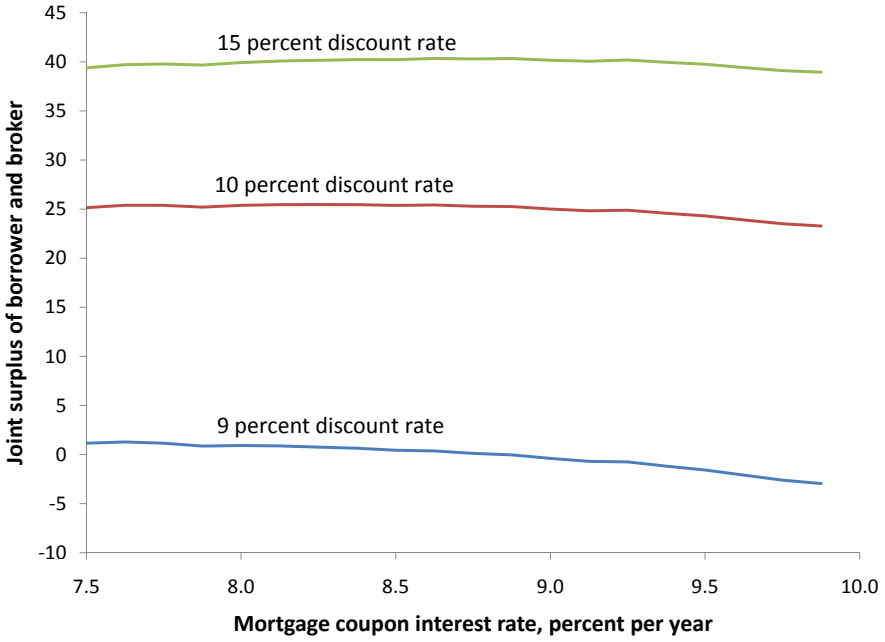

Figure 2. Joint Surplus of Borrower and Broker, 7-Year Expected Mortgage Life

surplus is even higher and reaches a vaguely defined maximum at 8 5/8 percent.

Figure 3 shows the same three lines for borrowers who plan to pay the loan off in 4 years. In these cases, the surplus rises with the interest rates to maximums at 9 1/4 percent for the low-discount borrower and 9 1/2 percent for the two higher-discount borrowers. It pays the broker-borrower pair to take advantage of the higher YSP that goes with the higher coupon rate, because the borrower only pays the higher rate for 4 years.

The basic message of the investigation of the joint surplus as a function of the interest rate and resulting YSP is that lenders offer YSP schedules in their rate sheets that make the broker-borrower pair close to indifferent to the interest rate if they plan to pay the loan off in seven years. No compelling economic force tells the pair what rate to pick in that case. Our data show fairly wide dispersion across rate categories, consistent with the lack of such a compelling force. Maximization of the joint surplus would push the terms toward higher YSPs and lower cash origination charges if the borrower expects to repay in less than seven years or has an unusually high discount rate.

III. Distribution of the Broker's Margin

Under our conclusion that mortgage customers shop from only two brokers, we can calculate the distribution of the broker's margin—the amount that borrowers

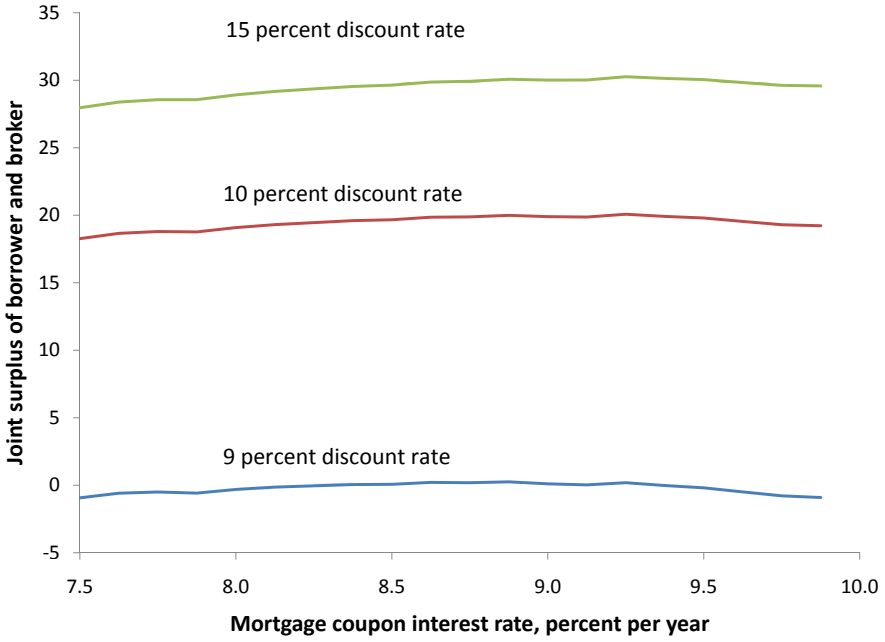

Figure 3. Joint Surplus of Borrower and Broker, 4-Year Expected Mortgage Life

leave on the table, in the sense that they pay more than the broker's reservation price, which is his cost. The margin is the difference between the actual charge, the cost of the broker with the higher of the two costs, and the broker's own cost, the lower of the two costs. The Appendix explains how we calculate this distribution. Figure 4 shows the distribution of the margin, along with the distributions of the broker's cost by loan, and the distribution of the total origination charge. Note that the distribution of broker cost by loan lies to the left of the distribution of cost by broker, shown in Figure **??**, because the shopping process gives more business to the lower-cost brokers. The low-cost brokers appear more often among loans than their share of the broker population. The distribution of cost by loan is somewhat irregular in comparison to the other distributions shown in this paper, because the minimum function gives high weight to the shape of the distribution of cost for fairly low cost. The irregularity is a feature of the underlying data, not an artifact of our calculation process.

Note that the distribution of broker margin in Figure 4 is not terribly different from the exponential that Antje Berndt, Burton Hollifield and Patrik Sands (2010) assume in their approach to measuring the distribution of broker cost. But they also assume that cost is normally distributed, an assumption less supported by our results. Of course, their approach has the advantage that it does not rest, as ours does, on a strong assumption about borrowers' shopping strategies.

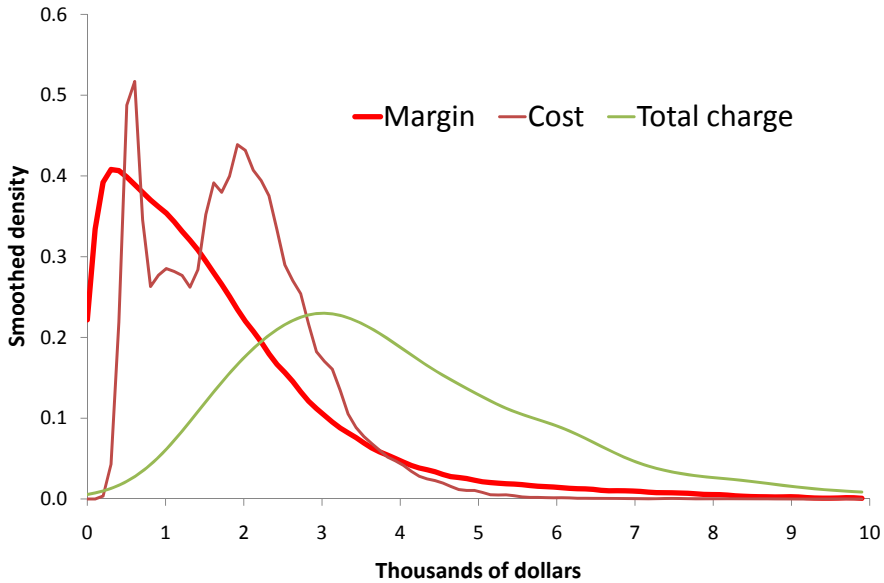

Figure 4. Distributions of Broker Margin, Broker Cost, and Total Origination Charge, by Loan

IV. Details of Shopping Calculations

A. *Calculating smoothed densities from quantiles*

The standard kernel smoother, such as `ksdensity` in MatLab, takes a vector interpreted as a set of random draws from a distribution and returns the smoothed density of that distribution. Over a mesh $P_i = i/M$, the quantiles of the distribution $F(x)$, say x_i, with $F(x_i) = P_i$, can be interpreted as random draws from the distribution—they all have equal probability. Thus the application of the kernel smoother to x_i yields the smoothed density of x.

B. *Inferring the distribution of broker cost*

Recall that

$$H(\tau) = 1 - (1 - B(\tau))^N - NB(\tau)(1 - B(\tau))^{N-1}. \tag{4}$$

Our approach to inverting this equation to find the distribution of broker cost B given the distribution H from our descriptive model is to find the quantiles $k(P)$

such that

$$H(k(P)) = 1 - (1-P)^N - NP(1-P)^{N-1}. \tag{5}$$

The distribution $P = B(k)$ is the inverse of the quantile function $k(P)$.

C. *Inferring the distribution of broker margin*

Each borrower makes two independent draws of brokers, with costs k_i and k_j. The winning broker's margin is $|k_i - k_j|$. For the 299^2 combinations of the two, measured at the percentiles k_i of the broker cost distribution for the base case, we compute the margin. We treat the resulting vector of margins as a set of independent draws with equal probability from pairs of brokers. We then apply the kernel smoother to that vector to find the smoothed density. We do the same for $\min(k_i, k_j)$ to find the distribution of the cost among loans.

D. *Simulating outcomes for more intensive shopping*

Given the quantile function for broker cost, $k(P)$, we calculate the distribution, $H_N(\tau)$ of the second-lowest cost, τ, for $N = 3$ and $N = 4$ from equation (5), taking $\tau = k(P)$. We invert $P = H_N(\tau)$ to get the quantile function $\tau_N(P)$.

V. Bootstrap

Our bootstrap procedure repeats all of the calculations in the paper 100 times by drawing random samples with replacement from the loan data. These calculations include the 299 quantile estimations and the calculations of the distributions of broker costs based on shopping from two brokers and the calculations of the benefits from shopping from three or four brokers. Thus, for example, the standard errors in Table 5 are based on recalculating the table 100 times from estimation results for the resampled data.

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