Adverse Selection and Credit Rationing in a Crisis[1]

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How costly was it for banks to extend additional credit to households at the onset of the financial crisis? We present empirical evidence on the role of adverse selection and moral hazard in determining the cost of new lending following a discontinuous rise in the cost of capital in the summer of 2007. We use unique data on millions of credit card accounts for a leading commercial bank to analyze the effects of the rise in the cost of capital on new and continuing lending and consumer delinquency. Consistent with credit rationing theories, the rise in interest rates resulting from the increased cost of capital led to a sharp increase in default rates for new borrowers, despite a rise in the relative creditworthiness of new borrowers along observable dimensions. Our results suggest an important role for informational frictions in determining credit availability during the financial crisis.

Keywords: Credit rationing, adverse selection, financial accelerator.

JEL Classification: E21, G12

Introduction

An important focus of research on credit crises has been that bank lending may be curtailed by weak bank balance sheets, despite potentially profitable opportunities to lend to households and firms (Gertler and Kiyotaki, 2010). A related but distinct motivation for reductions in bank lending during such periods is a rise in financial frictions associated with adverse selection and moral hazard which reduces the profitability of lending opportunities.

Credit crises are typically associated with an increased cost of capital for banks. Jaffee and Russell (1976) and Stiglitz and Weiss (1981) show that changes in the cost of capital may translate into movements not only in interest rates but also in the supply of funds banks are willing to lend. They note that as a bank raises the interest rate it charges on loans, the probability of default may rise for one of two reasons. First, the pool of borrowers willing to take up the loan at that interest rate worsens, leading to increased adverse selection. Second, if the cost of default is fixed, the rise in interest rates may make it less attractive for any given borrower to repay the loan, leading to increased moral hazard.

According to credit rationing theories, a bank facing an increased cost of capital recognizes that raising interest rates will provoke some borrowers to default (for either moral hazard or adverse selection reasons), reducing the profitability of the marginal borrower. Since the bank may not be able to raise its profits by raising interest rates as the cost of capital rises, credit may be "rationed" to certain consumer groups and other groups may be excluded from credit markets altogether. Adams et al. (2009) document the importance of these types of informational frictions in reducing lending to subprime borrowers in the auto loan market.

Recent theoretical work has extended these ideas to analyze how informational frictions affect the availability of credit during a financial crisis (Chari et al., 2010; Kurlat 2010). If the

financial crisis leads to a rise in the cost of capital, this may worsen informational frictions through the mechanisms described above.

We seek to quantify the importance of such effects in determining the profitability of bank lending to consumers during the recent financial crisis. To identify the effects of interest rates on consumer default behavior, we make use of a discrete change in the cost of capital in the summer of 2007, in the last months before the onset of the 2008 -2010 recession. On July 31, 2007, two Bear Stearn's hedge funds with substantial subprime mortgage portfolios filed for bankruptcy. This was followed a week later on August 7, 2007 by BNP Paribas suspending withdrawals from investment funds that were invested in subprime loans. Figure 1 shows that these events led to an abrupt increase in the cost of capital for financial firms: the spread on asset backed commercial paper jumped from close to zero to over 60 basis points.[2]

We study the consequences of this event for consumer lending using a unique dataset of millions of credit card accounts for a leading commercial bank. We show that the rise in the cost of capital led to an abrupt increase in interest rates, and an abrupt fall in credit limits. Consistent with credit rationing theories, raising interest rates on new customers led to a discontinuous rise in the rate of default for new cohorts. The rise in defaults occurred even though the creditworthiness of new borrowers improved abruptly relative to existing customers along observable dimensions. These findings suggest that the abrupt rise in APR's led to a substantial increase in adverse selection of new customer cohorts.

In contrast, we find little effect of the rise in APR's on default behavior of existing cohorts. This suggests that the dominant informational friction caused by the rise in APR's was adverse selection as opposed to moral hazard. In the case of credit cards, moral hazard may arise from a rise in APR's because a rise in payments raises the benefits of defaulting relative to paying on

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[2] See Kacperczyk and Schnabl (2010) for a detailed discussion of these events.

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time. In distinguishing between adverse selection and moral hazard effects, we rely on the fact that an increase in the probability of default for *new* cohorts of borrowers may arise either because these borrowers are adversely selected or because of diminished incentives to to repay (moral hazard); while a rise in default for *existing* cohorts must primarily reflect moral hazard effects, since the selection of borrowers is essentially fixed in this case. This approach is similar to Karlan and Zinman's (2009) approach to distinguishing between adverse selection and moral hazard effects in an experimental setting using the distinction between initial offer and subsequent "contract" interest rates.

Credit rationing theories predict that as the cost of capital rises, the bank may find it unprofitable to lend to certain groups of customers for which informational frictions are particularly large—that is, they may decide to "red-line" credit to certain observable groups (Riley, 1987). Our finding that the creditworthiness of new borrowers improved abruptly relative to existing customers in response to the increase in the cost of capital is consistent with this prediction.[3]

Credit rationing has also been proposed as one potential explanation for the "stickiness" of credit card interest rates in response to movements in the underlying cost of capital. In line with the previous literature, we find that the spread of interest rates over the cost of capital moves inversely with the cost of capital (Berger, 1992). The credit card interest rates in our dataset are, however, much less sticky than those observed in the 1980's and early 1990's.[4] Our evidence suggests that interest rates to both new and existing borrowers increased in response to the abrupt rise in the cost of capital we study.

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[3] This effect is closely related to the "flight to quality" in financial accelerator models in response to an increase in financial frictions. See Gertler and Gilchrist (1996) for a discussion of these effects.

[4] During this period, many credit cards had essentially fixed interest rates. See e.g., Ausubel (1991) , Stango (2000), Knittel and Stango (2003) for a discussion of credit card interest rates in the 1980's and early 1990's.

The recent literature on credit constraints has also emphasized the importance of credit commitments in determining the allocation and terms of credit in times of crisis. Ivashina and Scharfstein (2010) emphasize that new lending to firms was curtailed substantially during the financial crisis relative to credit to existing borrowers who were able to draw down credit lines. We observe an abrupt decline in credit limits to both new and existing customers, and a decline in the number of new accounts. The rise in the relative creditworthiness of new customers along observable dimensions also suggests that the bank tightened its standards for new credit following the sharp rise in the cost of capital. However, an existing credit line seems to have afforded little protection for existing customers against the increase in the cost of credit.

Our work is related to a small number of papers that have studied moral hazard and adverse selection problems in consumer credit. These include analyses by Edelberg (2004) and Adams et al. (2009) for the automobile loan market, Ausubel (1999) and Agarwal et al. (2010) for the credit card market, Karlan and Zinman (2009) for micro-lending in a developing country, and Freedman and Jin (2010) for the online lending site Prosper.com. Our study is also related to Gross and Souleles' (2002a,b) analysis of consumer spending and default behavior in the credit card market.[5]

One important difference between our study and existing experimental work using credit card data is that the increase in the cost of capital we analyze led to a much more broad-based increase in interest rates than arises in experimental studies. Experimental studies typically analyze how the selection of borrowers responding to an offer depends on the terms of the offer. However, such manipulations hold fixed the alternative offers available at that point in time,

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[5] Our analysis of default in the credit card market is also related to studies of consumer bankruptcy such as Tertilt et al. (2010). Importantly, however, many credit card defaults do not lead to consumer bankruptcy.

even from the same bank. The adverse selection response to the terms of an individual offer may be larger than those arising from a broad-based increase in interest rates.

From a macroeconomic standpoint, informational frictions such as adverse selection and moral hazard drive a wedge between the cost of capital and the interest rate faced by consumers. Dynamics in this wedge may play an important role in propagating the effects of macroeconomic and financial shocks on the economy, as discussed in recent work by Curdia and Woodford (2009), Chari et al. (2010) and Kurlat (2010) and emphasized more generally in the literature on the financial accelerator (Bernanke, Gertler and Gilchrist, 1999), and have important implications for the transmission of monetary policy (Gertler and Gilchrist, 2001).[6]

1. Theoretical Framework

Our theoretical framework for analyzing adverse selection and moral hazard effects in consumer credit markets follows the seminal work of Jaffee and Russell (1976). Consider the following simple two period model. Let us consider a large number of individuals with identical observable characteristics, where an observably identical group is indexed by i. Each individual has the utility function $U(C_1^i, C_2^i)$ defined over first and second period consumption, and receives an exogenous income stream. Loans are taken out at the beginning of period 1 and bears the one-period grow interest rate R. If a loan is repaid, this occurs at the beginning of period 2.

The decision to repay a loan versus defaulting depends on the trade-off between the interest rate and an assumed cost of default, denoted Z. This is a catch-all for a variety of potential costs

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[6] Our study is also related to the analysis in Puri et al. (2010) of how German Landesbanken responded to negative shocks to their balance sheets related to the US subprime crisis. Their study focuses on how banks respond to a negative shock to their balance sheets, whereas ours focuses on the effects of an abrupt shock to the bank's cost of capital.

of default, including worsened future borrowing ability and the social stigma associated with default.[7]

Consider a loan of size L^*. A borrower who decides to repay the loan receives the following consumption in the two periods, given an exogenous income stream (Y_1^i, Y_2^i). For simplicity, we assume Y_1^i is given. However, Y_2^i is stochastic and given by $Y_2^i = \bar{Y}_2^i + \varepsilon$, where $\varepsilon \sim F$.

If the borrower decides to repay the loan, he or she receives:

$$C_1^i = Y_1^i + L^*$$

$$C_2^i = Y_2^i - RL^*$$

Alternatively, if the borrower decides not to repay the loan, he or she receives:

$$C_1^i = Y_1^i + L^*$$

$$C_2^i = Y_2^i - Z$$

We can immediately observe the source of both the moral hazard and adverse selection problems in this context. Let us first consider moral hazard. The borrower chooses to default whenever $Z < RL^*$. The incentives to default therefore rise with the interest rate R and the loan size L^* and fall with the cost of default Z^i.

Adverse selection occurs because the incentives to take a loan depend on the costs of default Z^i and the distribution of second period income F which cannot be observed by the lender. If the probability of default is positive, a borrower with a lower cost of default Z faces a lower expected cost of taking on a loan. As the interest rate R increases, the pool of borrowers becomes more adversely selected in that only individuals with a sufficiently high probability of default—i.e., a low value of Z^i or particularly risky income distribution F—are willing to take the loan.

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[7] See Tertilt et al. (2010) for a discussion of alternative sources for the cost of default.

2. Data and Institutional Facts

We study these issues using a unique dataset of millions of credit card accounts for a leading commercial bank. The dataset covers the period between the second quarter of 2000 and the third quarter of 2009, and it includes information on APR, credit limit, FICO score, an internal risk score, and delinquency (90+days past due) and default behavior. We merge these data with credit bureau information on the cardholder's mortgages, auto and student loan balances, the length of her credit history, the total number of secured and unsecured credit lines, and the total credit card and home equity line amounts.

The borrower's FICO score captures the borrower's repayment behavior on all currently open credit lines and it is updated on a quarterly basis after credit issuance. In addition, the lender developed an internal behavior scoring model based on the account repayment behavior with this institution, to assess the likelihood of delinquency in the following 6 months. Table 1 contains summary statistics on selected variables.

Our data also include aggregate commercial paper spreads and amounts issued and outstanding from the Federal Reserve Board, and credit card receivable asset backed securities for the major credit card issuers, from Bloomberg. Asset backed commercial paper and longer maturity securities are a major source of financing for credit card companies. The most active players in this market are the very large credit card issuers, which finance the majority of the credit card receivable they originate this way, while most of the smaller issuers do not participate in this market. Unlike the mortgage-ABS, the credit card ABS have implicit recourse and the credit card issuer retains the risk of the securitized pool deteriorating. Such recourse can take the form of the issuer adding high quality securities to the pool or removing early amortization

triggers so to keep the quality of the pool constant (Calomiris and Mason, 2004). Our dataset contains all the credit card accounts issued by the financial institution that provided the data, irrespective of whether they were financed through securitization or not.

3. Evidence

An important difficulty in evaluating the predictions of asymmetric information theories regarding a change in the cost of capital is that such changes are often gradual and closely related to factors that directly influence a household's desire to borrow. For example, declines in the Federal Funds rate during recessions are closely related to declines in employment with a direct effect on household balance sheets. Moreover, changes in the cost of capital are typically small, making their effects difficult to disentangle from other slow-moving changes in the macroeconomic environment.

Figure 1 illustrates the sharp spike in the spread on asset backed commercial paper that occurred at the start of August 2007. The shock occurred early in the financial crisis and reflected relatively obscure developments in the balance sheets of investment funds invested in subprime assets. The summer of 2007 was a relatively tranquil period in terms of the overall macroeconomic environment, lying substantially before the rise in unemployment and decline in GDP that would befall the economy in the subsequent recession. It is unlikely that the typical credit card customer was aware of, or had much reaction to events in the commercial paper market that summer.

In this regard, the sharp movements in the cost of capital in the summer of 2007 afford a unique opportunity to study how a shock to the cost of capital affects consumer borrowing behavior. Our key assumption is that while the cost of capital experienced a discrete change in

August 2007, other variables with a direct influence on households' propensity to borrow and default—such as households' current and expected future incomes—did not change discontinuously at this point. Given this assumption, our approach is to use a discontinuity-based approach to analyze the implications of this change in the cost of capital on household borrowing behavior, and in particular, the severity of the adverse selection and moral hazard problems faced by the bank.

We begin by studying how the bank adjusted interest rates in response to this sharp increase in the cost of capital. Figure 2 presents a graph of the prime rate, along with the Annual Percentage Rates (APR's) charged to new and existing credit card customers. The graph shows that, in line with previous research, a 1 percentage point drop in the prime rate corresponds to drop in the interest rates to both new and existing customers of much less than 1 percentage point. Thus, while there is a systematic tendency for APR's to move in the same direction as the prime rate, the spread between the APR and the prime rate declines is markedly negatively correlated with the prime interest rate. Figure 3 illustrates the relationship between prime interest rates and spreads directly over the 2000-2009 period.

Figure 2 illustrates that interest rates rose sharply and dramatically—by more than one percentage point—following the rise in the cost of capital in the summer of 2007 that we discuss above. The initial rise in APR's affected both new and existing credit card customers. Subsequently, however, the rise in APR's to existing customers was reversed, while the APR's to new customers remained persistently high. The bank also adjusted the line sizes offered to customers in response to the abrupt increase in the cost of capital. Figure 4 illustrates the change in the line sizes offered to new and existing customers following the August 2007 cost shock.

The figure shows that the bank abruptly reduced the lines sizes of both new and existing customers in responds to the cost shock.

Recent research has shown that the distinction between new and continuing credit lines is crucial in assessing the nature of a reduction of credit availability in the economy (Ivashina and Scharfstein, 2010). We find that an existing customer relationship with the bank provided a consumer with only modest protection against the effects of an increase in the cost of capital on the terms of lending. As we describe above, APR's rose for both new and existing customers, though the increase was more persistent for new customers. However, because the reduction in line size applied to both new and continuing customers, and because new customers account for only a small fraction of the bank's total outstanding credit commitments in a given month, most of the reduction in total credit commitments following the cost shock arose from a reduction in line sizes to existing customers. Figure 5 illustrates that the cost shock was associated with a dramatic reduction in the bank's total outstanding credit commitments—but the majority of the reduction was associated with a reduction in credit commitments to existing customers, as opposed to a reduction in credit commitments to new customers.

These events allow us to study both adverse selection and moral hazard effects caused by an increase in the cost of capital. The default behavior of new customer cohorts following the cost shock may reflect both moral hazard and adverse selection effects. On the other hand, adverse selection is relatively unimportant for existing customers since attrition rates are low over short horizons. Increases in the default rate for existing customers can therefore be interpreted as arising from moral hazard concerns.

Evidence on Adverse Selection Effects

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Credit rationing theories such as the framework described in section 2 predict that a rise in interest rates will lead the borrowing pool to deteriorate, raising the probability of default. Figure 6 depicts default rates for new customers, along with the APR to new customers for the time period surrounding the cost shock we analyze. The measure of default we consider is the probability that a customer is at least 90 days overdue after 1 quarter on file with the bank— essentially, the probability that the customer fails to make even the first payment on his or her credit card.

The figure shows an abrupt rise in default coinciding exactly with the APR increase in the summer of 2007. The default probability nearly doubled over the period when APR's were increased. This abrupt rise in the probability of default suggests a substantial worsening in the pool of borrowers following the APR increase. This increase in the probability of default occurred despite an apparent improvement in the characteristics of new borrowers in terms of observable characteristics. Figure 7 depicts average FICO scores for new and existing customers since 2000. The FICO scores of new and existing customers appear to comove closely before the summer of 2007. After the summer of 2007, the FICO scores of new customers rose substantially relative to existing customers, suggesting that if unobservable factors were unchanged, these new cohorts should have had exceptionally *low* default probabilities. The increase in the FICO scores of new versus existing customers over this period is consistent with the prediction of the credit rationing literature that lenders may wish to "red-line" or restrict borrowing to less creditworthy customers in response to an increase in the cost of capital.

Figures 8 and 9 depict alternative views of how the abrupt increase in APR's affected the probability of default for different cohorts. Each line in Figure 8 depicts the probability of default for a given cohort at a particular point in time. The measure of default in this figure is the

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probability that the customer is at least 90 days overdue at a given point in time. This probability

rises steadily as the cohort ages, and its members have had more time to default.[8] Cohorts

entering the sample following the abrupt APR increase in the summer of 2007 had sharply

different default probabilities than preceding cohorts. Similarly, Figure 9 depicts the probability

of default as a function of cohort age. The figure shows a sharp break in the probability of

default of cohorts following the increase in APR's in the summer of 2007.

Evidence on Moral Hazard Effects

The rise in the cost of capital in the summer of 2007 led to a rise in interest rates to both new

and existing customers. To study the effect of the cost shock on households' incentives to

default (moral hazard) we study how this change affected the default probabilities for existing (as

opposed to new) customers. Figure 8 suggests that the effect of the increase in APR's on the

default rate of existing customers was small. Existing cohorts deviated little from the previous

"age" profile of default in response to the rise in APR's in the summer of 2007. These results

suggest that adverse selection as opposed to moral hazard effects were the main informational

frictions faced by the bank in responding to the increase in the cost of capital it experienced in

the summer of 2007.

4. Conclusions and Future Work

We exploit an abrupt increase in the cost of capital emanating from the commercial paper

market in the summer of 2007 to study the adverse selection and moral hazard effects of an

increase in interest rates. We document quantitatively large effects of the increase in APR's on

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[8] The kink at 36 months occurs because this is when many credit cards are renewed. The bank chooses not to renew cardholders with a high probability of future default, lowering the rate of increase of these default cures.

the adverse selection of the pool of new bank customers, but much smaller moral hazard effects on the behavior of existing customers.

In future work, we would like to carry out a more detailed quantitative analysis of the effects of the APR increase on default behavior for different customer segments, as well as of the implications of these effects for the profitability of the bank. We would also like to use for formal regression discontinuity approaches to estimate the qualitative results documented here.

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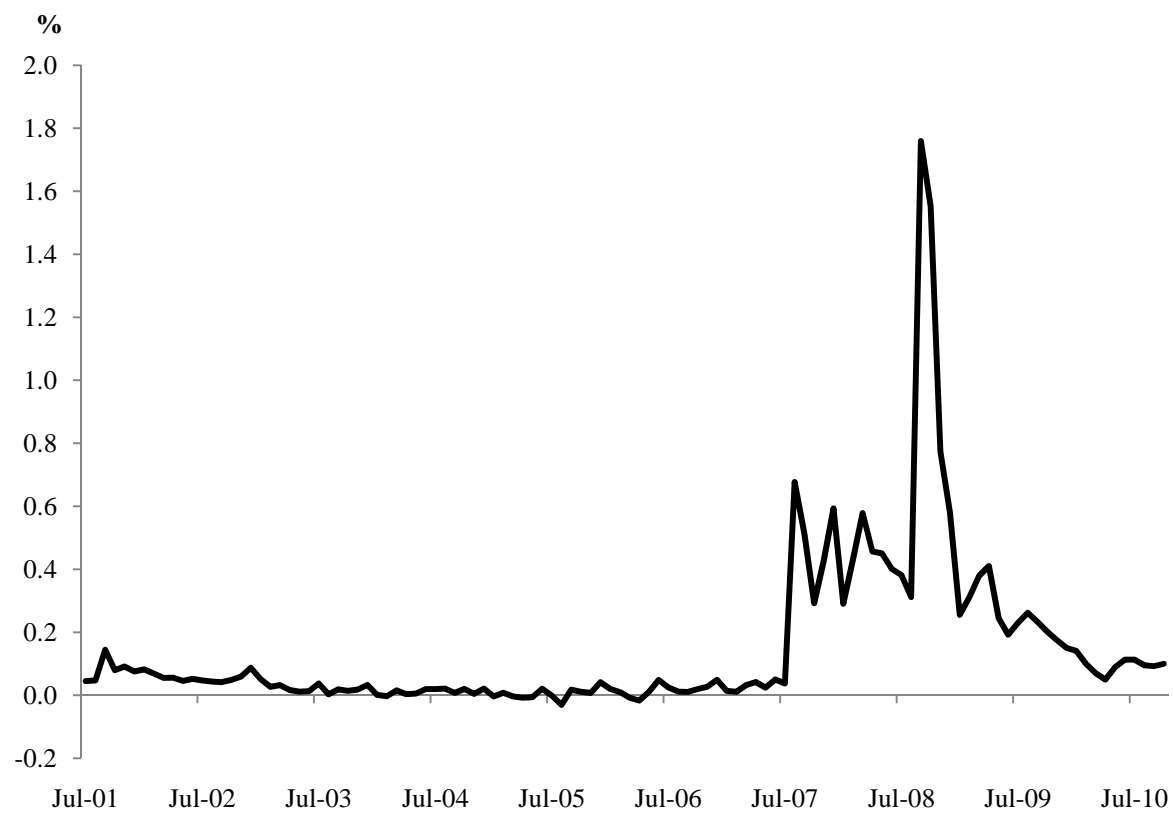
Figure I: Asset Backed Commercial Paper Spread over Federal Funds Rate
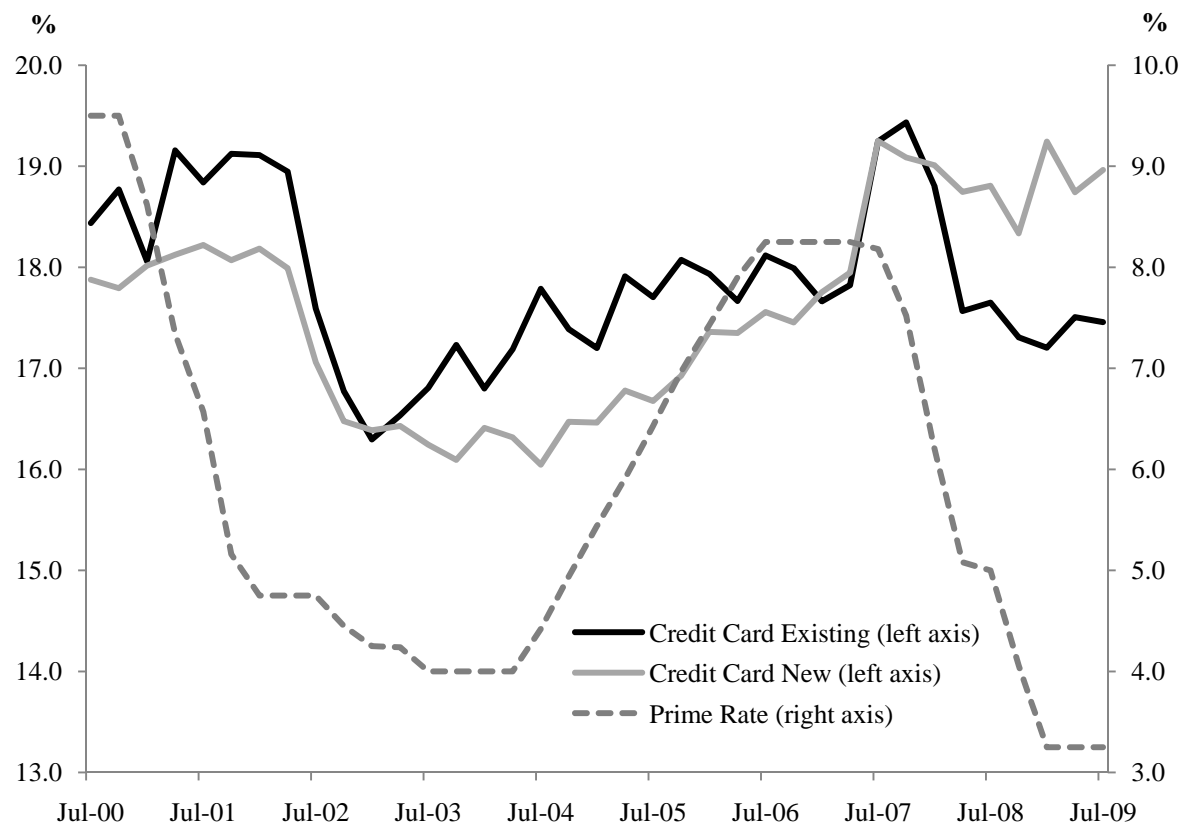
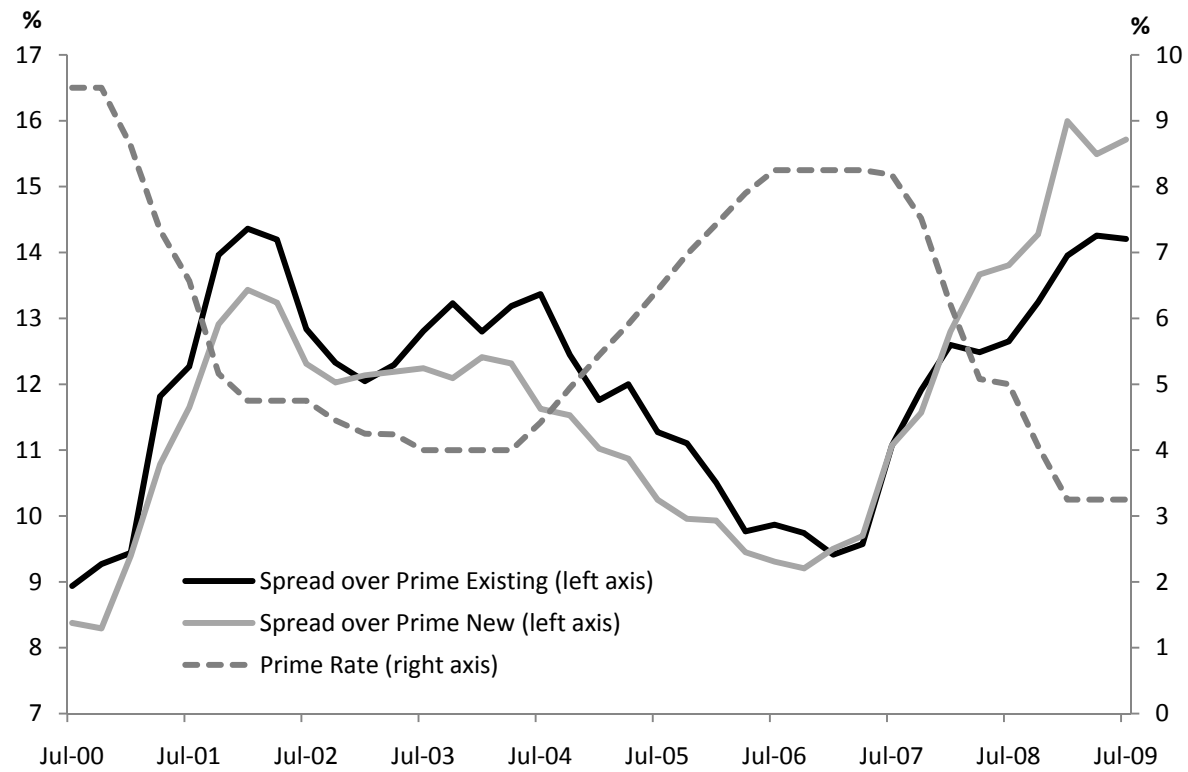Figure II: Credit Card Interest Rates and the Prime Rate

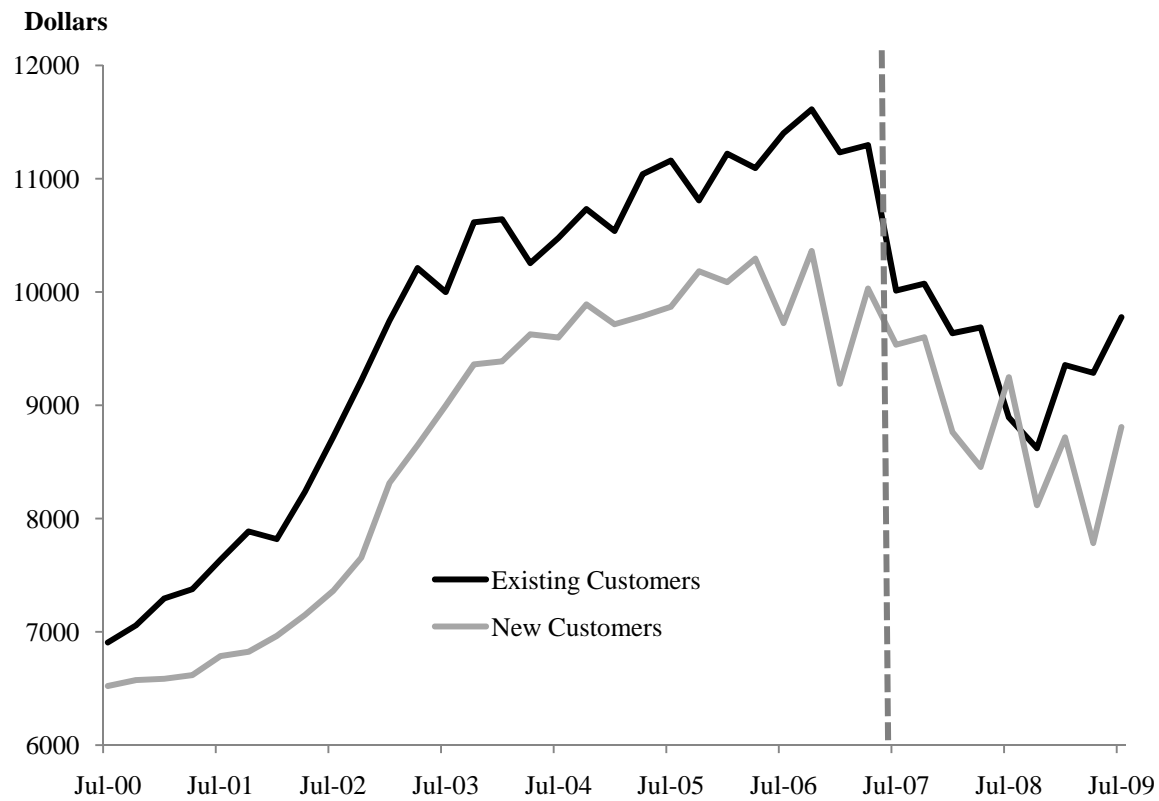Figure III: Credit Card Interest Rate Spread over Prime Rate
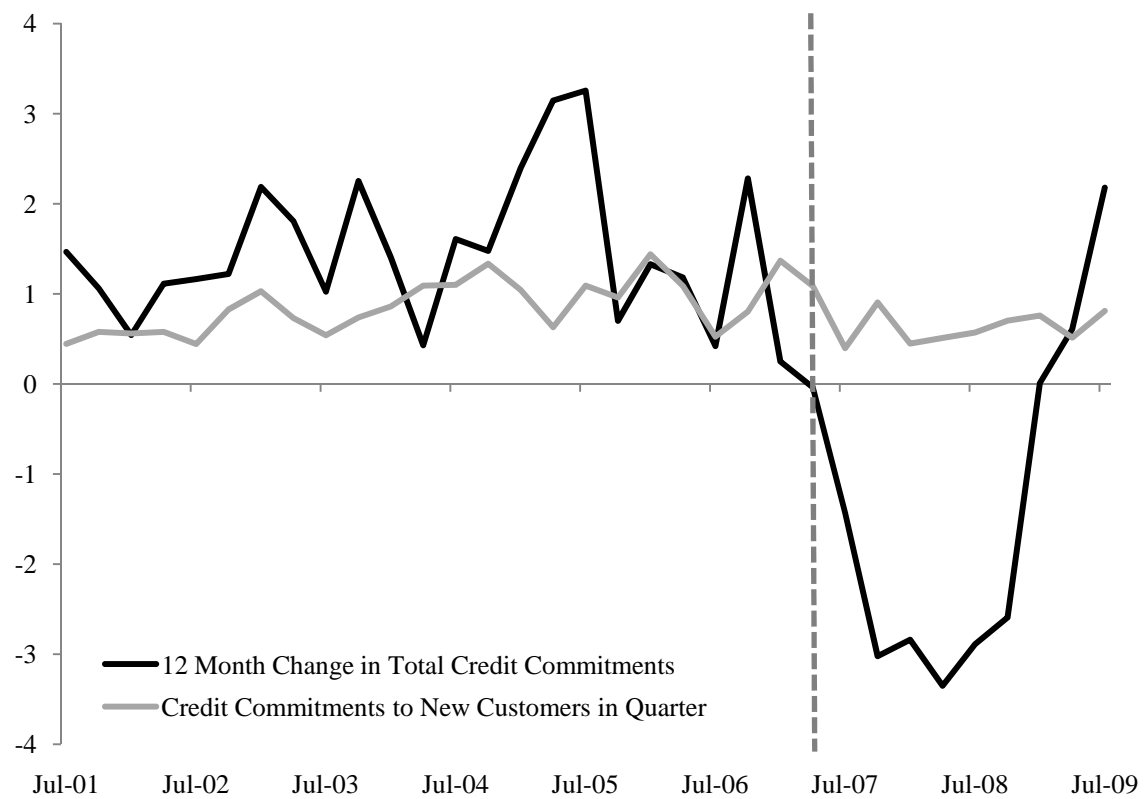
Figure IV: Average Credit Card Line Size
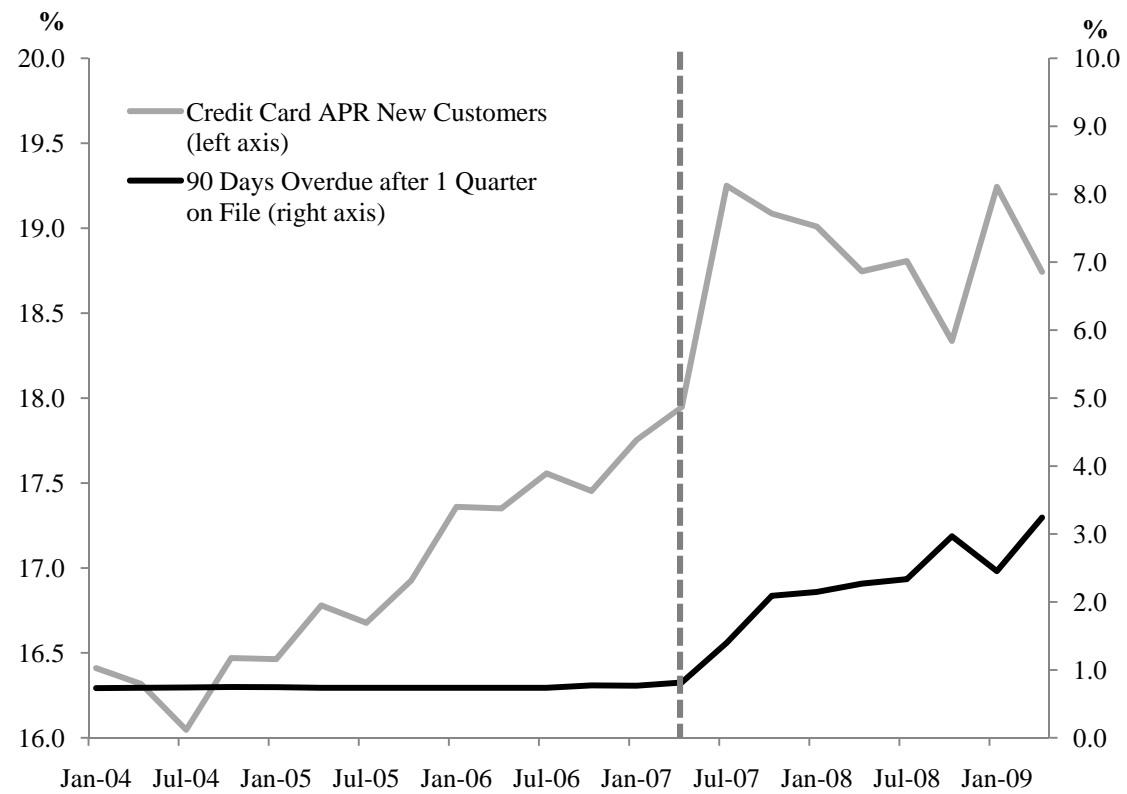
Figure V: Changes in Credit Commitments

Figure VI: Credit Card Interest Rates and Default

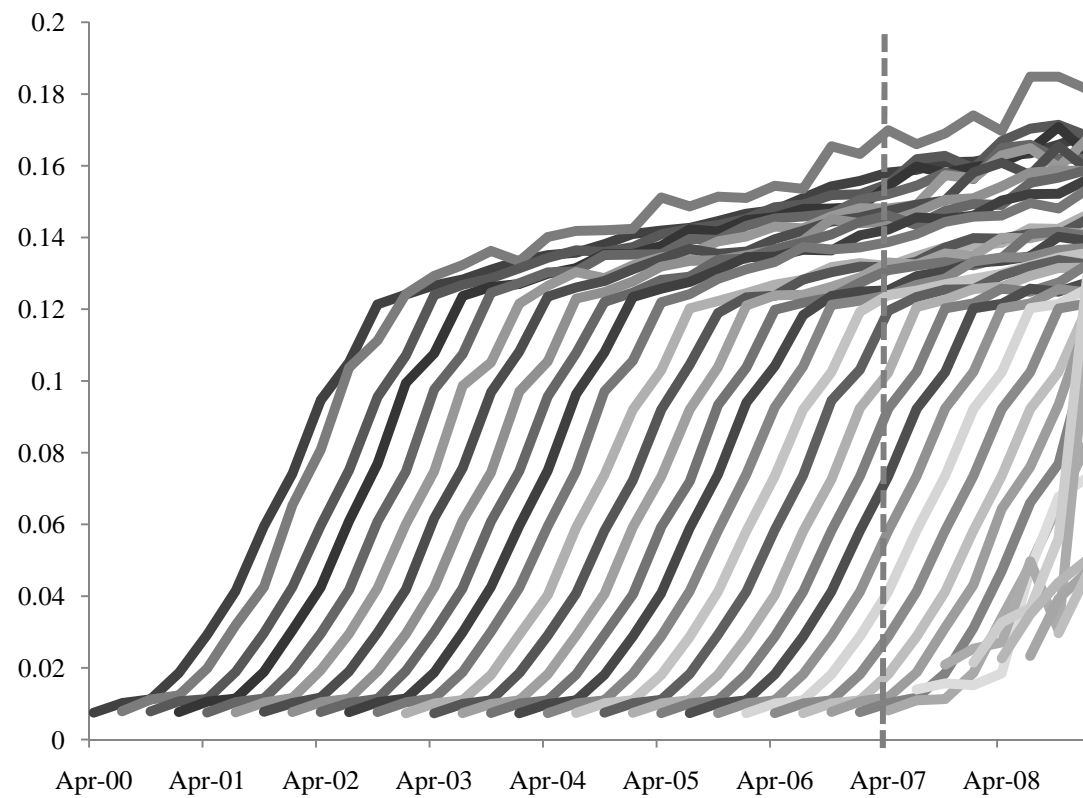Figure VII: FICO Credit Score for New and Existing Customers

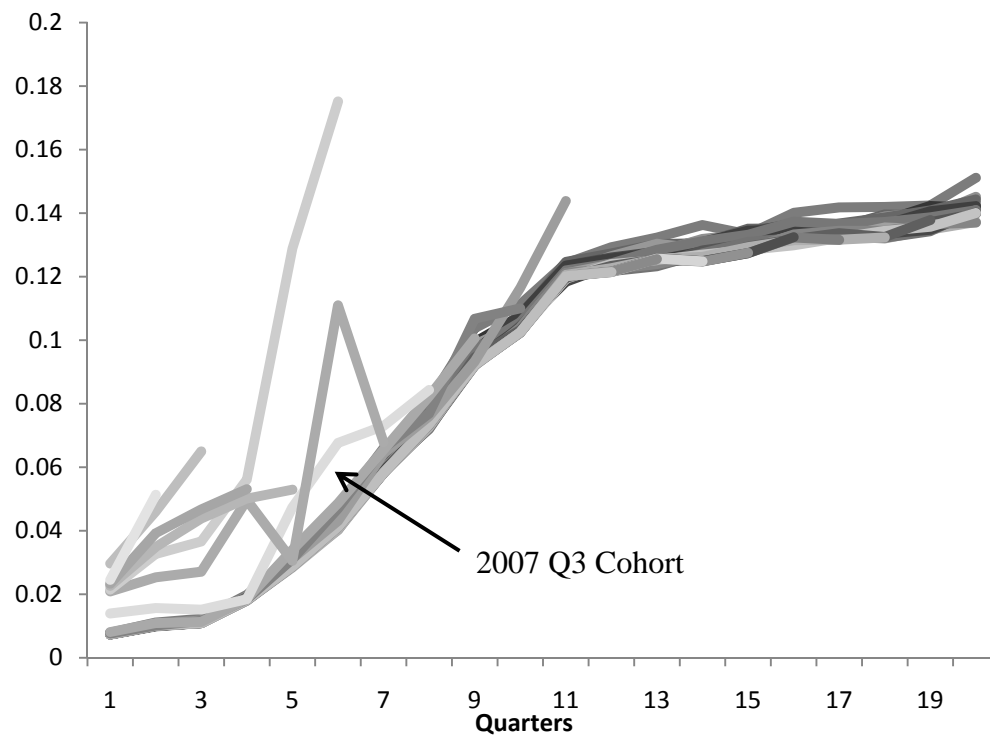Figure VIII: 90 Day Delinquency Rates by Cohort and Time

Figure IX: 90 Day Delinquency Rates by Cohort and Age

Table I
Averages by Year for New and Existing Accounts

This Table contains averages for new and existing accounts over the years in our sample for a subset of our variables. Line Size is the account credit limit; APR is the interest rate for purchases, Home Equity Balance is the account holder's home equity balance as reported in the credit report; Charge Off Amount is the average amount charged off on delinquent accounts; Debt is the account's revolving balance; and Credit History is the length an individual has been on file with the credit bureau.

Year	Existing/New Accounts	Nr of Accounts	Line Size	APR	Home Equity Balance	Charge Off Amount	Debt	Length of Credit History (months on file)
2000	Existing	1,256,161	$6,960.98	18.47145	$2,360.66	$4,552.06	$2,574.36	67.53348
	New	28,179	$6,575.29	17.6856	$2,348.72			57.83483
2001	Existing	1,359,316	$7,548.83	18.7933	$2,965.03	$4,704.30	$2,770.43	67.94699
	New	26,752	$6,931.01	18.10728	$2,992.91			54.30216
2002	Existing	1,334,277	$8,497.99	18.10533	$4,299.86	$4,873.00	$2,761.02	68.37074
	New	24,975	$7,993.99	17.42748	$4,290.47			48.39557
2003	Existing	1,306,811	$10,142.15	16.71588	$6,085.33	$4,731.60	$2,892.33	68.79466
	New	27,199	$9,343.40	16.28734	$6,204.19			47.1622
2004	Existing	1,373,429	$10,526.45	17.29003	$6,687.76	$4,922.00	$2,981.22	69.1745
	New	37,505	$9,747.50	16.3104	$6,674.73			51.25002
2005	Existing	1,525,036	$10,886.79	17.72148	$6,613.20	$4,814.77	$3,038.51	69.54119
	New	30,819	$10,108.29	16.71255	$6,661.47			55.81973
2006	Existing	1,595,157	$11,331.66	17.92766	$6,710.75	$4,430.30	$3,183.85	69.93291
	New	32,429	$9,826.45	17.43031	$6,743.55			51.7597
2007	Existing	1,627,882	$10,653.21	18.54126	$6,872.65	$4,540.42	$3,224.60	70.38264
	New	34,088	$9,088.71	18.50963	$6,882.75			45.15705
2008	Existing	1,596,585	$9,209.33	17.83251	$6,793.10	$4,580.90	$3,351.16	70.8166

	New	22,653	$8,466.59	18.7256	$6,828.14			40.26028
2009	Existing	1,629,428	$9,473.16	17.38964	$6,672.52	$4,526.24	$3,318.16	71.19421
	New	26,095	$8,517.82	18.98369	$6,715.41			42.65578