How Do Minimum Payment Changes Affect Credit Card Arbitrage?

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ABSTRACT

This paper examines how changes in the minimum payment percentage and effective maturity of introductory offers affect credit card arbitrage. Credit Card arbitrage involves taking a cash advance on, or making purchases against, a credit card that offers a low or zero percent introductory interest rate. The proceeds are deposited into a Federal Deposit Insurance Corporation (FDIC) insured money market account. Profits from this strategy are dependent on factors including the minimum payment due on the credit card each month. Recently, under pressure from the U.S. Office of the Comptroller of the Currency, some banks have increased the minimum monthly payment percentage on their cards. We measure the sensitivity of Credit Card arbitrage profits to changes in the offer maturity and the required minimum monthly credit card payment. We also analyze how offer duration changes with changes in the minimum monthly payment. These calculations represent an important contribution to the literature because of the unique pattern of credit card loan payments.

Keywords: Credit Cards; Arbitrage; Duration; Minimum Payments

INTRODUCTION

Credit card use in world economies has increased dramatically over recent years. The percentage of purchases completed using payment cards in the U.S. increased from about 43 to 56 percent between 1999 and 2005 (American Bankers Association and Dove Consulting, 2005). Bolt and Humphrey (2007) find a 140 percent increase in payment card use in eleven European countries from 1987-2004. The effects of these increases have manifest themselves throughout the economy. For example, Amromin and Chakravorti (2009) find that debit card use has resulted in lessened demand for small denomination currency and coins used to make change. Indeed, some merchants no longer accept cash as a payment method (Rafsanjani, 2006).

Many banks offer low interest rate introductory offers to entice individuals to apply for, use and carry balances on their credit cards. The offers have varying features, but they typically provide the individual with a low interest rate for a prescribed amount of time. If the individual does not pay off the credit card balance before the introductory offer expires, the interest rate increases to a normal, markedly higher, rate. However, if the individual pays the card balance off before expiration of the introductory offer, there is often the potential for that consumer to earn an arbitrage profit.

Introductory offers have various features and limits. Some opportunities can be completed through a simple cash advance against the credit card. Others require the cardholder to make a purchase to receive the introductory interest rate. The term of an offer may vary from a few months to a few years. The minimum monthly payments also vary from card to card. Some cards allow the individual to earn airline frequent flier miles, or other membership points when using the card, thus improving the potential for arbitrage profits. Still others limit credit card arbitrage by imposing annual fees, and cash advance fees. Commonly the introductory offers can be repeated multiple times on the same card.

Banks set the minimum monthly payments due on credit cards at any level they choose. They have commonly set the minimum monthly payment at two to two and one-half percent of the outstanding balance. However recently, under pressure from the U.S. Office of the Comptroller of the Currency, some banks have increased the minimum monthly payment percentage on their cards. For example, Citibank and Bank of America have announced they are increasing the minimum monthly payment percentage on their credit cards from two to four percent (Warnick, 2008). These changes can have a large impact on consumers, including altering opportunities to engage in credit card arbitrage.

This paper contributes to the existing body of literature in two ways. First, we compute the Macaulay Duration for credit card offers at varying levels of minimum monthly payments. Credit cards have a unique payment pattern that do not easily allow users to calculate or otherwise visualize the effective loan maturity. This is the first known research to complete these computations. Armed with this information borrowers will be better able to compare competing credit card offers that have complex and differing loan repayment patterns. We also extend the work of Jalbert, Stewart and Jalbert (JSJ) (2008) who show how individuals can take advantage of introductory credit card offers to earn arbitrage profits. Specifically, this research demonstrates how banks can alter credit card arbitrage opportunities by the consumer by changing the effective maturity of the offer. Potential arbitrage profits from an offer can be changed by either directly reducing the offer length or by increasing the minimum percentage due on the credit card each month. This research examines various combinations of offer maturities and minimum payment requirements. The results show the potential for arbitrage profits can be altered substantially by changing the effective maturity of the offer. Finally, we demonstrate computation of the derivative of the change in arbitrage profit with respect to a change in the minimum monthly payment. These computations will allow consumers to easily compare potential arbitrage profits on competing credit card offers having different minimum monthly payment amounts. Banks can also use these computations to design credit card offers that minimize the potential for the consumer to engage in arbitrage.

The rest of the paper is organized as follows: In section II, the relevant literature is discussed. The following section discusses how, changes to the minimum monthly payment percentage on a credit card affects the profitability of various arbitrages. Next, the Jalbert Stewart and Jalbert (2008) model of credit card arbitrage is presented. The analysis continues by considering how the effective maturity of an introductory offer affects potential arbitrage profits. The paper closes with some concluding comments and observations.

PRIOR LITERATURE

The literature on credit cards addresses various issues associated with the issuance and use of the cards. Bolt and Chakravorti (2008), Chakravorti and To (2002) and others propose models that explain interactions between consumers, merchants and card issuers. Recent works have begun to incorporate the affects of credit acquisition as a part of credit card use on these relationships (Chakravorti and Emmons, 2003 and Chakravorti and To, 2007). However, these models limit themselves to credit obtained when buying an item and delaying payment, thereby obtaining credit. No known research in this line has examined the role of cash advances against credit cards.

Ausuel (1991), Calem (1992) and DeMuth (1986) examine the profitability, structure and performance of the credit card industry. In an interesting article, Ausubel (1991) finds that credit card operations earn a three to five times higher return than the overall banking industry. He finds that about 25 percent of credit card customers pay off the entire balance on their accounts each month and 75 percent carry some balance from one month to the next. Credit card arbitrage opportunities presumably decay the profitability of credit card operations for banks by allowing consumers to earn a risk-free return, which is either partly or fully financed by the bank offering the card. It follows that a customer's arbitrage profit is an opportunity cost to the bank. For introductory offers to persist, however, the findings of Ausubel may indicate that a small percentage of bank customers are engaging in credit card arbitrage. If 75 percent of credit card customers carry a balance each month it stands to reason that the issuing bank's marginal benefit of attracting new customers through introductory offers outweighs the marginal cost of the offers including those arising from credit card arbitrage.

Ausubel (1991) and Calem and Mester (1995) examine how credit card interest rates change when general interest rates change in the economy. The general findings of this line of literature are that credit card rates are

slower to respond to a decrease in interest rates than other financial products. Calem and Mester (1995) find empirical support for each of three explanations for this stickiness in rates. These explanations are 1) that cardholders incur search costs if forced to find another credit card, 2) cardholders incur switching costs if forced to find another credit card and 3) that banks face an adverse selection problem if they unilaterally reduce credit card rates. This paper provides additional evidence on the adverse selection problem. If arbitrage opportunities can be reduced, adverse selection problems may be, at least in part, limited.

King and King (2005) argue that consumers should prefer the use of credit cards to debit cards under the assumption the credit card balance is paid on time each payment period. They consider the use of credit cards to be a substitute for cash, checks, and debit cards. Gross and Souleles (2002), examine how people respond to credit supply changes finding that increased credit limits lead to increased debt levels. Brito and Hartley (1995) show that borrowing on credit cards at high interest rates can be rational because of low transaction costs relative to bank loans. Bank loans require an individual to visit a bank, document income and assets and pay various fees. On the other hand, for a current cardholder, borrowing against a credit card requires a simple telephone call.

Ausubel (1999) examines preapproved credit card solicitations. He finds that solicitation recipients over respond to the introductory interest rate, relative to the interest rate that applies after the introductory period and the duration of the introductory offer. Specifically, he finds that consumers are two to three times as responsive to changes in the introductory interest rate compared with dollar-equivalent changes in the duration of the introductory offer. He also finds that individuals are at least three times as sensitive to changes in introductory interest rates relative to dollar-equivalent changes in the post-introductory interest rate. The sensitivity to introductory rates found by Ausubel (1999) could indicate that individuals engage in credit card arbitrage. If cardholders pay off the credit balance at the end of the introductory period, the post-introductory interest rate is irrelevant. The research in this paper extends this line of literature by precisely measuring arbitrage profits at different introductory offer maturities. This analysis provides added evidence regarding the motivations of individuals to respond to introductory offer solicitations.

Bi and Montalto (2004) argue the emergency funds an individual keeps is a function of credit availability and other factors. They find that about 65 percent of households rely to some degree on credit card borrowing and 33 percent borrow more than $8,000 on their credit cards. Credit card arbitrage offers one method for individuals to lessen the cost of holding emergency funds.

Jalbert, Stewart and Jalbert (2008) provide an examination of credit card arbitrage. They identify and analyze the factors that determine potential arbitrage profits. They calculate the arbitrage profit earned at different levels of these variables. Specifically, they examine variations in credit card and money market interest rates, the time frame of the introductory offer and the fixed fees associated with taking the offer. They identify potential arbitrage profits under various combinations of these variables. They go on to analyze how engaging in credit card arbitrage affects the credit score of the arbitrageur. In this paper we extend the analysis of Jalbert, Stewart and Jalbert (2008) by providing evidence on how altering the maturity of the offer and minimum payment requirements affect arbitrage opportunities.

THE JALBERT STEWART AND JALBERT MODEL

Jalbert, Stewart and Jalbert (2008) develop the following formula to calculate the potential profits from credit card arbitrage:[1]

[1] The formula presented here is a restated version of the formula presented in Jalbert, Stewart and Jalbert (2008). Using the notation of this paper the formula presented by Jalbert, Stewart and Jalbert (2008) was:

$\$\text{Profit} = B(1+IM)^K - (B+F)(P)\sum_{i=1}^{K}(1+IC-P)_i^{K-1}(1+IM)^{K-i} - (B+F)(1+IC-P)^K$. The expression provided in equation (1) is a clearer specification of the relationship.

$$\$\text{Profit} = B\left(1+\frac{IM}{12}\right)^{K} - P(B+F)\left(\frac{\left(1+\frac{IM}{12}\right)^{K}-\left(1+\frac{IC}{12}-P\right)^{K}}{\frac{IM}{12}-\frac{IC}{12}+P}\right) - (B+F)\left(1+\frac{IC}{12}-P\right)^{K} \quad (1)$$

where \$Profit is the dollar amount of the arbitrage profit, *B* is the amount of funds borrowed on the credit card, *P* is the minimum monthly payment on the credit card expressed as a percentage of the amount borrowed, *IM* is the annual percentage rate earned on the money market account, *IC* is the annual percentage rate paid on the credit card, *K* is the number of months in the analysis and *F* is the fixed charge associated with taking the cash advance. Thus, six different variables affect the potential for arbitrage profits[2].

To show the use of equation 1, consider a credit card with a \$10,000 available credit limit. The cardholder receives an introductory offer of 3 percent APR for six months with a cash advance fee of 2 percent and maximum of \$75. The minimum payment due each month equals two percent of the outstanding balance. The card does not have an annual fee. The cardholder has access to a money market account that pays 5 percent APR. The arbitrage profit is:

$$\$\text{Profit} = 10{,}000\left(1+\frac{.05}{12}\right)^{6} - .02(10{,}000+75)\left(\frac{\left(1+\frac{.05}{12}\right)^{6}-\left(1+\frac{.03}{12}-.02\right)^{6}}{\frac{.05}{12}-\frac{.03}{12}+.02}\right) - (10{,}000+75)\left(1+\frac{.03}{12}-.02\right)^{6} = \$20.58$$

The \$20.58 profit is earned over the six-month offer period. Most credit cards allow the cardholder to repeat the offer. In this example, the consumer could complete the transaction twice each year allowing them to earn a \$41.16 profit. For a card that requires an annual fee, the second transaction undertaken in a year will earn a larger profit than the first. The annual fee is paid only once, so economies of scale are recognized in the second transaction.

MINIMUM PAYMENT PERCENTAGES AND OFFER TERMS

Here we examine how altering the required minimum monthly payment percentage and offer length can affect credit card arbitrage profits. This research is relevant for consumers/investors who are examining various credit cards for potential arbitrage profits and for those that are considering voluntarily paying more than the cardholder agreement specified minimums. In the latter case, we show that it may be inefficient to make a payment larger than the minimum due on an introductory credit card offer. This research is also important for banks that wish to design their credit card product offerings to achieve the maximum potential profit.

We begin by computing the arbitrage profit under several combinations of monthly minimum payments, offer length and money market rate. Next, we calculate the impact of changing the minimum payment and offer length in three ways. First, we calculate the Macaulay duration to measure how changing the offer length and minimum payment due affect the maturity of the loan (Macaulay, 1938). Second, we calculate the derivative of the profit equation with respect to a change in the minimum monthly payment to obtain a precise mathematical specification of this relationship. Finally, we complete a series of regression analysis to further explore the relationship.

[2] Jalbert, Stewart and Jalbert (2008), do not incorporate annual fees on the credit card into their analysis. They also do not incorporate secondary benefits associated with credit card use such as benefits from frequent flier miles and other program rewards.

Computation Of $Profit At Different Minimum Payment Levels And Offer Lengths

In this section, we calculate the $Profit at various minimum payment and offer length combinations. Panel A of Table 1 presents the arbitrage profit for a $10,000 cash advance when the credit card interest rate is 1% annually and a money market rate of 2% annually. A fixed charge of $75 is assumed throughout the example. The profit is determined for several different combinations of minimum payment percentage, *P*, and offer length, *K*. Minimum payment percentage varies from 2% to 10%. Length of offer ranges from 3 months to 120 months. Each successive panel raises the money market rate by one percent up to a maximum of 5% in Panel D. Each of the four panels indicates that arbitrage profits are positively related to the offer length and negatively related to the required minimum payment percentage.

Table 1: Arbitrage Profits And Duration Values For $10,000 Cash Advance

Panel A: Credit Card Rate = 1%; Money Market Rate = 2%; Fixed Fee = $75												
	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($50.63)	($27.53)	($5.63)	$15.14	$361.04		2%	2.9	5.7	8.3	10.8	45.7
4%	($51.12)	($29.86)	($10.93)	$5.95	$157.80		4%	2.9	5.4	7.7	9.7	24.9
6%	($51.61)	($32.07)	($15.75)	($2.10)	$76.86		6%	2.8	5.2	7.1	8.7	16.7
8%	($52.09)	($34.17)	($20.14)	($9.16)	$35.25		8%	2.8	4.9	6.6	7.9	12.5
10%	($52.56)	($36.15)	($24.14)	($15.35)	$10.09		10%	2.7	4.7	6.1	7.2	10.0
Panel B: Credit Card Rate = 1%; Money Market Rate = 3%; Fixed Fee = $75												
	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($26.02)	$20.53	$64.79	$106.90	$868.56		2%	2.9	5.7	8.3	10.8	45.7
4%	($27.01)	$15.85	$54.18	$88.47	$439.25		4%	2.9	5.4	7.7	9.7	24.9
6%	($27.99)	$11.42	$44.51	$72.32	$266.04		6%	2.8	5.2	7.1	8.7	16.7
8%	($28.95)	$7.23	$35.70	$58.16	$176.23		8%	2.8	4.9	6.6	7.9	12.5
10%	($29.90)	$3.26	$27.69	$45.74	$121.66		10%	2.7	4.7	6.1	7.2	10.0
Panel C: Credit Card Rate = 1%; Money Market Rate = 4%; Fixed Fee = $75												
	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($1.38)	$68.79	$135.70	$199.54	$1,447.34		2%	2.9	5.7	8.3	10.8	45.7
4%	($2.86)	$61.77	$119.74	$171.82	$766.82		4%	2.9	5.4	7.7	9.7	24.9
6%	($4.33)	$55.12	$105.21	$147.52	$488.73		6%	2.8	5.2	7.1	8.7	16.7
8%	($5.77)	$48.82	$91.97	$126.21	$343.33		8%	2.8	4.9	6.6	7.9	12.5
10%	($7.19)	$42.86	$79.92	$107.51	$254.53		10%	2.7	4.7	6.1	7.2	10.0
Panel D: Credit Card Rate = 1%; Money Market Rate = 5%; Fixed Fee = $75												
	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	$23.31	$117.25	$207.09	$293.07	$2,105.88		2%	2.9	5.7	8.3	10.8	45.7
4%	$21.33	$107.88	$185.77	$255.99	$1,146.49		4%	2.9	5.4	7.7	9.7	24.9
6%	$19.38	$99.00	$166.35	$223.49	$749.47		6%	2.8	5.2	7.1	8.7	16.7
8%	$17.45	$90.59	$148.67	$194.99	$540.20		8%	2.8	4.9	6.6	7.9	12.5
10%	$15.55	$82.64	$132.57	$169.98	$411.75		10%	2.7	4.7	6.1	7.2	10.0

This table shows credit card arbitrage profits and duration values. Credit Card Rate = 1%, Money Market Rates range from 2% to 5%, Minimum Payment Percentages (P) range from 2% to 10%, Offer length (K) ranges from 3 to 120 months. Fixed cash advance fee = $75.

Figure 1 presents a visual representation of Panel B of Table 1 in order to facilitate the reader's understanding of how sensitive the arbitrage profit is to changes in the term of the agreement and the minimum payment percentage. The figure displays an analysis of profits from a $10,000 cash advance with a $75 advance fee. The vertical axis shows the profit amount. The horizontal axis shows the minimum monthly payment. The series of bars shows profits for varying offer lengths. The figure demonstrates that profits are highly sensitive to both offer length and minimum payment due. For example, the profit on a 120 month offer is more than $800 when a 2% minimum payment applies, but is just over $100 when a 10% minimum payment applies. An analysis of the 2% minimum payment offer shows the effects of offer length. A three month offer produces a negative profit, but the 120 month offer produces a profit of more than $800. The combined analysis emphasizes the importance of carefully examining offer terms before engaging in credit card arbitrage.

The worst outcome in Table 1 panel A occurs when the minimum payment is 10% and the offer length is just 3 months. The most profitable outcome occurs in panel D where the money market rate of 5% provides a 4% interest rate differential. Under these conditions, a 10-year offer with a 2% minimum payment would produce a $2,105.88 arbitrage profit. Clearly, greater arbitrage profits are associated with lower required payment percentages and longer term offers. With shorter offers and higher minimum payments, there is often not enough time to earn enough interest to overcome the $75 fixed charge.

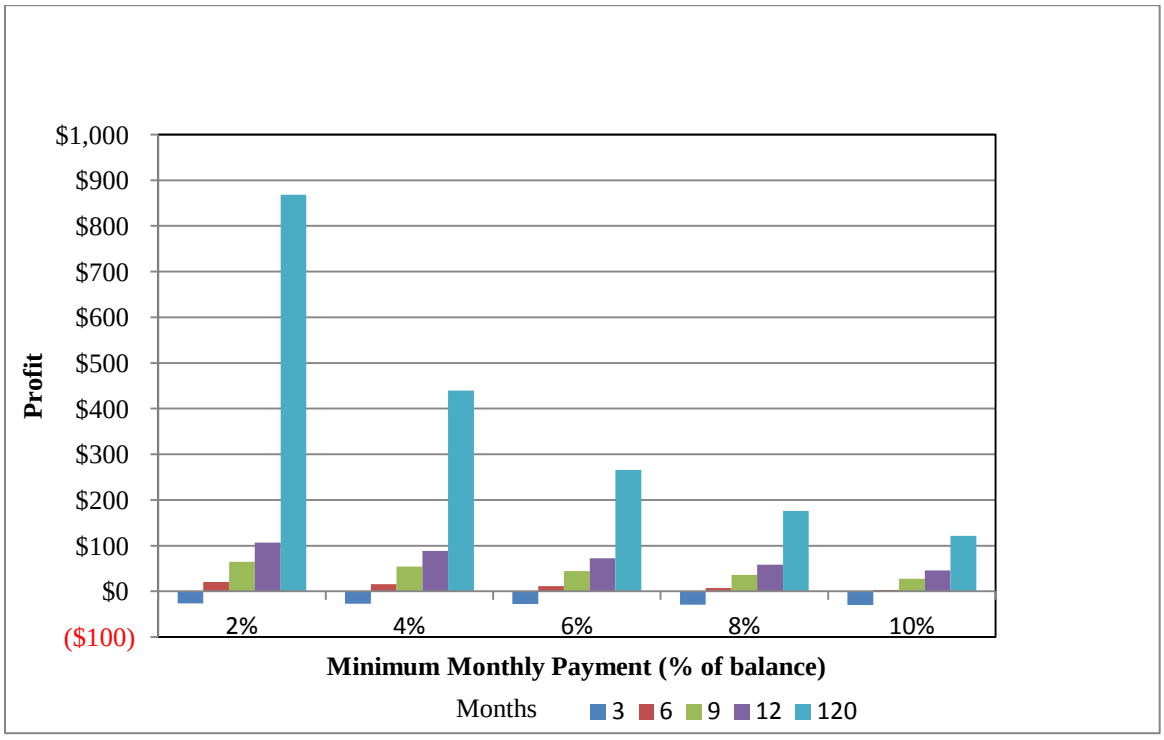

Figure 1: Profit for a $10,000 Cash Advance
This table shows the profit for a $10,000 cash advance. For this figure, the credit card rate is 1 percent. The money market rate is 3%. The cash advance fee is $75.

Macaulay Duration

The Macaulay Duration, referred to hereafter as duration, provides added insight into the effect of parameter changes on the *$Profit*. Credit card loans are unique in their payment structure. Most loans are amortized so the loan payment is based on the amount borrowed at the outset. Credit card loans are unique because the minimum monthly payment amount changes each month. The minimum monthly payment is set as some percentage

of the beginning monthly balance. This procedure makes it difficult to calculate or easily visualize the effective loan maturity. The duration calculations completed here provide an easy way for users to identify the loan maturity.

Duration is a parameter that is commonly used when evaluating debt contracts. It is generally used in evaluating interest rate risk for bonds. It provides the lender, in our case the bank issuing the credit card, a comparative measure of the recovery time of loaned funds. For the arbitrageur, it provides a measure of how long the funds will be borrowed. In effect, taking out a cash advance is equivalent to the user issuing a bond to the bank. If no principal is paid on the loan until maturity, then the duration would equal the loan term. This would be analogous to a zero-coupon bond. A shorter duration occurs when at least some principal payments are made before maturity. The offer length and minimum payment due both affect the duration. The equation for Macaulay Duration, is:

$$Duration = \left(\frac{1}{B}\right) \times \sum_{i=1}^{K} \frac{i\left(pmt_i\right)}{\left(1+\frac{IC}{12}\right)^i} \tag{2}$$

where pmt_i is the total payment made toward the credit card debt in month i and all other terms are as previously defined.

We calculate the duration, in months, for each offer over our previously described range of minimum payment and offer length. The duration is calculated by dividing the weighted sum of the present values of the loan payments by the loan amount. The weights are integers representing the months in which the payments are made. Duration is calculated for various offer lengths and minimum payments in Table 1. First the results show that offer duration is positively related to the offer term and negatively related to the minimum payment percentage. This is similar to the behavior of the arbitrage profits themselves and is evidence that longer offer duration implies greater potential arbitrage profit. Since the money market rate does not affect the offer duration, the duration values are uniform across panels. For example, the duration of a 120-month offer with a 2% minimum payment is 45.7 in each panel, regardless of the applicable money market rate.

Table 2 presents the arbitrage results over the same range of minimum payments and offer term. However, in Table 2, the credit card offer rate is 3% and the money market rates range from 4% to 7% in panels A through D respectively. The relationships between arbitrage profit, minimum payment percentage, and the offer length persist.

A comparison of Table 1 and Table 2 reveals an interesting difference between profitable arbitrages and nonprofitable arbitrages. Specifically, for profitable arbitrages the higher the rate level the more profitable the arbitrage, holding other factors constant. The opposite is true for offers that lose money. In these situations, the higher the general interest rate level, the greater the loss on the arbitrage, holding other factors constant. For example, in panel B of Table 1, we see that a one-year offer with a minimum payment of 2% on a credit card rate of 1% and a money market rate of 3%, achieves a profit of $106.90. In the matching panel of Table 2, we see that credit card rate of 3% and money market rate of 5% on an otherwise identical offer produces a slightly higher arbitrage profit of $108.78. The opposite results when comparing losing offers. In panel A of each table, we consider a 12-month offer with a 10% minimum payment. In Table 1 where the credit card rate is 1% and the money market rate is 2%, we witness a loss of $15.35. The corresponding loss is slightly larger in Panel A of Table 2, when the credit card interest rate is 3% and the money market rate is 4%. Here, the higher rates produce a slightly greater loss at $15.71. This shows that for a constant spread between the credit card rate and money market rate, higher interest rate levels amplify the arbitrage results. Profitable offers are more profitable at higher interest rate levels. Unprofitable offers lose even more money at higher interest rate levels.

Table 2: Arbitrage Profits And Duration Values For $10,000 Cash Advance

Panel A: Credit Card Rate = 3%; Money Market Rate = 4%; Fixed Fee = $75

	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($50.92)	($27.88)	($5.82)	$15.30	$440.55		2%	2.9	5.7	8.3	10.8	45.7
4%	($51.41)	($30.23)	($11.18)	$5.96	$192.63		4%	2.9	5.4	7.7	9.7	24.9
6%	($51.90)	($32.46)	($16.06)	($2.23)	$93.83		6%	2.8	5.2	7.1	8.7	16.7
8%	($52.38)	($34.57)	($20.51)	($9.41)	$43.03		8%	2.8	4.9	6.6	7.9	12.5
10%	($52.86)	($36.56)	($24.56)	($15.71)	$12.32		10%	2.7	4.7	6.1	7.2	10.0

Panel B: Credit Card Rate = 3%; Money Market Rate = 5%; Fixed Fee = $75

	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($26.23)	$20.58	$65.55	$108.78	$1,059.75		2%	2.9	5.7	8.3	10.8	45.7
4%	($27.22)	$15.87	$54.81	$90.03	$536.11		4%	2.9	5.4	7.7	9.7	24.9
6%	($28.20)	$11.41	$45.02	$73.60	$324.73		6%	2.8	5.2	7.1	8.7	16.7
8%	($29.16)	$7.19	$36.11	$59.20	$215.11		8%	2.8	4.9	6.6	7.9	12.5
10%	($30.11)	$3.19	$28.00	$46.55	$148.50		10%	2.7	4.7	6.1	7.2	10.0

Panel C: Credit Card Rate = 3%; Money Market Rate = 6%; Fixed Fee = $75

	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	($1.51)	$69.25	$137.41	$203.14	$1,765.70		2%	2.9	5.7	8.3	10.8	45.7
4%	($2.99)	$62.18	$121.26	$174.94	$935.77		4%	2.9	5.4	7.7	9.7	24.9
6%	($4.46)	$55.48	$106.56	$150.22	$596.43		6%	2.8	5.2	7.1	8.7	16.7
8%	($5.90)	$49.14	$93.16	$128.54	$418.99		8%	2.8	4.9	6.6	7.9	12.5
10%	($7.33)	$43.13	$80.96	$109.51	$310.63		10%	2.7	4.7	6.1	7.2	10.0

Panel D: Credit Card Rate = 3%; Money Market Rate = 7%; Fixed Fee = $75

	Arbitrage Profits						Duration					
P	K=3	6	9	12	120		P	K=3	6	9	12	120
2%	$23.26	$118.12	$209.77	$298.41	$2,568.75		2%	2.9	5.7	8.3	10.8	45.7
4%	$21.28	$108.68	$188.19	$260.70	$1,398.87		4%	2.9	5.4	7.7	9.7	24.9
6%	$19.33	$99.74	$168.54	$227.64	$914.49		6%	2.8	5.2	7.1	8.7	16.7
8%	$17.40	$91.28	$150.64	$198.64	$659.14		8%	2.8	4.9	6.6	7.9	12.5
10%	$15.50	$83.26	$134.34	$173.18	$502.41		10%	2.7	4.7	6.1	7.2	10.0

This table shows credit card arbitrage profits and duration values. Credit Card Rate = 3%, Money Market Rates range from 4% to 7%, Minimum Payment Percentages (P) range from 2% to 10%, Offer length (K) ranges from 3 to 120 months. Fixed cash advance fee = $75.

Further investigation of the relationship between the arbitrage profit level and duration appears in Table 3. Each column provides slope and intercept estimates for the following relationship:

$$\$\text{Profit} = \beta(Duration) + \alpha \tag{3}$$

This relationship was estimated for each combination of offer length and interest rate differential presented in Tables 1 and 2. We define the interest rate differential, ΔI, as the money market rate minus the credit card rate. For offers of one-year or shorter, we observe an interesting similarity in the slope and intercept estimates for this equation. This relationship allows the following generalization about the relationship between $Profit and the duration of the offer:

$$\$\text{Profit} \approx (8.5)(\Delta I)(Duration) - F \quad for\ K \le 12 \tag{4}$$

This representation shows the $Profit from the arbitrage is a function of the offer duration, the interest rate spread, and the fixed charge. Persistence of the 8.5 value is an interesting result. For interest rate differentials of 1%, the slope of the relationship is approximately 8.5 in all cases. For interest rate differentials of 2%, the slope is about twice that amount or 17. This is true for differentials of 3% and 4% as well, where the slope coefficients are approximately 25.5 and 34 respectfully. It is also interesting that the absolute value of the intercept tends to be close to the fixed cost amount.

To provide analytical support for the empirical relationship between $Profit and Durations shown in (4), we substitute the formula for duration (2) into the profit formula (1). This process results in the following approximation[3]:

$$Profit \cong B * Duration * \left(\frac{IM}{12} - \frac{IC}{12}\right) - F \quad (5)$$

A good approximation for Profit and a sense for how it is related to Duration may be obtained using this approximation formula. This approximation is useful because it greatly simplifies the equation for Profit. Profit can be calculated exactly using the original equation for more precise measurements.

To demonstrate these computations, consider a credit card offer with a $75 fixed cash advance card and a 1% credit rate. An individual borrows $10,000 on the card and invests it at a 5% money market rate for 3 months. The offer has Duration of 2.9. The profit is approximated as:

$$Profit \cong \$10{,}000 * 2.9 * \left(\frac{0.05}{12} - \frac{0.01}{12}\right) - \$75 \cong 8.5 * 4 * 2.9 - \$75 = \$23.60$$

The resulting figure of $23.60 is a close approximation to the $23.31 profit figure reported in Table 1 for this combination of inputs.

Table 3: Linear Coefficient Estimates for $Profit as a Function of Offer Duration

	Credit Card Rate = 1%							**Credit Card Rate = 3%**				
ΔI = 1%	K=3	6	9	12	120		ΔI = 1%	K=3	6	9	12	120
Intercept	-75.4	-75.8	-76.1	-76.5	-87.9		Intercept	-75.7	-76.5	-77.2	-77.9	-107.2
Slope	8.4	8.5	8.5	8.5	9.5		Slope	8.4	8.5	8.6	8.7	12.0
ΔI = 2%							ΔI = 2%					
Intercept	-75.6	-76.1	-76.5	-76.9	-85.2		Intercept	-75.9	-76.7	-77.5	-78.2	-103.9
Slope	16.9	16.9	17.0	17.1	20.9		Slope	16.9	17.0	17.2	17.4	25.5
ΔI = 3%							ΔI = 3%					
Intercept	-75.7	-76.3	-76.7	-77.0	-73.3		Intercept	-76.0	-76.9	-77.6	-78.2	-89.2
Slope	25.3	25.4	25.6	25.7	33.4		Slope	25.3	25.6	25.9	26.1	40.7
ΔI = 4%							ΔI = 4%					
Intercept	-75.9	-76.5	-76.8	-76.8	-50.2		Intercept	-76.1	-76.9	-77.5	-77.9	-60.9
Slope	33.7	33.9	34.1	34.4	47.4		Slope	33.8	34.2	34.6	35.0	57.8

This table shows regression coefficient estimates for the equation $\$\text{Profit} = \beta(Duration) + \alpha$. Cash Advance = $10,000, Offer Length (K) ranges from 3 to 120 months. Interest Rate Differential ΔI ranges from 1% to 4%.

[3] See Appendix 1 for the development of Equation 5.

Table 4: Profit on a $10,000 Cash Advance with a 2 percent minimum monthly payment

Panel A: Until the Loan is Paid Off (10 Years)						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	217.08	160.07	131.58	-124.93	103.08	-238.93
1%	449.26	390.45	361.04	96.38	331.63	-21.25
1.5%	697.44	636.74	606.39	333.25	576.04	211.86
2%	962.54	899.89	868.56	586.62	837.23	461.31
2.5%	1,245.57	1,180.88	1,148.53	857.43	1,116.19	728.05
3%	1,547.54	1,480.74	1,447.34	1,146.72	1,413.93	1,013.11
3.5%	1,869.57	1,800.57	1,776.07	1,455.56	1,731.57	1,317.56
4.0%	2,212.81	2,141.52	2,105.88	1,785.09	2,070.23	1,612.52
4.5%	2,578.47	2,504.81	2,467.98	2,136.50	2,431.15	1,989.18
5%	2,967.85	2,891.72	2,853.65	2,511.06	2,815.58	2,358.80
Panel B: 18 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	64.67	13.86	-11.55	-240.21	-36.96	-341.84
1%	129.83	78.96	53.52	-175.40	28.09	-277.15
1.5%	195.48	144.55	119.09	-110.10	93.62	-211.97
2%	261.63	210.64	185.14	-44.31	159.65	-146.29
2.5%	328.27	277.22	251.70	21.97	226.17	-80.12
3%	395.42	344.31	318.76	88.76	293.20	-13.46
3.5%	463.07	411.90	386.32	156.06	360.74	53.72
4.0%	531.23	480.00	454.39	223.86	428.77	121.40
4.5%	599.91	548.62	522.97	292.17	497.33	189.59
5%	669.10	617.75	592.07	360.99	566.40	258.29
Panel C: 12 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	45.38	-5.15	-30.42	-257.79	-55.68	-359.85
1%	90.97	40.41	15.14	-212.36	-10.14	-313.47
1.5%	136.78	86.20	60.91	-166.70	35.62	-267.86
2%	182.81	132.20	106.90	-120.83	81.60	-222.04
2.5%	229.06	178.43	153.11	-74.74	127.80	-176.00
3%	275.53	224.87	199.54	-28.42	174.21	-129.74
3.5%	322.23	271.54	246.20	18.11	220.86	-83.26
4.0%	369.14	318.43	293.07	64.87	267.72	-36.56
4.5%	416.28	365.54	340.18	111.85	314.81	10.37
5%	463.65	412.88	387.50	159.05	362.12	57.52
Panel D: 6 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	23.91	-26.35	-51.48	-277.63	-76.60	-378.14
1%	47.87	-2.39	-27.53	-253.71	-52.66	-354.23
1.5%	71.88	21.61	-3.52	-229.73	-28.66	-330.27
2%	95.94	45.67	20.53	-205.71	-4.61	-306.26
2.5%	120.05	69.77	44.63	-181.63	19.49	-282.20
3%	144.22	93.93	68.79	-157.51	43.64	-258.08
3.5%	168.43	118.14	92.99	-133.33	67.85	-233.91
4.0%	192.70	142.40	117.25	-109.10	92.10	-209.70
4.5%	217.02	166.71	141.56	-84.82	116.41	-185.43
5%	241.39	191.08	165.92	-60.48	140.77	-161.11
Panel E: 3 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	12.28	-37.85	-62.91	-288.48	-87.98	-388.73
1%	24.57	-25.56	-50.63	-276.2	-75.69	-376.46
1.5%	36.86	-13.27	-38.33	-263.91	-63.39	-364.17
2%	49.17	-0.96	-26.02	-251.61	-51.09	-351.87
2.5%	61.49	11.36	-13.71	-239.30	-38.77	-339.56
3%	73.82	23.69	-1.38	-226.98	-26.44	-327.24
3.5%	86.16	36.03	10.96	-214.64	-14.11	-314.91
4.0%	98.51	48.38	23.31	-202.3	-1.76	-302.57
4.5%	110.87	60.73	35.67	-189.95	10.60	-290.22
5%	123.24	73.10	48.03	-177.58	22.97	-277.86

This table indicates the arbitrage profits on a $10,000 cash advance at varying fixed cost and interest rate combinations. Panel A assumes a payoff of 10 years. The Credit Card interest rate is 1% in all cases. The money market interest rate varies as indicated by the interest differential value. For example, an interest differential of 1% represents a money market interest rate of 2%.

Table 5: Profit on a $10,000 Cash Advance with a 4 percent minimum monthly payment

Panel A: Until the Loan is Paid Off (10 Years)						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	118.91	61.42	32.67	-226.04	3.93	-341.02
1%	247.54	187.71	157.80	-111.40	127.89	-231.04
1.5%	386.49	324.24	293.11	12.98	261.99	-111.53
2%	536.43	471.65	439.25	147.72	406.86	18.15
2.5%	698.05	630.63	596.91	293.49	563.20	158.64
3%	872.09	801.91	766.82	451.01	731.73	310.64
3.5%	1059.32	986.27	949.74	621.00	913.22	474.90
4.0%	1260.57	1184.52	1146.49	804.28	1108.47	652.18
4.5%	1476.69	1397.52	1357.93	1001.67	1318.35	843.32
5%	1708.61	1626.18	1584.97	1214.04	1543.75	1049.19
Panel B: 18 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	55.21	4.35	-21.07	-249.95	-46.51	-351.67
1%	110.87	59.91	34.42	-194.93	8.94	-296.86
1.5%	166.98	115.90	90.36	-139.47	64.83	-241.61
2%	223.53	172.34	146.76	-83.56	121.16	-185.92
2.5%	280.53	229.24	203.60	-27.20	177.95	-129.78
3%	337.99	286.59	260.89	29.61	235.19	-73.19
3.5%	395.90	344.40	318.64	86.87	292.89	-16.14
4.0%	454.28	402.67	376.86	144.59	351.05	41.36
4.5%	513.12	461.40	435.54	202.78	409.67	99.33
5%	572.43	520.60	494.68	261.42	468.76	157.76
Panel C: 12 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	40.82	-9.73	-35.00	-262.48	-60.28	-363.59
1%	81.85	31.25	5.95	-221.75	-19.35	-322.95
1.5%	123.08	72.43	47.11	-180.81	21.78	-282.11
2%	164.52	113.82	88.47	-139.67	63.12	-241.07
2.5%	206.16	155.41	130.04	-98.32	104.67	-199.82
3%	248.01	197.21	171.82	-56.77	146.42	-158.37
3.5%	290.07	239.22	213.80	-15.01	188.38	-116.70
4.0%	332.34	281.44	255.99	26.96	230.55	-74.83
4.5%	374.82	323.87	298.40	69.14	272.92	-32.75
5%	417.50	366.51	341.01	111.53	315.51	9.53
Panel D: 6 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	22.75	-27.51	-52.64	-278.82	-77.77	-379.35
1%	45.55	-4.72	-29.86	-256.10	-55.00	-356.64
1.5%	68.40	18.11	-7.03	-233.32	-32.17	-333.89
2%	91.30	41.00	15.85	-210.49	-9.30	-311.09
2.5%	114.25	63.94	38.78	-187.61	13.63	-288.23
3%	137.25	86.93	61.77	-164.68	36.61	-265.33
3.5%	160.30	109.96	84.80	-141-71	59.63	-242.37
4.0%	183.40	133.05	107.88	-118.68	82.71	-219.37
4.5%	206.55	156.19	131.01	-95.60	105.83	-196.32
5%	229.75	179.38	154.19	-72.47	129.01	-173.21
Panel E: 3 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	12.03	-38.10	-63.16	-288.73	-88.22	-388.99
1%	24.07	-26.06	-51.12	-276.71	-76.19	-376.97
1.5%	36.13	-14.00	-39.07	-264.67	-64.14	-364.93
2%	48.19	-1.94	-27.01	-252.62	-52.08	-352.89
2.5%	60.26	10.13	-14.94	-240.56	-40.01	-340.84
3%	72.35	22.21	-2.86	-228.49	-27.93	-328.77
3.5%	84.44	34.30	9.23	-216.41	-15.84	-316.70
4.0%	96.55	46.40	21.33	-204.32	-3.74	-304.61
4.5%	108.66	58.51	33.44	-192.22	8.37	-292.52
5%	120.79	70.63	45.56	-180.11	20.49	-280.41

This table indicates the arbitrage profits on a $10,000 cash advance at varying fixed cost and interest rate combinations. Panel A assumes a payoff of 10 years. The Credit Card interest rate is 1% in all cases. The money market interest rate varies as indicated by the interest differential value. For example, an interest differential of 1% represents a money market interest rate of 2%.

Table 6: Profit on a $10,000 Cash Advance with a 10 percent minimum monthly payment

Panel A: Until the Loan is Paid Off (10 Years)						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	48.20	-9.64	-38.56	-298.87	-67.49	-414.56
1%	100.93	40.37	10.09	-262.41	-20.19	-383.52
1.5%	158.48	95.09	63.39	-221.87	31.70	-348.66
2%	221.20	154.84	121.66	-176.97	88.48	-309.69
2.5%	289.46	219.99	185.25	-127.36	150.52	-266.30
3%	363.62	290.89	254.53	-72.72	218.17	-218.17
3.5%	444.09	367.96	329.89	-12.69	291.83	-164.95
4.0%	531.29	451.60	411.75	53.13	371.90	-106.26
4.5%	625.69	542.26	500.55	125.14	458.84	-41.71
5%	727.76	640.43	596.76	203.77	553.10	29.11
Panel B: 18 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	36.10	-14.85	-40.33	-269.63	-65.81	-371.55
1%	72.55	21.39	-4.19	-234.41	-29.77	-366.72
1.5%	109.33	57.97	32.28	-198.84	6.60	-301.57
2%	146.45	94.89	69.10	-162.95	43.32	-266.08
2.5%	183.92	132.15	106.26	-126.71	80.37	-230.25
3%	221.74	169.76	143.77	-90.13	117.78	-194.09
3.5%	259.90	207.72	181.62	-53.21	155.53	-157.58
4.0%	298.42	246.03	219.83	-15.94	193.63	-120.73
4.5%	337.29	284.69	258.39	21.67	232.09	-83.53
5%	376.53	323.71	297.30	59.64	270.90	-45.99
Panel C: 12 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	30.27	-20.33	-45.64	-273.35	-70.94	-374.56
1%	60.71	10.01	-15.35	-243.52	-40.70	-344.94
1.5%	91.32	40.51	15.11	-213.53	-10.29	-315.14
2%	122.10	71.19	45.74	-183.36	20.28	-285.18
2.5%	153.06	102.04	76.54	-153.02	51.03	-255.05
3%	184.18	133.07	107.51	-122.51	81.95	-224.74
3.5%	215.49	164.27	138.66	-91.83	113.05	-194.27
4.0%	246.96	195.64	169.98	-60.98	144.31	-163.63
4.5%	278.61	227.18	201.47	-29.95	175.76	-132.81
5%	310.44	258.91	233.14	1.25	207.37	-101.82
Panel D: 6 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	19.63	-30.64	-55.79	-282.04	-80.92	-382.59
1%	39.31	-11.00	-36.15	-262.52	-61.30	-363.14
1.5%	59.03	8.70	-16.47	-242.97	-41.63	-343.63
2%	78.80	28.44	3.26	-223.36	-21.92	-324.08
2.5%	98.62	48.23	23.04	-203.71	-2.16	-304.49
3%	118.47	68.06	42.86	-184.02	17.65	-284.85
3.5%	138.39	87.94	62.72	-164.27	37.50	-265.16
4.0%	158.34	107.87	82.64	-144.49	57.40	-245.43
4.5%	178.34	127.84	102.59	-124.65	77.35	-225.65
5%	198.39	147.86	122.60	-104.77	97.33	205.82
Panel E: 3 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	11.32	-38.81	-63.88	-289.47	-88.95	-389.73
1%	22.64	-27.49	-52.56	-278.18	-77.63	-378.46
1.5%	33.98	-16.16	-41.24	-266.88	-66.31	-367.17
2%	45.32	-4.82	-29.90	-255.57	-54.97	-355.87
2.5%	56.68	6.53	-18.55	-244.25	-43.63	-344.56
3%	68.05	17.89	-7.19	-232.92	-32.27	-333.24
3.5%	79.43	29.26	4.18	-221.58	-20.91	-321.91
4.0%	90.81	40.64	15.55	-210.23	-9.53	-310.57
4.5%	102.21	52.03	26.94	-198.87	1.85	-299.23
5%	113.62	63.43	38.34	-187.50	13.25	-287.87

This table indicates the arbitrage profits on a $10,000 cash advance at varying fixed cost and interest rate combinations. Panel A assumes a payoff of 10 years. The Credit Card interest rate is 1% in all cases. The money market interest rate varies as indicated by the interest differential value. For example, an interest differential of 1% represents a money market interest rate of 2%.

Table 7: Profit on a $10,000 Cash Advance with a 20 percent minimum monthly payment

Panel A: Until the Loan is Paid Off (10 Years)						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	24.15	-33.81	-67.80	-323.64	-91.78	-439.57
1%	50.67	-10.13	-40.54	-314.17	-70.94	-435.78
1.5%	79.73	15.95	-15.95	-302.98	-47.84	-430.56
2%	111.52	44.61	11.15	-289.94	-22.30	-423.76
2.5%	146.22	76.03	40.94	-274.90	5.85	-415.27
3%	184.05	110.43	73.62	-257.68	36.81	-404.92
3.5%	225.24	148.01	109.40	-238.11	70.79	-392.55
4.0%	270.00	189.00	148.50	-216.00	108.00	-378.00
4.5%	318.60	233.64	191.16	-191.16	148.68	-361.08
5%	371.31	282.19	237.64	-163.37	193.08	-341.60
Panel B: 18 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	20.88	-30.15	-55.67	-285.32	-81.18	-387.38
1%	41.99	-9.32	-34.97	-265.87	-60.63	-368.50
1.5%	63.34	11.75	-14.05	-246.21	-39.84	-349.39
2%	84.93	33.05	7.11	-226.32	-18.82	-330.06
2.5%	106.75	54.59	28.51	-206.20	2.43	-310.51
3%	128.81	76.37	50.15	-185.84	23.93	-290.73
3.5%	151.12	98.38	72.02	-165.26	45.66	-270.72
4.0%	173.67	120.65	94.14	-144.44	67.63	-250.47
4.5%	196.46	143.15	116.50	-123.38	89.85	230.00
5%	219.50	165.91	139.11	-102.09	112.31	-209.29
Panel C: 12 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	19.66	-31.00	-56.33	-284.28	-81.66	-385.60
1%	39.44	-11.37	-36.77	-265.43	-62.18	-367.05
1.5%	59.36	8.39	-17.09	-246.45	-42.57	-348.38
2%	79.41	28.28	2.72	-227.34	-22.84	-329.58
2.5%	99.59	48.31	22.67	-208.10	-2.97	-310.66
3%	119.89	68.45	42.74	-188.73	17.02	-291.61
3.5%	140.34	88.74	62.95	-169.23	37.15	-272.42
4.0%	160.91	109.16	83.28	-149.61	57.41	-253.11
4.5%	181.62	129.71	103.76	-129.85	77.80	-233.67
5%	22.47	150.40	124.36	-109.96	98.33	-214.10
Panel D: 6 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	15.46	-34.84	-59.99	-286.33	-85.14	-386.93
1%	30.96	-19.38	-44.56	-271.12	-69.73	-371.81
1.5%	46.51	-3.89	-29.09	-255.87	-54.28	-356.66
2%	62.09	11.65	-13.57	-240.57	-38.80	-341.46
2.5%	77.72	27.22	1.98	-225.24	-23.27	-326.23
3%	93.38	42.84	17.57	-209.87	-7.70	-310.95
3.5%	109.09	58.50	33.20	-194.46	7.91	-295.64
4.0%	124.83	74.19	48.87	-179.00	23.55	-280.28
4.5%	140.62	89.93	64.59	-163.51	39.24	-264.88
5%	156.45	105.71	80.34	-147.97	54.97	-249.45
Panel E: 3 Month Interest Rate Time Period						
Interest Differential	None	2% Max $50	3% Max $75	3% No Max.	4% Max $100	4% No Max
.5%	10.19	-39.95	-65.01	-290.63	-90.08	-390.90
1%	20.39	-29.76	-54.83	-280.5	-79.91	-380.80
1.5%	30.60	-19.56	-44.64	-270.36	-69.72	-370.68
2%	40.82	-9.35	-34.44	-260.21	-59.52	-360.56
2.5%	51.05	0.87	-24.23	-250.05	-49.32	-350.42
3%	61.29	11.09	-14.01	-239.88	-39.10	-340.27
3.5%	71.54	21.33	-3.77	-229.71	-28.88	-330.12
4.0%	81.80	31.58	6.47	-219.52	-18.64	-319.95
4.5%	92.06	41.83	16.72	-209.32	-8.40	-309.78
5%	102.34	52.10	26.98	-199.11	1.86	-299.60

This table indicates the arbitrage profits on a $10,000 cash advance at varying fixed cost and interest rate combinations. Panel A assumes a payoff of 10 years. The Credit Card interest rate is 1% in all cases. The money market interest rate varies as indicated by the interest differential value. For example, an interest differential of 1% represents a money market interest rate of 2%.

MINIMUM PAYMENT PERCENTAGE

Next, we calculate the arbitrage profit for varying offer maturities and minimum payment percentages. The results are presented for minimum payments of 2%, 4%, 10% and 20% in Tables 4-7 respectively. The five panels in each table show the arbitrage profits for varying maturities of the introductory offer. The columns in each table show the arbitrage profit for varying fixed cash advance charges. Finally, the rows in each table report the arbitrage profit for various interest rate differentials between the money market rate earned by the cardholder and the interest rate paid on the credit card. Each of the tables assumes a $10,000 cash advance with a 1% credit card rate. The money market rate for each cell equals 1% plus the interest rate differential specified for that row.[4]

Comparing the results across Tables 4-7, reveals the affect of changing the minimum monthly credit card payment. When comparing Tables 4 and 5, clearly credit card arbitrage becomes less profitable as the minimum payment changes from two percent to four percent. Interestingly, the decline in profit is small for shorter maturity offers. For a three-month offer with a 3 percent interest rate differential and no cash advance fees, the decline in arbitrage profit is only $1.47 ($73.82 to $72.35). However, for longer-term maturities we see the decline in profit is larger. To show this affect we examine the first column of Panel A for Tables 4 and 5 which reports the results for an introductory offer that is valid until the card is paid off. We selected a 10-year maturity and calculated the arbitrage results. In this case, for a 3 percent interest rate differential we see the profit drops by $675.45 ($1,547.54 to $872.09) when the minimum monthly payment increases from two to four percent. As such, banks that offer longer maturity introductory offers can substantially lessen potential arbitrage losses by increasing the minimum monthly payment percentage on their credit cards.

Comparing Tables 6 and 7 allows us to see the affect of more extreme changes in minimum monthly payment percentages. Again, for the short maturities, arbitrage opportunities are not reduced substantially by the change in minimum payments. Table 7, Panel E shows that for the three-month offer with a three-percent differential, no cash advance fees and a 20% minimum payment, the arbitrage profit is $61.29. This is down from $73.82 for the comparable arbitrage in Table 4. For the longer-term maturities, the arbitrage profits continue to erode with the increase in minimum payments. Again examining Column 1 of Panel A we notice that for ten and twenty percent minimum payments the arbitrage profit declines to $363.62 and $184.05 respectively. This represents a substantial decrease from the $1,547.54 arbitrage profit available at a two-percent minimum payment.

Derivative Of The $Profit Equation

A final demonstration of the sensitivity of the arbitrage to changes in the maturity of the offer is provided by computing the derivative of the *$Profit* equation with respect to P. This calculation mathematically expresses how *$Profit* changes when the underlying parameters change.

We calculate the change in *$Profit*, with respect to a change in the minimum monthly payment that is due on the credit card in each month, *P*. The resulting derivative is:

$$\frac{\partial \text{Profit}}{\partial \text{P}} = -\frac{(B+F)\left((1+IM)^K-(1+IC-P)^K\right)}{IM-IC+P} - \frac{P(B+F)(1+IC-P)^K K}{(1+IC-P)(IM-IC+P)} + \frac{(B+F)\times P\left((1+IM)^K-(1+IC-P)^K\right)}{(IM-IC+P)^2} + \frac{(B+F)(1+IC-P)^K K}{(1+IC-P)} \quad (6)$$

Once again, returning to our example, the change in $Profit with respect to a change in the minimum monthly payment is calculated as follows:

[4] The arbitrage profit is a function of both the interest rate differential and the level of interest rates. The greater the level of interest rates the greater the arbitrage profit holding the interest rate differential constant.

$$\frac{\partial \text{Profit}}{\partial \text{P}} = -\frac{(10{,}000+75)\left(\left(1+\frac{.05}{12}\right)^{6}-\left(1+\frac{.03}{12}-.02\right)^{6}\right)}{\frac{.05}{12}-\frac{.03}{12}+.02} - \frac{.02(10{,}000+75)\left(1+\frac{.03}{12}-.02\right)^{6}6}{\left(1+\frac{.03}{12}-.02\right)\left(\frac{.05}{12}-\frac{.03}{12}+.02\right)}$$

$$+\frac{(10{,}000+75)\times.02\left(\left(1+\frac{.05}{12}\right)^{6}-\left(1+\frac{.03}{12}-.02\right)^{6}\right)}{\left(\frac{.05}{12}-\frac{.03}{12}+.02\right)^{2}} + \frac{(10{,}000+75)\left(1+\frac{.03}{12}-.02\right)^{6}6}{\left(1+\frac{.03}{12}-.02\right)}$$

$$\frac{\partial \text{Profit}}{\partial \text{P}} = -241.67$$

The negative sign on the solution indicates that as the minimum payment due each month increases, the arbitrage profit declines by -$2.42 for a 100 basis point change in the minimum monthly payment. This result is consistent with our earlier findings and occurs because the minimum payment lessens the money the cardholder borrows. This lower loan balance limits the extent to which a positive interest rate differential can be earned. Banks should consider this effect when designing introductory credit card offers. Carefully crafting the features of the offer can motivate customers while minimizing the propensity for arbitrage.

CONCLUDING COMMENTS

This paper examines how changes in minimum monthly payments affect credit card loan duration and the potential for arbitrage profits. The duration computations represent an important contribution to the literature given the unique nature of credit card loan payments. This paper also extends the work of Jalbert, Stewart and Jalbert (2008) by examining how changes in required minimum payments and the maturity of an introductory credit card offer affect the potential for individuals to earn arbitrage profits. We measure the change in arbitrage profits associated with a change in the minimum monthly payment. We find that altering the minimum monthly payment requirement substantially changes the potential for arbitrage profits for long-term offers, but does not have a strong impact on short-term offers. We examine arbitrage profits under several fixed charge combinations. Finally, the partial derivative of the arbitrage profit with respect to changes in the minimum payment due is calculated.

The results presented here should be of interest to arbitrageurs as well as financial institutions. Using the results here, arbitrageurs can easily determine the potential profitability of various credit card offers. Financial institutions can use the results presented here to design their introductory offers. Financial institutions might apply the findings here to other products as well.

Little research exists on credit card arbitrage. This paper provides an extension to the current body of knowledge; however, much work remains. Future research might examine issues such as the effect of a missed credit card payment on arbitrage profits, the effect of a money market interest rate shift midway through an arbitrage position and many other areas.

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APPENDIX 1: Development of Equation 5

Profit, equation (1), can be written in the following form, to separate terms involving B and F:

$$Profit = B * \left[\left(1+\frac{IM}{12}\right)^{K} - \left(1+\frac{IC}{12}-P\right)^{K}\right] * \left[\frac{\frac{IM}{12}-\frac{IC}{12}}{\frac{IM}{12}-\frac{IC}{12}+P}\right] - F$$
$$* \left[\left(1+\frac{IC}{12}-P\right)^{K} + P * \left(\frac{\left(1+\frac{IM}{12}\right)^{K} - \left(1+\frac{IC}{12}-P\right)^{K}}{\frac{IM}{12}-\frac{IC}{12}+P}\right)\right]$$

The expression for Duration shown in equation (2) results in the following formula:

$$Duration = \frac{1}{P} * \left[\frac{\left(1+\frac{IC}{12}\right)^{K} - \left(1+\frac{IC}{12}-P\right)^{K}}{\left(1+\frac{IC}{12}\right)^{(K-1)}}\right]$$

Since $\frac{IC}{12}$ is a very small number, $\left(1+\frac{IC}{12}\right)$ is close to 1. So, a good approximation of Duration for all values of K is the much simpler expression:

$$Duration \cong \frac{1-(1-P)^{K}}{P}$$

Likewise, since $\frac{IM}{12}$ is a very small number, the formula for Profit above may be approximated by the much simpler expression

$$Profit \cong B * [1-(1-P)^{K}] * \left[\frac{\frac{IM}{12}-\frac{IC}{12}}{P}\right] - F$$

Substituting the expression for Duration into this Profit equation provides the following good approximation for Profit as a liner function of Duration.

$$Profit \cong B * Duration * \left(\frac{IM}{12}-\frac{IC}{12}\right) - F$$

This approximation is particularly useful for holding periods of less than two years.

NOTES

