How optimal are credit card companies? Comparing randomized vs. non-randomized offers*

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Abstract

This paper studies third-degree price discrimination as a strategy to improve profitability. We assess the optimality of credit card company offers using a dataset from a large credit card company that has subsamples of cardholders who have received either randomized or non-randomized balance transfer offers. Using the randomized subsamples, we directly estimate the counterfactual distributions of expected profit streams for any contract offer. By comparing these counterfactual profits to actual observed profits in the non-randomized subsamples, we are able to evaluate the optimality of all balance transfer offers. To analyze contract optimality we conduct further counterfactual analyses from two other perspectives: number of consumers who achieve optimality in each contract, and rankings of all contracts. We also study different aspects of profit, including static profit and dynamic profit. We find that credit card companies target based on multi-objective profit, and we provide a strategy by which credit card companies could send offers according to consumers characteristics to generate increased profitability.

Keywords: credit cards, balance transfers, optimality; offer strategy;

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1 Introduction

The credit card industry in the United States is a multi-billion dollar industry. On average, an American household holds 3.5 credit cards of an average of $15,956 in credit, thus making the credit card the most significant source of consumer credit. In recent decades, the increasing competitions in the credit card industry and enhanced regulations of interest rate caps have led to wide variations of products offered by credit card companies to their customers, as well as more elaborate and more complex pricing schemes.

Every year, a typical credit card company makes a huge number of credit offers, both to attract new customers and to encourage existing customers to increase their borrowings. This raises the question of how optimally firms make the offers. Are the specific terms of the offer (including interest rates, fees, credit limits) optimal, in terms of generating the most profit to the firm?

In this paper, we investigate the optimality of balance transfer offer, one of the increasingly popular offers credit card companies make to existing customers. A balance transfer is essentially an extension of loan to existing customers, usually at a low or typically zero interest rate during an introductory promotional period. After such promotional period, if the loan is not yet paid off, it will be added to the customer's existing balance, and at the same time will start to accumulate interest at the regular interest rate, which is typically much higher than the promotional rate. Subsequently consumers have choices of paying off their debt at promotional interest rate or fixed interest rate as offered differently. Usually the promotional rate is zero or very low within limited duration, while fixed rate offer is comparatively higher but without time limit. The consumers are allowed to choose to take both offers type at the same time, while they can take either or none of the two.

To assess optimality, we analyze data from a large credit card issuer that made balance transfer offer to their existing customers. Our data distinctively include two groups of subsamples, randomized offers and non-randomized offers made to customers.

We develop our analysis of optimality from several perspectives. We first, within the randomized offer subsamples, directly estimate the profit stream from each customer the company can make, for any counterfactual offer. Discrete comparison of the maximized estimated counterfactual profit with actual observed profit from non-randomized subsamples allows us to determine the optimality of contracts. If the actual profit exceeds the estimated counterfactual profit, we could conclude that the firm made its offers optimally. However, on the contrary, if our estimated counterfactual profit is more than the actual profit, this

indicates that the firm is not optimizing, and possibly is not using all the information at its disposal when crafting the offers. As a result, we find that in six out of eleven contracts estimated counterfactual profits are, on average, no lower than the corresponding actual profits. This means that the firm is not fully optimizing in these contracts.

The next crucial part of our analysis of optimality uses counterfactual analysis however from two different perspectives. In our first counterfactual analytical method, the consumers in each contract group are redistributed based on which contract results to give highest expected profit among the eleven, simply equivalent to that every consumer is reassigned to his optimal contract. By counting the total number of consumers in each redistributed contract group reaching optimal, we can find out the most optimal contract among all. Besides, this analysis displays the number of consumers whose originally assigned contract is already optimal. We find that generally less customer-favorable offers to consumers (of high interest rates, short promotional duration and high one-time fee) are optimal, inducing higher profits. For example, contract 38 in which the highest interests occur appears to be optimal contract to approximately 40% consumers.

The other perspective focuses on the ranking of expected profit from counterfactual analysis for every contract group. We compare and rank the average total profits among eleven contracts, in order to predict profits from different contracts and accordingly elucidate contract optimality. Consistently, the less customer-favorable offers rank at top.

The default risk is not our concern in this paper because the observed average default rate of all consumers in our data is as low as 0.0005. However, credit card companies assign and send the offer based on customers credits. Therefore, subsequently, we implement FICO credit score from Equifax bureau to categorize all consumers into three subgroups based on their credit score, to reveal the effect of credit rating on judging the contract optimality. Instead of the entirety of consumers in the data, the three subgroups are assessed separately, from the same perspectives. Explicitly, we find that most of the contracts are optimal in high and middle FICO groups, whereas eight out of eleven contracts are not optimal in low FICO group. In counterfactual analysis, we find the optimality of offer to be hinging on FICO group, and the contract ranks in high FICO group are generally higher. However, the total expected profit increases while FICO score decreases.

The total profit in the above baseline analysis consists of only finance charge and fee. However, in reality, for credit card companies there are additional profit sources, one of which is profit from consumption, in the form of merchant fee. Nevertheless, we cannot

define and directly estimate the profit from consumption, because the interest costs and the discount programs between merchants and firms are unobservable. Alternatively, we predict counterfactual consumptions to indirectly infer the portion of profit and thus check the optimality of the offers. We find that the contract ranks substantially change from those in baseline analysis, The top ranking optimal contracts in baseline analysis are ranked in the middle, the bottom ranking contracts in baseline analysis are ranked top or at least higher in consumption, implying that different contracts are designed to target at different components of profit.

The last part of the paper further extends the same counterfactual analysis of total profit to study potential profits from a long-run view. Estimation of potential profits is based on the last month carrying balance of all consumers. When evaluating contract optimality in terms of short-run profits, including either finance charge and fee or profit from consumption, we observe that the most customer-favorable contract (lowest interest rates and fees) always rank at bottom . However, we find reversed ranking results, that of the customer-favorable contracts turn out to be optimal in pursuing potential profits in a long run. Overall, our research results illustrate that the credit card company designs and sends out optimal contracts targeting at both short-run and long-run profit.

Related literature This paper joins a large empirical literature studying credit cards. Because credit cards are such a significant source of consumer credit, there have been a number of papers looking at consumer credit card use. For instance, (Gross and Souleles 2002) look for evidence of liquidity constraints using credit card usage data, and (Calem and Mester 1995) present evidence on consumer-level switching and search costs associated with credit cards. Credit card data have also been used to assess consumer rationality, with respect to choice of fixed-rate vs. low-introductory rate contracts ((Agarwal and Souleles 2006), (Shui and Ausubel 2004)). (Laibson and Gabaix 2006) document the incidence of "mistakes" (such as incurring late fees) that consumers make over the life cycle in a number of financial markets, including the credit card market.[1]

There has also been a lot of empirical work looking at the supply-side of credit card markets. (Ausubel 1991) documents that interest rates have been persistently high in the credit card industry, and explores some explanations related to consumer myopia. (Knittel and

[1] These studies complement studies of the rationality of consumers' contract choices in other markets, including telephone calling plans ((Miravete 2003), (Chintagunta and Narayanan 2007)) and health club memberships ((Della Vigna and Malmendier 2006)).

Stango 2003) test whether the observed interest rate stickiness can be explained by collusion with the regulated interest rate ceilings as a focal point. Another strand in the literature has looked for evidence of asymmetric information in credit card markets: (Ausubel 1999) present evidence on adverse selection, and (Hu and Tan 2006) look for evidence of both adverse selection and moral hazard.

In this paper, we focus on a question which, to our knowledge, has not been addressed in the existing credit card literature, which is how optimal the credit card companies are in the offers which they make. For this question, the paper which is most closely related to ours is a recent paper by (Einav and Levin 2012a), which also considers optimal pricing in consumer credit markets, using data from a subprime automobile loan market. In this paper, the authors estimate a model of consumer demand for automobile loans, which they then use to assess the optimality of the observed contracts. Our paper differs from (Einav and Levin 2012a) in two aspects. First, we focus on balance transfer offers in credit card markets, which are quite different (in terms of the contractual parameters) than subprime automobile loan contracts. Second, we assess optimality by comparing the firm's revenues and profits from its randomized vs. non-randomized offers. Since the firm's non-randomized offers should presumably be more optimal than its randomized offers, any evidence that revenues in the R subsample are not lower than in the NR subsample can be indicative of sub-optimality.

Moreover, they are working on another paper (Einav and Levin 2012b) to study the adoption of automated credit scoring at this large auto finance company. They identify two distinct benefits of risk classification: high-risk borrowers and low-risk borrowers. In our paper, we also check the risk classification defined by FICO score from Equifax bureau.

2 Data and market description

We use a dataset provided by a large credit card issuer, consisting of balance transfer (hereafter BT) offers made to existing cardholders. The dataset consists of two subsamples. Customers in one subsample were made randomized (R) offers, whereas customers in the other subsample were made non-randomized (NR) offers. The BT offers made by the firm varied in the balance transfer fee, the interest rate, and also the length of the promotional period (as explained in specific below).

For the R subsample, monthly credit card usage is observed for the fourteen months extending from January 2005 to February 2006. The BT offers were made in June 2005 (month 6),

and most acceptances were observed in the following month (month 7). For the customers in the NR subsample, we have monthly credit card usage observations for eighteen months from January 2005 to June 2006. The non-randomized offers were made two months later than the randomized offers, in August 2005, and most customers responded to them by September 2005.

For customers in both the R and NR subsamples, we observe all the monthly credit card usage variables which the firm kept track of (and these variables constitute the "private information" of the firm concerning these customers). These variables, as described in Table 8 and Table 9, include interest payments and fees, monthly purchases, cash advance, and other increases in the customer's balance, the firm's internal credit score (which can differ from the industry-wide FICO credit score for the customer) and the age of customer account, risk ranking and the number of checks used in past 6 months.

Besides these firm-level variables, we also have the monthly variables of each customer in the Equifax database. Such industry-wide information about each customer is tracked by the credit bureau. These variables are incorporated into Table 8 and Table 9, including the customer's total debt outstanding (across all credit accounts), FICO credit score, number of credit cards and their limits, the age of newest tradelines, number of credit cards with their balance is higher than 50% of the limits, incidence of delinquencies, and number of credit inquiries.

Firstly, it is worthy remarking the structure of a typical BT offer in detail. A BT offer consists of checks which customers can write and cash from any bank, however of only an amount up to a certain fraction of their credit limit. Essentially a BT is an additional loan extended to existing consumers, at an interest rate which is much lower than the usual "purchase" rate accruing on the customer's credit card purchases. Customers may use the BT to, but not limited to, pay off a balance from another credit card (hence the term "balance transfer").

For the customers taking the BT offers in this study, they can choose from two options for paying back the BT. The first, and the more preferred option, is a "promotional rate" (hereafter PR) contract whereby customers pay no (or very low) interest for the BT amount within a promotional period of six months or nine months or twelve months. After the promotional period ends, however, the remaining BT balance is added to the rest of the customer's balance, and will begin to accumulate interest at a much higher rate, as the purchase rate.

The second option available to customers is a "fixed-for-life" (hereafter FFL) in which the BT loan accumulates interest at a fixed rate which is higher than the promotional rate, but lower than the regular purchase rate. In principle, this fixed rate always continues to hold perpetually. However, for both contract options, if the customer makes any "mistakes" on the credit card account, such as making late payment, the advantageous BT interest rates increase to the purchase rate, and the BT balance is automatically added to the regular balance.[2]

Through summary statistics, we find out that all of the respondents to the offer are those who had previous experience of using BT checks. Therefore, our analysis assesses those people who used BT checks in history.

Table 1 presents summary statistics on the offers made to the R and NR subsamples, along with the takeup rates of each option (PR or FFL). Note that the R and NR subsamples differ in both the types of contracts offered, as well as in the frequency of the different offers. There are eleven contracts offered to customers in both subsamples: 16, 19, 20, 24, 25, 26, 28, 29, 35, 36 and 38. The most offered contract in the NR subsample, contract 2, was not offered to the R customers. Hence, extrapolation is an issue in our exercise of evaluating the optimal contract, and this is an issue we will address in our empirical work in the future.

Table 2 and Table 3 show the major summary statistics by offers to the all of contracts in R subsample. There are twenty-four contracts are offered to customers in the R subsample. Mean values and standard deviations are computed for the following variables: Protected balance(Pb balance) of the internal firm, finance charge, fee, purchase spending, payments, cash spend of the account, behavior score of the study bank calculated by itself, the beacon score (FICO score) from the credit bureau, the number of bank credit cards, total credit cards known to be held, the credit limit on the internal credit card and the combined resolving credit limit from the credit bureau. Randomization is observed in these two tables.

Table 4 shows the same major statistics by offers to the NR subsample. There are fourteen contracts are offered to the consumers in NR subsample. The observed values of each variable largely differ between contracts. Hence, non-randomization is observed.

[2] Most customers are not aware of this feature when they take a BT offer. And this feature could be considered an "add-on" or "shrouded" attribute in the sense of (Ellison 2005) or (Gabaix and Laibson May 2006).

3 Empirical method

The main idea of the empirical exercise in this paper is to exploit the data subsample with randomized offers in order to estimate the counterfactual profit functions, which gives the profit the firm could expect to earn from a customer under any counterfactual BT offer. Because firms should presumably be designing contracts more optimally in the NR subsample than in the R subsample. A comparison of the counterfactual profits estimated from the R subsample with the actual profits observed in the NR subsample should shed light on how optimal the firm's offers are.

Specifically, let D denote a BT offer, and (X, ϵ) denote the observed and unobserved customer characteristics. (Here we mean observed and unobserved from the researcher's perspective; the firm is assumed to observe both X and ϵ.) Let $\Pi(X, \epsilon, D)$ denote the profits obtained by offering contract D to consumer (X, ϵ).

Let $\tilde{\Pi}(X, D) \equiv E_{\epsilon|X}\Pi(X, \epsilon, D)$, the expected profit from offering contract D to a customer with observed characteristics X. The goal of our estimation is to recover the full function $\tilde{\Pi}_{X,D}(\cdots)$, using the R subsample. Because the contractual terms D are assigned randomly in the R subsample, D is orthogonal to (X, ϵ), so that $\tilde{\Pi}_{X,D}(X, D')$ would be a valid counterfactual of the expected profit that the customer with observed characteristics X would yield when offered an alternative contract D'. (Note that while D is assigned randomly in the R subsample, the customer's choices of whether or not to undertake the BT, and whether to choose the PR or FFL contract, are not exogenous. This will limit the types of counterfactuals which we can estimate from the R subsample, a matter we will spell out below.)

After estimating $\tilde{\Pi}_{X,D}(\cdots)$, we can determine

$$D^*(X) = \text{argmax}_{D\in\mathcal{D}}\tilde{\Pi}_{X,D}(X, D),$$

the optimal contract which the firm could make from a consumer with observed characteristics X, where $\mathcal{D}$ denotes the set of contracts that the firm can choose from. Let

$$\tilde{\Pi}^*(X) \equiv \tilde{\Pi}_{X,D}(X, D^*(X))$$

denote that corresponding optimized profits. Both $D^*(X)$ and $\tilde{\Pi}^*(X)$ can be constructed given an estimate of $\tilde{\Pi}_{X,D}(\cdots)$.

Next, from the NR subsample, we can directly estimate the average profits that the firm made from customers with characteristics X, denoted $\Pi^{NR}(X)$. Since presumably that the

firm's offers in the NR sample should be more optimal than the offers in the R subsample, our test for optimality will entail comparing whether

$$\tilde{\Pi}^*(X) \overset{?}{\leq} \Pi^{NR}(X). \tag{1}$$

If this inequality holds, we would conclude that the firm is making offers optimally, for customers with characteristics X. An overall test of optimality can be derived by integrating over the customer characteristics X:

$$E_X\tilde{\Pi}^*(X) \overset{?}{\leq} E_X\Pi^{NR}(X). \tag{2}$$

What types of firm suboptimality can we detect using our test? Because we only observe X, but not ϵ, we can only determine the optimal contract $D^*(X)$, which is the optimal contract if the firm were restricted to the condition that only on the observed customer characteristics X. Hence, if the firm also conditions just on X, then we should expect that $\tilde{\Pi}^*(X) = \Pi^{NR}(X)$, for all X.

However, the firm also observes ϵ, thus they can potentially benefit better than from $D^*(X)$ by offering the contract $D^*(X, \epsilon)$, which is conditioned on both X and ϵ; that is,

$$D^*(X, \epsilon) = \text{argmax}_{D\in\mathcal{D}}\Pi(X, \epsilon, D).$$

In this case, $\tilde{\Pi}^*(X)$ should be no greater than $\Pi^{NR}(X)$, because, for all X,

$$\tilde{\Pi}^*(X) = E_{\epsilon|X}\Pi(X, \epsilon, D^*(X)) \leq E_{\epsilon|X}\Pi(X, \epsilon, D^*(X, \epsilon)) = \Pi^{NR}(X). \tag{3}$$

In this case, we should expect Eq. (1) to hold with inequality.

Because we don't observe ϵ, our test for optimality is conservative in the sense that we reject optimality only with strong contradictory evidence. That is, we can only detect suboptimality when the contract offered in the NR subsample is inferior to $D^*(X)$. We cannot detect suboptimality if the firm was offering contracts according to the suboptimal rule $\bar{D}(X, \epsilon) \neq D^*(X, \epsilon)$, as long as $E_X E_{\epsilon|X}\Pi(X, \epsilon, \bar{D}(X, \epsilon)) \geq E_X E_{\epsilon|X}\Pi(X, \epsilon, D^*(X))$.

From Eq. (3), it also clearly suggests that the validity of our test requires an implicit assumption, that the distribution of $\epsilon|X$ is identical in both the R and the NR subsamples. This would be satisfied if either the firm randomly places customers in the R or the NR subsamples, or more restrictively, they place customers in the R or NR subsamples only conditional on the observed characteristics X. It would be violated if, on the other hand, the firms place customers based not only on X, but also on the unobserved characteristics ϵ.

3.1 Estimating counterfactual revenues from randomized data

Next we describe how we estimate the counterfactual expected revenue function $\tilde{\Pi}^r_{X,D}(\cdots)$ using the randomized data. When estimating $\tilde{\Pi}^r(X, D)$, we do not condition on the subsample of customers who accept the BT offer, neither can we condition on whether a customer chooses the promo-rate (PR) or fixed-for-life (FFL) BT contract. Even though the contract offer D is randomly assigned in the R subsample, the subsequent customer decisions are not random. They depend not only on the observed (X, D), but also on the unobserved characteristics ϵ. For convenience, define a discrete variable Y for the customer's choice variable, where

$$Y = \begin{cases} 0 & \text{if customer rejects BT offer} \\ 1 & \text{if customer accepts, and chooses PR contract} \\ 2 & \text{if customer accepts, and choose FFL contract.} \end{cases}$$

Hence, if we were to estimate (say) $E(Z|X, D, Y = 1)$, the expected revenue for all customers with observed characteristics X, contract offer D, who choose the PR contract, this conditional mean function cannot be used to generate expected revenues under a counterfactual contract D': that is, $E(Z|X, D', Y = 1)$ is not the counterfactual revenues for customers with characteristics X, who choose the PR contract given offer D'. (Essentially, the problem is that we cannot hold the contract choice fixed at PR while we vary the offer to D'.)[3]

Hence, the conditional expected revenue $\tilde{\Pi}^r(X, D)$ is estimated using all customers with observed characteristics X who were offered D, regardless of whether the offer was accepted (and, if accepted, regardless of whether the FFL or PR contract was chosen). There is a direct analogy between the empirical exercise here and an "intent-to-treat" analysis common in randomized drug trials. In drug trials, the drug treatment is randomly assigned across patients, but patient compliance or attrition cannot be controlled by the researchers. An intent-to-treat analysis compares outcomes across assigned drug treatment groups, regardless of whether patient actually undertakes the assigned treatment.[4]

[3] On the other hand, because of randomization, the contract choice equations $Pr(Y = j|X, D),\ j = 0, 1, 2$ can be used to generate valid counterfactuals choice probabilities. That is, $Pr(Y = 1|X, D')$ gives the probability of choosing the PR contract when the offer is exogenously changed to D'.

[4] There has been recent research on Bayesian approaches to the ITT problem (e.g. Imbens and Rubin (1997)) and we are exploring whether these tools can be applied to our setting.

Estimating total revenues Each customer in the R dataset can be described by the pair (X, D), For each (X, D), we consider two components of the firm's total revenues.

- Z_1: finance charges for months 7-14 (interest payments). Finance charges are the most direct source of revenues for the firm.
- Z_2: fees for months 7-14 (including BT fee for those who undertook a BT). Fees are the another most direct source of revenues for the firm.

Estimating $E(Z_1|X, D)$ and $E(Z_2|X, D)$, the expected finance charges and expected fees for customer (X, D) are only complicated by the consideration that we must define the finance charges and fees for all customers (X, D), regardless of whether or not they accepted the BT offer (and regardless of whether they chose the PR or FFL contract). For the customers, the finance charges and fees over months 7-14 are just equal to:

$$Z_1 + Z_2 = \sum_{t=7}^{14} (Fee_t + FC_t) \tag{4}$$

where Fee_t denotes any fees paid in month t (such as late fees) on existing account, and FC_t denotes finance charge in month t (which will depend on the balance in month t, and the interest rate for those balances).

Hence, the expected value $E(Z_1 + Z_2|X, D)$ can be computed as the sample average of $Z_1 + Z_2$ over all customers with the same (X, D):

$$E(Z_1 + Z_2|X, D) = \frac{\frac{1}{N}\sum_{i=1}^{N}(Z_{1i}\mathbf{1}_{X_i=X,D_i=D} + Z_{2i}\mathbf{1}_{X_i=X,D_i=D})}{\frac{1}{N}\sum_{i=1}^{N}\mathbf{1}_{X_i=X,D_i=D}}.$$

For the current results, we estimate $E(Z_1 + Z_2|X, D)$ by regressing $Z_1 + Z_2$ on the components of X and D, as will be described in the next section.

Estimating total profits Considering the importance of cost and its impact on the total profit of the credit card company, we include cost into the revenue equations. The cost of a bank is the London Interbank Offered Rate (LIBOR) which is the average interest rate estimated by leading banks in London if customers accept the BT offer and decide to borrow the money from the bank. We can estimate not only the revenue but the profit of the firm. The average LIBOR rate in year 2005 to 2006 is around 0.05.

For customers who reject the BT offers, the total profit is equal to:

$$Z_1 + Z_2 = \sum_{t=7}^{14} (Fee_t + FC_t) \tag{5}$$

For customers who accepted the BT offer, no matter which offer they choose, the total profit is computed as:

$$Z_1 + Z_2 = \sum_{t=7}^{14} (Fee_t + FC_t - 0.05 \times transbalp_t). \tag{6}$$

$transbalp_t$ denotes the transferred balance of the customers using PR or FFL contract.

3.2 A first check of optimality

As a first check of optimality, we examine whether the total profit Z_1+Z_2 are higher in the non-randomized subsample, than in the randomized subsample. If the credit card company is making offers rationally, then the profits in the non-randomized subsamples should generate profits which are no lower than the profits generated from the offers to the customers in the randomized subsample. This profit ranking should hold both unconditionally (across all X and D), as well as conditionally.

In Figure 1, 2 and 3 we present graphs of the cumulative distribution functions for total profit in the R and the NR subsamples. The top graph shows the unconditional CDF, computed across all customers in each subsample. We observe that the CDF for the non-randomized subsample stochastically dominates (ie. lies below) the CDF for the randomized subsample, indicating that total profit tends to be higher in the NR subsample. This is consistent with firm rationality.

This pattern is generally repeated in the other graphs, which show the conditional CDFs computed for the 11 contracts offered to customers in both the NR and R subsamples. Except for contract 28 and 38, we observe that the CDF for the NR subsample tends to lie above the CDF for the randomized subsample. However, the lines are so close that we can assume that there is no difference between the NR and the R subsamples for contract 28 and 38.

Hence, total profit tends to be larger, both conditionally and unconditionally, in the NR subsample. Such observation is in line with the rationality of the firm's offers.

In Tables 5, 6 and 7, we present the summary statistics on the distributions of total profit and their components Z_1, Z_2 in the R and the NR subsamples, both unconditionally, and also conditionally on the offered contracts. The figures in those tables support the findings from the graphs: strong evidence of higher profits in the NR subsample for the profit measure, but more mixed evidence for the other measures.

The summary statistics for the R subsample also provide some evidence of the optimal (profit-maximizing) contracts, because they are the unconditional (on X) profit distributions for counterfactual contract offers.

For finance charge (Z_1), contracts 28 and 38 yield the highest profits, both on average and using the median. Their contract parameters are (0, 4.99, 6, 60) and (1.9, 5.99, 6, 60). Since finance charge is calculated based on the interest rates, we see that the fixed rate is high in these two contracts. As for fee (Z_2), contracts 18 and 20 yield the highest profits on average with corresponding contract parameters (0, 2.99, 9, 75) and (0, 2.99, 12, 75). These two contracts have \$75 one-time fee which leads to the high profit for the credit card company. Among the components of the profit, finance charge dominates the total profit. This can explain why contract 28 and 38 yield the highest profit.

A Check from Regression To measure the optimality of BT offer for credit card company, we investigate the effect of BT offer varying between the R and the NR subsamples. we use regression model as below:

$$Z_1 + Z_2 = \alpha_{d(i)} + \beta_{d(i)} D_t + X_i \delta + \epsilon. \tag{7}$$

where i is a consumer, $Z_1 + Z_2$ is an outcome variable of total profit, $d(i)$ is the alternative of R and NR, D_i is a dummy variable which takes the value of 1 for NR subsample and X_i is a set of other characteristics. In this specification, $\beta_{d(i)}$ represents the difference of total profit the firm can earn in the R and the NR subsamples.

We estimate the regression and show result in the first two columns in Table 10. The coefficient of D_i is 13.609 which states that the firm can get \$13.61 more per customer from the NR subsample than from the R sample. It proves the optimality of the firm again. Most of the X_i are highly significant and we will use them to predict the profit from the R subsample. The internal balance and EFX balance can bring up total profit by \$0.02 and \$0.001 respectively. This suggests that the effect of internal balance is more significant than the effect of aggregate balance. The number of cards and the credit record are both

negatively related to total profit. Such negative effects can be reasoned by the fact that, usually good credit record consumers have more cards and they can pay off the debt in time. The internal credit limit increases the profit by \$0.008 and the total credit card limit decreases the profit by \$0.0007. If the consumer has higher limit in this study credit card company, they tend to use often, but if they have more cards from other banks, then they obviously decrease the frequency to use the card in study credit card company and hence decrease the profit. The derogatory event does not significantly impact the profit because the average default rate is as low as 0.00005 in our dataset. Also we find out that total profit increases \$0.55 for customers holding their account one month longer.

The last two columns in Table 10 present the estimation results of profit differences across the R and the NR subsamples in subgroups. All consumers are divided into three subgroups by FICO score (Beacon Score in the data). The consumers in high FICO group are those whose scores are in top 25% and the consumers in bottom 25% are defined as low FICO group. The consumers between them are middle FICO group. We use regression model as below:

$$Z_1 + Z_2 = \alpha + \beta_1 D_t * DL_t + \beta_2 D_t * DM_t + \beta_3 D_t * DH_t + X_i\delta + \epsilon. \tag{8}$$

where DL_t is a dummy variable which takes the value of 1 for consumers in low FICO group, and DM_t is dummy variable for middle FICO group and DH_t is the dummy variable for high FICO group. The other variables are as same as equation (8). In this specification, β_1, β_2, β_3 represent the difference of total profit the firm can obtain from the R and the NR subsamples in different subgroups.

The total profit from the NR subsample is \$19.43, \$10.51 and \$15.36 more than that from the R subsample in low FICO group, middle FICO group and high FICO group, respectively. Nevertheless, the profit difference is estimated to be \$13.61 when all consumers are studied as a unity. Hence, the profit difference of consumers with bad credit record is the highest.

4 Results

In this section we report preliminary results of our analysis, in which all the expectations described in the previous section are estimated by regressions.

We estimate $E(Z_1 + Z_2|X, D)$ using the regression

$$Z_1 + Z_2 = X\beta_1 + D\beta_2 + XD\beta_3 + \epsilon. \tag{9}$$

In Table 8 and Table 9, we present summary statistics on the consumer characteristics

included in X, and the offer characteristics in D for R and NR subsamples.

Tables 11 and 12 show results from OLS regressions for the total profit and the total revenue. In these two tables, the regressions coefficients are generally reasonable , but the point estimates are not as significant as expected. The coefficients indicate that profits are negatively related to the promotional rate and one-time fee, but positively related to the fixed rate and promotional duration though the coefficients of one-time fee and promotional duration are not significant.

In our estimation, the total profit is increased \$56 with 1% increase of FFL and the total profit is decreased \$38.5 with 1% increase of PR. The higher the FFL, the lower profit from consumers with good credit record is. The total profit of good credit record consumers decreases 7 cents if FFL is increased by 1%. The effect for PR are opposite. If PR is increased by 1%, the total profit for consumers with good credit history increases by 5 cents. The result states that they prefer to take up PR offer. Also the higher the PR, the lower the effect of CCC balance on profit is. The rest X variables show similar effects with the above regression results except for behavior score. The coefficient is positive which tells that total profit increases 0.3 dollar for customers with better credit record. The effect of BT offer on total revenue is the same to total profit, but with a smaller magnitude. The total revenue increases 42 dollars with 1% increase of FFL and decreases 34 dollars with 1% increase of PR.

4.1 Optimal Contract

The graph in Figure 4 summarizes the current results, regarding the optimality of the firm's offers to the NR customers. The graph plots the CDF of the observed total profit (Blue line) and the best profit predicted using the OLS regression coefficients from Table 11 (red line). For about 60% of the observations in the NR subsamples (and for most of the range of profits), we see that the CDF for predicted profits lies below the CDF for the observed profits, evidence that the best predicted profits outperform the observed profits. However, the difference between two lines are so neglegible that we can sufficiently predict the profit. In terms of total profit,then, many of the firm's observed contract choices are appear to be optimal.

Table 13 breaks down the optimized profits by contract. Before discussing the results from this table, we note that the "default" optimal contract is the observed contract. We predict the total profit for every customer in 11 contracts and record the contract with highest profit

as 1, others as 0. In the rare cases that the predicted profits are zero for all the contracts, the observed contract is recorded as, others as 0. The number in each cell represents the total number of customers whose predicted profit is the highest for that contract row. For example, the number 25 in the cell that is crossed by optimal contract 16 and observed contract 19 simply means there are 25 customers assigned by contract 19 actually get the highest predicted profit in contract 16, in other words their optimal contract is contract 16. The prominent "diagonal" elements in Table 13 are customers whose assigned contracts are already optimal across all contracts.

In Table 13, we exclusively concentrate on the eleven contracts the R and the NR subsamples have in common. Amongst these eleven contracts, contract 38 (1.9, 5.99, 6, 60) performs best, being optimal for over one third of all consumers, followed by contract 29 (0, 4.99, 6, 75), and then by contract 28 (0, 4.99, 6, 60) next. It is noteworthy that the best-performing contracts are those with high fixed interest rate and 6-month promotional duration.

Tables 14 summarizes the expected profit and the ranking of contracts common in the R and the NR subsamples, by comparing the expected profits across all contracts. For each contract, we firstly predict the expected profit and compare it with the observed profit from the NR subsample. Then, we substitute the contract parameters of other contracts into specific group of consumers assigned with any contract and rank the predicted profits among eleven contract groups. The objective is to investigate how much expected profit the firm can earn if the customers in one specific contract group are assigned with other contracts. The ranking suggests the most profitable contracts for the firm, in other words, optimal contracts. The left part of Table 14 presents the expected profit and ranking for every contract group of customers and the right part of it displays corresponding results of the best and the worst contract in each group.

The relatively small difference between the predicted profits and the observed profits in parentheses are consistent with the results in Figure 4. The best contracts 38, 29, 28 from Table 13 which all rank at top three appear to be optimal. For contract 28 and 29, the expected profits are very close (around $1) to their corresponding best contracts (contract 38) although they are not ranking first. All of three have high interest rates and 6 month promotional duration. The contract 25 (0, 3.99, 12, 60), 35 (1.9, 4.99, 12, 60), 36 (1.9, 4.99, 12, 75) rank 4th and their profits are about $10 less than their corresponding best contract, but $30 more than their corresponding worst contract. Comparing to its best contract 28, contract 25 has lower FFL and longer promotional duration, which is obviously a consumer-favorable offer. For contract 35, in contrast with contract 28, the PR is higher and the

promotional duration is longer. Though higher PR may bring higher profit, the longer promotional period weakens the profit. Contract 36 has lower FFL and longer promotional duration than contract 38, it explains the lower expected profit of contract 36. The rest five contracts 16, 19, 20, 24 and 26 rank from 6th to 10th. Particularly, contract 16 (0, 2.99, 6, 0) and 20 (0, 2.99, 12, 75) rank 10th and their profits are approximately $30 less than their corresponding best contracts. The expected profit of contract 16 actually is almost the same as its worst contract and both of them have 0 PR and low FFL. Hence, the expected profit is primarily impacted by two interest rates. In the choices between consumer-favorable offer that results in higher takeup rate and less consumer-favorable offer giving higher profit per contracted customer, the credit card company can obtain more profit from the latter.

4.2 Differential Effects across Subgroups

The FICO score allowed the credit card company to make systematically different offers to consumers with different credit records. We therefore compare the total profit the firm can obtain from different types of consumers. We defined the subgroups in previous section. Table 15 describes total number of optimal contracts for each contract in each subgroup. Contract 38 is the best in all three subgroups. This is consistent with the baseline result. There are over 1200 consumers optimized in contract 29 in both high FICO and middle FICO groups and they are approximately 20% and 10% of their subgroup totals respectively. However, the differences exist among three subgroups. In high FICO subgroup, contract 16, which is the most consumer-favorable offer (low interest rates and no BT fee) is optimal for one fourth of the consumers. While contract 28 (0, 4.99, 6, 60) is optimal for one fourth of consumers in middle FICO subgroup and contract 24 (0, 3.99, 9, 75) is optimal for less than one fourth consumers in low FICO subgroup.

In Table 16, the counterfactual analysis for the ranking is also performed in three subgroups. The average expected profit in every contract increases along the decrease of FICO score. Generally, the customers with low FICO tend to borrow more from bank and their carrying balances are higher. Hence the profits from them are higher than from good credit record consumers. In different credit record categories, the rankings for good record customers are usually higher or at least equal to the rankings for bad credit record customers except for contract 20 and 24. Possibly the unreasonably small number of observations in these two contracts (3 observations in contract 20 in High FICO group; 5 observations in contract 24 in low FICO group) cause measurement error in our estimation. Therefore, the results indicate that customers with good credit record get relative optimal contracts. Though

default risk is not our concern, the contracts are more optimal in high FICO group than them in low FICO group.

5 Extension of Profit

5.1 The Profit from Consumption

In the analysis above, only finance charge and fee as components of total profit are considered when determining the optimality. The finance charge and fee are collected only if consumers borrow but do not pay off the debt before the due date. In reality, the credit card company can earn additional profit from consumers' consumption in the form of merchant fee. However, the interest cost occurs to the credit card company when consumers borrow. Also there are some discount programs between credit card companies and merchants. Therefore, these unobservable behaviors of credit card companies impede our direct estimation of the profit from consumption. Hence, for each (X, D), we consider the third component of the firm's total profit from consumption and estimate expected consumption to check whether the contracts are optimized.

- Z_3: Consumption made during months 7-14. New purchases represent another source of revenues for the firm, through the merchant fees which the firm receives from the purchases.

The purchases Z_3 does not depend on whether a customer has accepted or declined a BT offer. Hence, for all customers, we define the total purchases as:

$$Z_3 = \sum_{t=7}^{14} \times newpurc_t \tag{10}$$

where $newpurc_t$ denotes new credit card purchases in month t.

Hence, the expected value $E(Z_3|X, D)$ can be computed as the sample average of Z_3 over all customers with the same (X, D):

$$E(Z_3|X, D) = \frac{\frac{1}{N}\sum_{i=1}^{N} Z_{3i}\mathbf{1}_{X_i=X, D_i=D}}{\frac{1}{N}\sum_{i=1}^{N} \mathbf{1}_{X_i=X, D_i=D}}.$$

In Table 17, we present the summary statistics on the distributions of Z_3 in the R and the NR subsamples, both unconditionally, and conditionally on the offered contracts. The

profit from consumption is higher in the NR subsample than that in the R subsample for most of the contracts. For consumption Z_3, contracts 22 (0, 3.99, 6, 75) and 36 (1.9, 4.99, 12, 75) yield the highest profits in the R subsample.

Table 18 exhibits the optimal contract for consumption calculated by the number of consumers. The contract being optimal to the most consumers is contract 20 (about 40% consumers), followed by contracts 38 and contract 26 (both about 14% consumers). Compare to baseline analysis, contract 38 continues to be optimal, but few consumers can get optimal contract of contract 20 and 26. Hence, the different components of the profit implement in different ways to bring profit to credit card company.

In Table 19, the ranking results of all contracts are listed. The top rank contracts are contract 20, 19 and 26, the profits of which are roughly 20% higher than their corresponding worst contracts. However, they only rank at 10th, 7th and 8th respectively in the baseline results. The drastic increase of their rankings indicates that these contracts become optimal when the profits come from a different source. On the other hand, contracts 25, 28, 35 rank from 8th to 10th, reversed from the baseline results in the other way. Nevertheless, the middle-ranked contracts in both analysis appear to be generally the same contracts, such as contract 36 and 24. Overall, contracts 38 and 29 provide higher total profits because of their high ranks in both analyses (4th and 6th in $Z_1 + Z_2$; 1st and 3rd in Z_3, respectively). The ranking results in this consumption analysis show significant variations from baseline analysis, except for those of contract 16 which ranks at bottom in both considerations of different profit components.

5.2 The Dynamic Profit in the Future

Based on rationality of credit card companies, they design optimal contracts in terms of profit maximization. Profit maximization could be achieved from all components of total profit including short-run profits such as finance charge, fee and consumption profit that we have considered, as well as the potential profit in the future from a long-run view. Hence, we regard the internal carrying balance of the last month as the source of potential profit in the form of accumulated interest on balances for the credit card company. By applying the same counterfactual analysis, we estimate potential profits of all contracts and then determine optimality by counterfactual analysis in terms of solely potential profit.

Table 20 describes the estimated potential profits by contract. On the contrary to Table 13, the top half of Table 20 is filled with large numbers meaning they are optimal contracts,

while the bottom half is filled with single or double numbers. Surprisingly, contract 16 is the most optimal contract with 10547 consumers which consist of 40% of total consumers. Contract 20 with 7561 consumers and contract 25 with 5740 consumers are following next. Interestingly, all of these contracts are not optimal in baseline results in Table 13, especially contract 16.

In Table 21, we present the rankings of potential profit of all contracts. Contracts 16, 20, 25 and 26 all rank at top 3, contrasting the fact that they rank 10th, 10th, 4th and 8th in baseline result respectively. Finally, completely opposite ranking results are observed for the contracts 28, 29, 35, 36, 38, comparing to baseline analysis.

6 Consumers characteristics for different targets

From above results, we find out that the credit card company targets on both static profit and dynamic profit. The optimized contracts are different for every target. Then how credit card company decide that which contract should be sent to which category of consumers is concerned. The consumers who assigned with top three optimal contracts in every target are picked up. Table 22 demonstrates their characteristics for different targets.

We find out that for first part of profit, consumers have high aggregate debt, but low debt in the credit card company. They have more cards and higher credit limit than other two groups of consumers and they use the credit card of this company less. Therefore, the credit card company should send out the high interest rates balance transfer offers to consumers who frequently use credit cards of other companies and carry high aggregate debt.

For the consumption group, consumers are loyal customers because they hold the accounts longer than other two groups of consumers and also their spending, payment, cash advance are high. Comparing to other two groups of consumers, though they have less aggregate debt, their protected balance are high. The higher credit limit of the credit card in this company confirms that consumers are loyal since the limit is improved with the time of account increases. Hence, the credit card company should send the offer with medium interest rates to these loyal consumers.

For dynamic profit group, consumers hold the accounts for shorter time and they carry high debt in aggregate level and company level. Their utilization ratio of credit cards inside and outside the company are high. Moreover, their credit scores in the credit card company and from Equifax bureau are comparatively low then other two groups of consumers. Hence, the credit card company should send the low interest rates offer to comparative new consumers

who also carry high debt and are constrained.

7 Conclusion

Our paper investigates the optimality of the contract offers a large credit card company sent to the existing customers. The primary conclusion is that credit card companies target at both short-term profit and long-term profit, taking advantage of the different characteristics of different consumers. To achieve profit maximization, the credit card company targets at higher short-run profit from less consumer-favorable offers (high FFL, PR, short promotional duration and high one-time fee) and higher long-run profit from more consumer-favorable offers (low interest rates and long promotional duration). Such strategy of price discrimination by designing different optimal contracts for different characteristic consumer groups ensures constant profit maximization to the credit card companies in both short-run and long-run. For different target of profit, credit card company should send low interest rates offer to constrained and new consumers who carry high debt; send medium interest rates offer to loyal customers who like to use its credit cards and send high interest rates offers to consumers who frequently use other companies' cards and try to take advantage of the promotion to pay off the debt in other companies.

Several aspects of our analysis may be interesting to follow up in other papers. Much of the literature emphasizes the profit from just finance charge and fee; our work highlights different targets of profit for credit card company. Both static profit and dynamic profit should be considered. Moreover, how to send out the offers according to consumers' characteristics becomes increasingly clear.

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Figure 1: Cumulative Distribution Function for Total Profits in R and NR Subsamples
Blue line: Random profits; Red line: Nonrandom profits

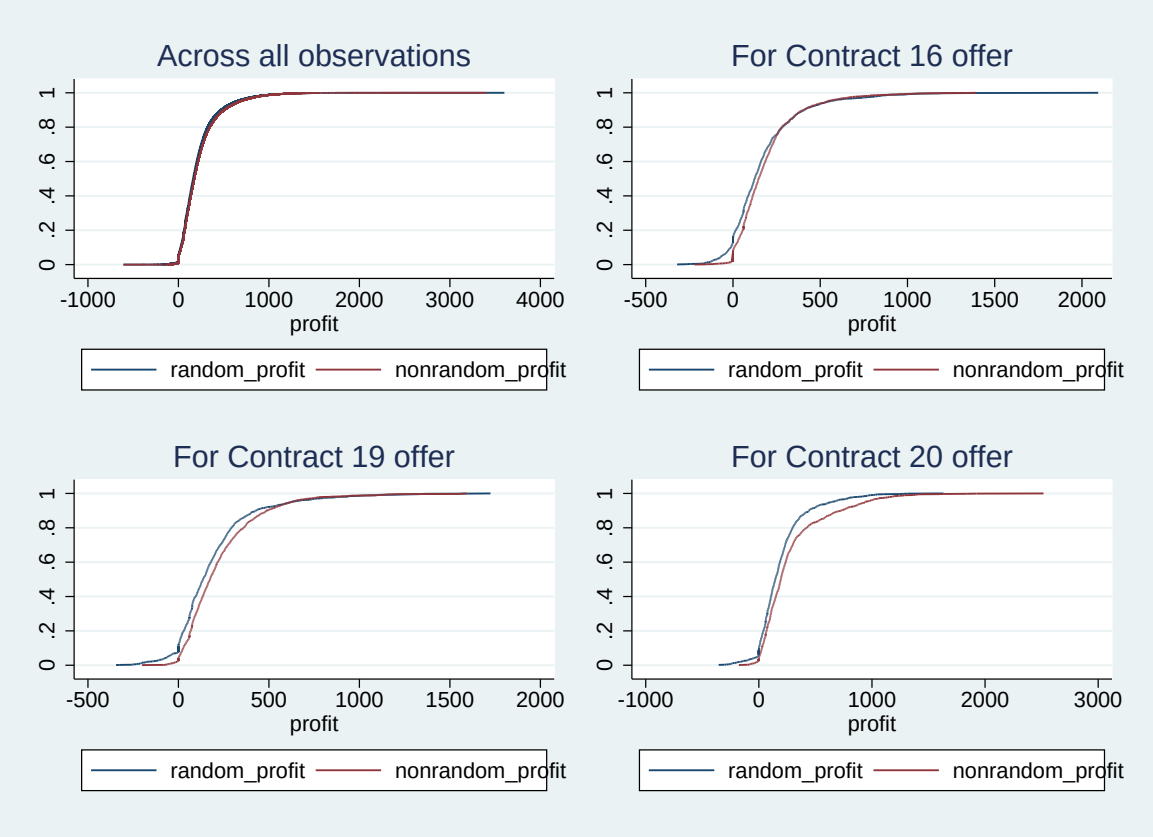

Table 1: List of Contracts Offered, and Take up Rates

Contract ID	Promo rate	FFL rate	Promo duration	BT fee	Num of offers(R)	Num of offers(NR)	Resp% (R)	Resp% (NR)
1	0	0	6	60	0	1,587	0	0.153
2	0	2.99	6	60	0	88,305	0	0.170
3	1.9	5.99	6	75	0	2,748	0	0.040
16	0	2.99	6	0	791	895	0.306	0.241
17	0	2.99	9	60	1,189	0	0.223	0
18	0	2.99	9	75	1,215	0	0.226	0
19	0	2.99	12	60	952	159	0.277	0.201
20	0	2.99	12	75	892	146	0.240	0.130
21	0	3.99	6	0	1,314	0	0.241	0
22	0	3.99	6	75	2,356	0	0.110	0
23	0	3.99	9	60	1,984	0	0.178	0
24	0	3.99	9	75	1,968	1,010	0.168	0.128
25	0	3.99	12	60	1,194	869	0.205	0.174
26	0	3.99	12	75	1,210	4,377	0.186	0.149
27	0	4.99	6	0	2,153	0	0.195	0
28	0	4.99	6	60	4,024	2,479	0.094	0.132
29	0	4.99	6	75	3,890	7,923	0.086	0.072
30	1.9	4.99	6	0	2,904	0	0.126	0
31	1.9	4.99	6	60	5,511	0	0.067	0
32	1.9	4.99	6	75	5,450	0	0.062	0
33	1.9	4.99	9	60	4,040	0	0.087	0
34	1.9	4.99	9	75	4,027	0	0.078	0
35	1.9	4.99	12	60	3,148	4,209	0.100	0.162
36	1.9	4.99	12	75	3,132	3,529	0.094	0.097
37	1.9	5.99	6	0	4,594	0	0.110	0
38	1.9	5.99	6	60	8,555	2,219	0.060	0.111
40	2.9	5.99	6	0	6,489	0	0.093	0

Table 2: Offer Summary Statistics for R subsample (Randomization)-Part 1

Offer ID	N	CCC balance	EFX balance	Purchase spending	Payment	Cash spend	Behavior score	Beacon score	CCC num	EFX num	CCC limit	EFX limit
16	791	2882.84	17558.06	75.06	398.92	2.18	716.19	733.21	0.98	15.8	8928.97	98216.15
(0 2.99 6 0)		*(2911.83)*	*(14499.26)*	*(240.9)*	*(563.05)*	*(25.94)*	*(98.71)*	*(44.09)*	*(0.22)*	*(7)*	*(3046.15)*	*(56196.07)*
17	1189	3202.40	18787.77	72.4	400.26	3.39	717.79	731.96	0.98	15.2	9285.18	96646.36
(0 2.99 9 60)		*(3246.31)*	*(15279.01)*	*(242.57)*	*(558.52)*	*(30.32)*	*(95.12)*	*(44.19)*	*(0.25)*	*(6.59)*	*(3330.04)*	*(54208.74)*
18	1215	3087.34	17640.84	77.98	402.96	4.49	710.36	734.92	0.97	15.2	9129.97	96705.53
(0 2.99 9 75)		*(3022.31)*	*(14697.34)*	*(215.67)*	*(532.15)*	*(54.85)*	*(112.57)*	*(46.17)*	*(46.17)*	*(46.17)*	*(3025.15)*	*(56781.28)*
19	952	3025.60	17693.31	72.17	388.68	2.55	710.21	737.39	0.97	15.8	9154.45	100680.3
(0 2.99 12 60)		*(3182.56)*	*(14936.51)*	*(208.37)*	*(547.59)*	*(31.77)*	*(113.42)*	*(46.59)*	*(0.25)*	*(7.09)*	*(3155.34)*	*(60824.63)*
20	890	3004.29	17429.89	71.04	369.34	3.8	716.67	733.99	0.98	15.8	9421.71	99139.45
(0 2.99 12 75)		*(3195.71)*	*(14982.48)*	*(195.46)*	*(533.57)*	*(55.75)*	*(100.53)*	*(46.27)*	*(0.26)*	*(7.19)*	*(3367.73)*	*(57483.89)*
21	1314	3065.26	18197.87	65.4	379.07	1.41	713.38	733.56	0.97	15.5	9093.95	97123.57
(0 3.99 6 0)		*(3117.26)*	*(15363.5)*	*(187.68)*	*(534.31)*	*(19.38)*	*(104.27)*	*(44.68)*	*(0.26)*	*(6.72)*	*(3323)*	*(55555.3)*
22	2356	3001.13	17753.22	75.06	398.92	2.18	716.19	733.21	0.98	15.8	8928.97	98216.15
(0 3.99 6 75)		*(2961.53)*	*(14892.27)*	*(202.83)*	*(536.08)*	*(32.91)*	*(87.25)*	*(44.97)*	*(0.24)*	*(6.62)*	*(3122.48)*	*(53900.1)*
23	1984	3159.18	17565.06	75.69	396.57	3.47	715.28	734.71	0.97	15.1	9207.94	92566.46
(0 3.99 9 60)		*(3161.78)*	*(13727.11)*	*(209.73)*	*(534.99)*	*(42.18)*	*(97.06)*	*(45.7)*	*(0.24)*	*(6.41)*	*(3114)*	*(53397.97)*
24	1968	3116.26	17972.5	71.98	382.77	2.23	714.05	735.25	0.98	15.1	9089.4	93984.38
(0 3.99 9 75)		*(3046.61)*	*(16205.7)*	*(202.18)*	*(506.36)*	*(22.73)*	*(105.81)*	*(46.38)*	*(0.22)*	*(6.6)*	*(3161.37)*	*(55403.66)*
25	1194	3084.57	18543.61	78.11	373.18	3.29	711.14	734.78	0.98	15.2	9236.83	97081.8
(0 3.99 12 60)		*(3162.63)*	*(16365.25)*	*(209.6)*	*(518.45)*	*(33.96)*	*(110.93)*	*(45.34)*	*(0.25)*	*(6.6)*	*(3257.07)*	*(54922.71)*
26	1210	3075.62	18026.81	86.91	399.17	2.88	713.79	733.39	0.98	15.6	9160.62	98001.1
(0 3.99 12 75)		*(3129.59)*	*(14720.2)*	*(313.41)*	*(599.22)*	*(31.43)*	*(101.93)*	*(45.14)*	*(0.23)*	*(6.58)*	*(3261.2)*	*(55181.8)*
27	2153	2969.22	17376.63	77.15	374.06	3.93	714.3	735.57	0.98	15.2	9080.25	97202.7
(0 4.99 6 0)		*(3108.11)*	*(14646.34)*	*(212.87)*	*(519.05)*	*(50.3)*	*(104.01)*	*(46.07)*	*(0.24)*	*(6.57)*	*(3102.07)*	*(55282.1)*

Notes: 1. Numbers in italic are Std. Dev.. 2. There are other characteristics which are used in the analysis are not included in this table and they are also randomized.

Table 3: Offer Summary Statistics for R subsample (Randomization)-Part 2

Offer ID	N	CCC balance	EFX balance	Purchase spending	Payment	Cash spend	Behavior score	Beacon score	CCC num	EFX num	CCC limit	EFX limit
28	4024	3191.27	17800.49	70.65	365.27	2.44	717.89	733.48	0.97	15	9241.35	93801
(0 4.99 6 60)		*(3124.09)*	*(15067.85)*	*(206.54)*	*(504.09)*	*(38.04)*	*(90.5)*	*(45.09)*	*(0.25)*	*(6.64)*	*(3148.01)*	*(62802.4)*
29	3890	3146.31	17546.24	80.22	374.52	2.57	714.88	735.84	0.97	14.9	9158.4	93234.2
(0 4.99 6 75)		*(3183.20)*	*(15017.97)*	*(232.98)*	*(515.82)*	*(26.9)*	*(103.08)*	*(45.66)*	*(0.24)*	*(6.41)*	*(3221.04)*	*(53995.6)*
30	2904	3022.97	18092.17	77.98	402.96	4.49	710.36	734.92	0.97	15.2	9129.97	96705.53
(1.9 4.99 6 0)		*(3146.21)*	*(15289.93)*	*(256.81)*	*(554.73)*	*(33.99)*	*(98.88)*	*(45.33)*	*(0.22)*	*(6.69)*	*(3211.29)*	*(56045.5)*
31	5511	3102.37	18007.81	72.56	389.71	4.05	716.02	733.73	0.97	15.3	9216.02	96355.5
(1.9 4.99 6 60)		*(3183.57)*	*(15135.8)*	*(212.11)*	*(542.96)*	*(61.41)*	*(101.74)*	*(45.4)*	*(0.25)*	*(6.68)*	*(3302.21)*	*(55248.9)*
32	5450	3015.98	17796.91	76.67	396.21	2.62	715.27	734.95	0.98	15.3	9279.68	96792.6
(1.9 4.99 6 75)		*(3147.01)*	*(15139.61)*	*(242.54)*	*(573.51)*	*(37.51)*	*(105.43)*	*(45.67)*	*(0.24)*	*(6.72)*	*(3239.35)*	*(54989)*
33	4040	2958.53	17900.47	67	373.8	2.15	714.63	735.29	0.98	15.4	9198.41	97930.8
(1.9 4.99 9 60)		*(3064.38)*	*(15023.83)*	*(188.64)*	*(509.57)*	*(25.3)*	*(106.51)*	*(45.43)*	*(0.25)*	*(6.52)*	*(3204.82)*	*(56170.8)*
34	4027	3038.42	18114.83	71.06	390.96	5.81	717.33	734.83	0.97	15.3	9120.86	97108.4
(1.9 4.99 9 75)		*(3139.17)*	*(15188.78)*	*(220.23)*	*(534.69)*	*(80.65)*	*(98.54)*	*(45.51)*	*(0.24)*	*(6.6)*	*(3272.05)*	*(54825.4)*
35	3148	2966.64	17376.77	75.34	394.93	2.54	713.27	735.6	0.98	15.4	9157.48	96420.1
(1.9 4.99 12 60)		*(3102.665)*	*(15021.08*	*(287.31)*	*(553.38)*	*(29.92)*	*(111.73)*	*(46.35)*	*(0.24)*	*(6.7)*	*(3258.96)*	*(54320.5)*
36	3132	2962.16	17738.16	72.55	389.99	2.82	712.74	734.84	0.97	15.2	9185.64	95283.9
(1.9 4.99 12 75)		*(3077.73)*	*(15777.19)*	*(214.29)*	*(524.74)*	*(44.95)*	*(111.95)*	*(46.64)*	*(0.23)*	*(6.57)*	*(3275.47)*	*(54239.6)*
37	4594	2990.18	17935.89	72.54	389.07	3.08	717.1	734.32	0.97	15.2	9101.62	95210.4
(1.9 5.99 6 0)		*(3117.28)*	*(15748.75)*	*(214.82)*	*(522.81)*	*(42.17)*	*(99.96)*	*(46.32)*	*(0.25)*	*(6.71)*	*(3147.01)*	*(53870.2)*
38	8555	3203.94	18453.27	73.23	396.31	2.99	714.23	732.51	0.97	15.2	9203.23	95432.5
(1.9 5.99 6 60)		*(3159.39)*	*(15494.82)*	*(210.81)*	*(547.29)*	*(39.33)*	*(103.66)*	*(46.08)*	*(0.24)*	*(6.49)*	*(3201.01)*	*(54459.5)*
40	6489	3104.26	17884.41	76.11	392.53	4.31	714.77	733.51	0.98	15.3	9139.34	95261
(2.9 5.99 6 0)		*(3176.44)*	*(15014.66)*	*(246.1)*	*(561.44)*	*(77.07)*	*(103.6)*	*(45.55)*	*(0.24)*	*(6.66)*	*(3264.1)*	*(54469.6)*

Notes: 1. Numbers in italic are Std. Dev.. 2. There are other characteristics which are used in the analysis are not included in this table and they are also randomized.

Table 4: Offer Summary Statistics for NR subsample (Non-Randomization)

Offer ID	N	CCC balance	EFX balance	Purchase spending	Payment	Cash spend	Behavior score	Beacon score	CCC num	EFX num	CCC limit	EFX limit
1	1587	4277.47	30144.18	74.75	306.57	6.66	638.22	643.86	1.01	14.71	7527.2	76856.76
(0 0 6 60)		(3420.01)	(13567.86)	(209.36)	(443.88)	(51.19)	(204.67)	(25.48)	(0.18)	(5.85)	(3070.67)	(43713.12)
2	88305	2922.88	16748.75	100.15	350.92	4.29	687.61	736.24	0.96	15.16	8886.94	91298.92
(0 2.99 6 60)		(3152.88)	(14587.64)	(270.59)	(504.07)	(58.81)	(134.28)	(44.71)	(0.25)	(6.69)	(3360.85)	(54257.18)
3	2748	7395.07	36292.49	41.08	499.64	3.33	709.23	704.68	0.97	16.07	11885.7	117793.9
(1.9 5.99 6 75)		(3489.83)	(23127.64)	(191.24)	(610.72)	(64.49)	(37.64)	(35.73)	(0.23)	(6.37)	(2869.54)	(54066.68)
16	895	4389.95	16936.32	131.43	424.82	2.5	687.91	723.48	1	16.7	7542.98	90193.74
(0 2.99 6 0)		(2936.94)	(12311.58)	(294.8)	(456.21)	(27.79)	(100.15)	(37.46)	(0.11)	(6.36)	(2854.81)	(55744.52)
19	159	3085.10	17324.84	107.54	230.77	7.28	708.49	686.01	0.99	10.09	3854.12	30984.22
(0 2.99 12 60)		(1073.62)	(14291.1)	(200.87)	(271.34)	(32.9)	(18.89)	(32.63)	(0.19)	(4.9)	(1249.03)	(24130.12)
20	146	9553.37	26012.16	365.47	569.03	3.69	707.4	694.45	0.93	8.03	10777.77	37389.25
(0 2.99 12 75)		(2161.70)	(15567.18)	(872.31)	(1013.37)	(22.75)	(15.61)	(30.04)	(0.25)	(4.34)	(2408.27)	(22619.48)
24	1010	3239.59	7297.927	287.59	420.57	8.48	723.56	778.01	0.94	11.52	8642.05	56049.4
(0 3.99 9 75)		(1702.32)	(6034.15)	(418.58)	(466.68)	(66.37)	(30.91)	(31.87)	(0.29)	(5.2)	(2605.37)	(35236.04)
25	869	5343.64	21215.15	213.75	340.72	6.62	709.23	689.98	0.94	9.34	7223.06	39733.16
(0 3.99 12 60)		(2758.54)	(15027.71)	(310.15)	(427.63)	(38.95)	(23.59)	(35.25)	(0.26)	(4.66)	(3017.31)	(26801.55)
26	4377	5223.35	16751.04	352.43	457.16	9.39	715.76	734.49	0.94	10.58	9852.67	55431.04
(0 3.99 12 75)		(2661.83)	(14277.35)	(457.73)	(555)	(79.7)	(26.46)	(40.88)	(0.26)	(5.01)	(2754.19)	(36112.63)
28	2479	3261.44	13592.38	68.73	382.9	6.43	715.04	742.18	0.98	14.34	8476.98	78329.83
(0 4.99 6 60)		(2304.19)	(10384.69)	(170.86)	(449.87)	(54.35)	(43.14)	(41.08)	(0.24)	(6.22)	(2858.257)	(44991.36)
29	7923	4661.15	20985.82	93.43	347.56	4.89	714.24	726.31	0.96	14.18	9491.48	87492.78
(0 4.99 6 75)		(2842.42)	(13672.1)	(258.74)	(448.97)	(51.95)	(33.16)	(39.04)	(0.25)	(5.98)	(2369.92)	(46093.69)
35	4209	6409.53	28622.73	86	352.52	9.33	708.34	696.34	0.94	12.17	9153.48	64181.77
(1.9 4.99 12 60)		(2738.96)	(17149.51)	(197.2)	(465.46)	(58.03)	(18.26)	(32.86)	(0.27)	(5.47)	(2726.68)	(36372.91)
36	3529	5081.35	21413.18	65.3	324.26	4.81	711.61	724.46	0.95	13.6	9451.48	79547.2
(1.9 4.99 12 75)		(2891.38)	(15073.05)	(174.36)	(412.81)	(61.07)	(33.28)	(41.45)	(0.26)	(5.58)	(2529.05)	(45533.96)
38	2219	2788.90	21654.11	55.76	346.89	9.83	712.04	704.1	0.98	14.77	8413.38	81965.08
(1.9 5.99 6 60)		(2644.61)	(14637.55)	(136.27)	(479.1)	(87.92)	(46.34)	(46.66)	(0.22)	(6.12)	(2705.98)	(45459.47)

Notes: 1. Numbers in italic are Std. Dev.. 2. There are other characteristics which are used in the analysis are not included in this table and they are also randomized.

Figure 2: Cumulative Distribution Function for Total Profits in R and NR Subsamples
Blue line: Random profits; Red line: Nonrandom profits

Figure 3: Cumulative Distribution Function for Total Profits in R and NR Subsamples
Blue line: Random profits; Red line: Nonrandom profits

Table 5: Summary Statistics on Total Profits

Contract	Subsample	Mean	Median	StDev	N	Contract	Subsample	Mean	Median	StDev	N
All	R	199.16	151.11	201.11	78152	26	R	187.61	145.54	197.60	1309
	NR	210.75	159.47	205.93	125175		NR	407.42	361.63	270.07	4377
1	R					27	R	178.16	131.96	197.24	2307
	NR	315.47	236.60	282.43	1587		NR				
2	R					28	R	213.56	162.88	208.29	4278
	NR	182.49	133.50	188.92	88305		NR	192.54	159.67	161.16	2479
3	R					29	R	208.20	159.14	206.07	4168
	NR	279.80	256.26	166.27	2748		NR	231.35	206.93	150.17	7923
16	R	158.19	114.20	209.00	858	30	R	194.28	147.12	201.41	3118
	NR	117.57	97.09	143.48	895		NR				
17	R	192.17	141.02	206.64	1273	31	R	203.91	156.24	192.51	5885
	NR						NR				
18	R	198.76	144.01	224.33	1319	32	R	201.56	153.43	196.92	5799
	NR						NR				
19	R	174.59	128.37	219.93	1012	33	R	201.07	149.08	202.35	4311
	NR	289.11	263.97	175.86	159		NR				
20	R	179.05	134.00	205.13	976	34	R	201.38	156.37	193.84	4336
	NR	738.26	767.59	338.40	146		NR				
21	R	181.84	140.91	208.87	1411	35	R	192.23	143.53	187.82	3371
	NR						NR	432.76	356.13	282.11	4209
22	R	196.42	151.76	188.01	2533	36	R	196.24	149.64	191.84	3353
	NR						NR	264.47	237.19	156.75	3529
23	R	194.29	151.02	197.92	2115	37	R	194.54	146.48	196.20	4930
	NR						NR				
24	R	197.09	145.21	210.65	2112	38	R	211.87	160.20	206.58	9173
	NR	206.92	186.25	139.76	1010		NR	229.70	180.84	199.77	2219
25	R	189.22	137.99	220.08	1280	40	R	200.24	150.86	201.29	6925
	NR	497.83	449.52	321.58	869		NR				

Table 6: Summary Statistics on Total Finance Charge

Contract	Subsample	Mean	Median	StDev	N	Contract	Subsample	Mean	Median	StDev	N
All	R	131.69	79.18	175.51	72982	26	R	128.27	73.9	166.47	1210
	NR	144.17	89.23	183.01	125175		NR	333.38	286.35	246.86	4377
1	R					27	R	125.23	71.34	163.87	2153
	NR	233.69	151.7	262.49	1587		NR				
2	R					28	R	142.07	88.81	183.62	4024
	NR	120.31	67.39	165.40	88305		NR	111.78	76.21	128.87	2479
3	R					29	R	137.38	84.75	182.70	3890
	NR	200.73	181.63	147.10	2748		NR	161.04	138.36	128.06	7923
16	R	123.86	79.55	168.84	791	30	R	130.09	78.15	177.76	2904
	NR	81.85	48.31	111.93	895		NR				
17	R	133.12	75.96	176.55	1189	31	R	133.13	81.46	172.86	5450
	NR						NR				
18	R	134.19	77.38	189.55	1215	32	R	128.27	78.04	171.36	5407
	NR						NR				
19	R	118.48	58.10	177.53	952	33	R	128.72	71.88	176.99	4040
	NR	225.17	219.97	155.51	159		NR				
20	R	121.94	68.96	163.14	892	34	R	129.98	79.78	173.56	4027
	NR	676.69	712.7	337.80	146		NR				
21	R	133.69	82.12	180.63	1314	35	R	125.29	73.68	166.85	3148
	NR						NR	351.06	274.77	263.65	4209
22	R	127.97	82.05	162.92	2356	36	R	124.94	71.46	168.71	3132
	NR						NR	193.49	169.16	136.16	3529
23	R	129.56	80.98	171.94	1984	37	R	127.35	76.75	170.13	4594
	NR						NR				
24	R	131.11	74.32	179.40	1968	38	R	140.07	87.02	183.29	8555
	NR	147.70	126.12	119.68	1010		NR	147.72	96.96	176.17	2219
25	R	128.93	71.82	178.04	1194	40	R	134.19	80.03	178.14	6489
	NR	425.70	379.75	305.16	869		NR				

Table 7: Summary Statistics on Total BT Fee

Contract	Subsample	Mean	Median	StDev	N	Contract	Subsample	Mean	Median	StDev	N
All	R	73.93	60	72.41	72982	26	R	74.87	60	68.94	1210
	NR	74.4	60	71.59	125175		NR	81.26	60	79.08	4377
1	R					27	R	65.19	60	68.73	2153
	NR	87.98	60	84.63	1587		NR				
2	R					28	R	77.46	60	76.68	4024
	NR	71.49	60	67.28	88305		NR	83.58	60	79.18	2479
3	R					29	R	73.94	60	75.10	3890
	NR	81.03	60	74.32	2748		NR	73.36	60	66.79	7923
16	R	59.39	45	68.14	791	30	R	71.04	60	73.52	2904
	NR	51.67	45.5	56.77	895		NR				
17	R	76.30	60	72.15	1189	31	R	75.39	60	71.22	5511
	NR						NR				
18	R	80.61	60	78.66	1215	32	R	76.39	60	73.39	5450
	NR						NR				
19	R	77.01	60	71.59	952	33	R	75.82	60	74.13	4040
	NR	67.05	47	76.66	159		NR				
20	R	78.23	60	74.92	892	34	R	74.90	60	73.10	4027
	NR	64.69	56.83	62.89	146		NR				
21	R	64.00	60	69.71	1314	35	R	72.05	60	66.00	3148
	NR						NR	84.72	60	83.95	4209
22	R	75.74	60	73.20	2356	36	R	75.98	60	72.67	3132
	NR						NR	73.82	60	66.81	3529
23	R	75.89	60	72.78	1984	37	R	70.54	60	69.44	4594
	NR						NR				
24	R	75.24	60	69.06	1968	38	R	75.18	60	72.67	8555
	NR	62.59	57.89	59.61	1010		NR	85.10	60	80.61	2219
25	R	77.34	60	71.44	1194	40	R	70.17	60	72.19	6489
	NR	77.93	60	82.34	869		NR				

Table 8: Summary Statistics on Randomized Sample

Variable	All sample (R)			Common Subsamples (R)		
	OBS	Mean	Std. Dev	OBS	Mean	Std. Dev
FFL	72982	4.9836	.8262	29756	4.9535	.8873
PR	72982	1.3346	1.0062	29756	.9473	.9500
BT fee	72982	49.9619	29.5575	29756	63.9965	12.7908
Promo duration	72982	7.4584	2.2011	29756	8.3213	2.8186
CCC balance	72982	3071.64	3131.87	29756	3102.11	3121.54
EFX balance	72982	17920.52	15198.29	29756	17919.54	15336.25
time	72982	60.4242	42.5346	29756	60.5199	42.4555
Risk ranking	72982	3.0719	.5150	29756	3.0708	.5217
Spending	72982	73.9662	225.106	29756	74.5647	227.4712
Payment	72982	388.5948	539.279	29756	385.762	534.40
Cash advance	72982	3.2156	47.2536	29756	2.7413	36.1383
CCC card num	72347	.9759	.2426	29510	.9746	.2405
EFX card num	72347	15.2419	6.6259	29510	15.2010	6.6094
EFX limit	72315	95981.94	55387.91	29503	95442.36	56036.66
CCC limit	72347	9178.728	3217.15	29510	9185.597	3212.668
Behavior score	72982	715.2532	102.7099	29756	714.3946	104.191
Beacon score	72313	734.3305	45.7039	29498	734.178	45.9189
Age of newest trade	72344	17.9601	20.6673	29508	17.9425	20.6164
Bank card trade num	72344	.5282	.6927	29508	.5263	.6929
Bank card inquiry num	71663	11.6523	7.3167	29233	11.7225	7.3604
Num of tradelines with major derogatory event	72344	.0069	.1306	29508	.0057	.1048
Promo bank card inquiry num	67509	4.3921	3.3273	27550	4.4006	3.3072

Notes: 1. All characteristics are averaged.

Table 9: Summary Statistics on Nonrandomized Sample

Variable	All sample (NR)			Common Subsamples (NR)		
	OBS	Mean	Std. Dev	OBS	Mean	Std. Dev
FFL	125175	3.4109	.9607	27815	4.7586	.6509
PR	125175	.1928	.5738	27815	.6801	.9109
BT fee	125175	62.0115	7.717679	27815	67.2290	14.1767
Promo duration	125175	6.6612	1.8594	27815	8.9755	2.9450
time	125175	61.0791	43.9492	27815	70.6998	44.6939
CCC balance	72982	3520.19	3264.41	27815	4733.18	2875.17
EFX balance	72982	18287.56	15313.84	27815	20316.62	14980.72
Risk ranking	125175	3.0995	.5392	27815	3.1320	.5870
Spending	125175	103.7624	273.3242	27815	137.8273	305.4824
Payment	125175	365.8147	506.554	27815	371.115	474.2489
Cash advance	125175	4.7340	58.5632	27815	6.9059	62.2576
CCC card num	123403	.9632	.2511	27809	.9561	.2501
EFX card num	124431	14.7860	6.5867	27811	13.0726	5.9364
EFX limit	124323	88627.17	53233.19	27779	73533.13	44692.98
CCC limit	123403	9028.222	3250.24	27809	9126.126	2731.297
Behavior score	125175	693.6554	117.6772	27815	712.4154	36.8698
Beacon score	124344	731.2096	45.5193	27810	722.722	43.3937
Age of newest trade	124416	18.4252	21.7072	27806	23.1040	25.4098
Bank card trade num	124411	.5800	.7781	27809	.4118	.6286
Bank card inquiry num	123078	11.2314	6.7371	27433	11.3183	6.8592
Num of tradelines with major derogatory event	124416	.0080	.1523	27806	.0058	.1080
Promo bank card inquiry num	116017	4.4229	3.3694	25764	4.2420	3.3225

Notes: 1. All characteristics are averaged.

Table 10: OLS regression for total profit varying across subsamples

Variable	Coefficient	t-stat	Coefficient	t-stat
D	13.6090	8.39***		
D*DL			19.4322	6.54***
D*DM			10.5155	5.09***
D*DH			15.3551	5.44***
CCC balance	.0211	67.18***	.0216	66.53***
EFX balance	.001	12.01***	.0009	11.06***
Time	.5534	27.18***	.5711	27.15***
Risk rating	-2.9587	−2.03***	-3.0957	−2.03***
Payment	-.0683	−42.60***	-.0687	−41.66***
Cash advance	.5271	34.88***	.5310	33.81***
CCC num	-46.6159	−14.64***	-47.0304	−14.28***
EFX num	-2.6867	−16.16*	-2.6956	.1715***
EFX limit	-.0007	−31.03***	-.0006	−29.96***
CCC limit	.0084	27.24***	.0088	27.70***
Behavior score	-.0625	−6.49***	-.0655	−6.64***
Beacon score	-.7860	−31.50***	-.7894	.0287***
Age of newest trade	.5355	12.85***	.5568	12.96***
Bank card trade num	-5.0027	−3.87***	-5.091	−3.83***
Bank card inquiry num	.6249	4.30***	.5803	3.88***
Num of tradelines with major derogatory event	-7.4153	-0.96	-7.4811	-0.94
Promo bank card inquiry num	-1.4976	−4.94***	-1.6239	−5.19***

Notes: 1. All characteristics are averaged.

Table 11: OLS regression for total profits in R subsample

Variable	Coefficient	t-stat
Contract offer variables		
FFL	56.0423	2.19^{***}
PR	-38.5356	-1.96^{***}
BT fee max	-.2747	-0.36
Promo duration	7.1411	1.22
Significant interaction terms		
$FFL * Behaviorscore$	-.0691	-1.99^{***}
$PR * CCCbalance$	-.0017	-1.74^{*}
$PR * Behaviorscore$	.0518	1.93^{*}
Characteristics variables		
CCC balance	.0164	2.55^{***}
EFX balance	.0001	0.04
Time	.4963	18.71^{***}
Risk rating	-.7419	-0.37
Payment	-.0709	-35.15^{***}
Cash advance	.5758	22.04^{***}
CCC num	-47.4589	-11.24^{***}
EFX num	-2.1674	-10.61^{*}
EFX limit	-.0005	-20.42^{***}
CCC limit	.0068	18.60^{***}
Behavior score	.2927	1.71^{*}
Beacon score	-.7651	-24.48^{***}
Age of newest trade	.5778	9.75^{***}
Bank card trade num	-3.8396	-2.42^{***}
Bank card inquiry num	.5307	3^{***}
Num of tradelines with major derogatory event	-5.8308	-0.57
Promo bank card inquiry num	-1.4282	-3.73^{***}

Notes: 1. All characteristics are averaged.

Table 12: OLS regression for total revenue in R subsample

Variable	Coefficient	t-stat
Contract offer variables		
FFL	42.2593	1.68^{*}
PR	-34.3803	-1.77^{*}
BT fee max	-.5034	-0.66
Promo duration	6.4493	1.12
Significant interaction terms		
$FFL * Behaviorscore$	-.0578	-1.69^{*}
$PR * CCCbalance$	-.0017	-1.81^{*}
$PR * Behaviorscore$	.0477	1.81^{*}
Characteristics variables		
CCC balance	.0138	2.22^{***}
EFX balance	.0015	1.15
Time	.4756	18.25^{***}
Risk rating	-1.7145	-0.88
Payment	-.0666	-33.64^{***}
Cash advance	.5685	22.15^{***}
CCC num	-50.9297	-12.27^{***}
EFX num	-2.1866	-10.9^{*}
EFX limit	-.0005	-20.81^{***}
CCC limit	.0075	20.92^{***}
Behavior score	.2006	1.19
Beacon score	-.7768	-25.3^{***}
Age of newest trade	.5812	9.99^{***}
Bank card trade num	-3.5204	-2.26^{***}
Bank card inquiry num	0.5471	-3.15^{***}
Num of tradelines with major derogatory event	-5.0323	-0.5
Promo bank card inquiry num	-1.4521	-3.86^{***}

Notes: 1. All characteristics are averaged.

Figure 4: Cumulative Distribution Functions for Actual Profit Components, and for Best Predicted Profit Components, in Non-randomized Subsample

Red line: Actual observed profits; Blue line: Best predicted profits

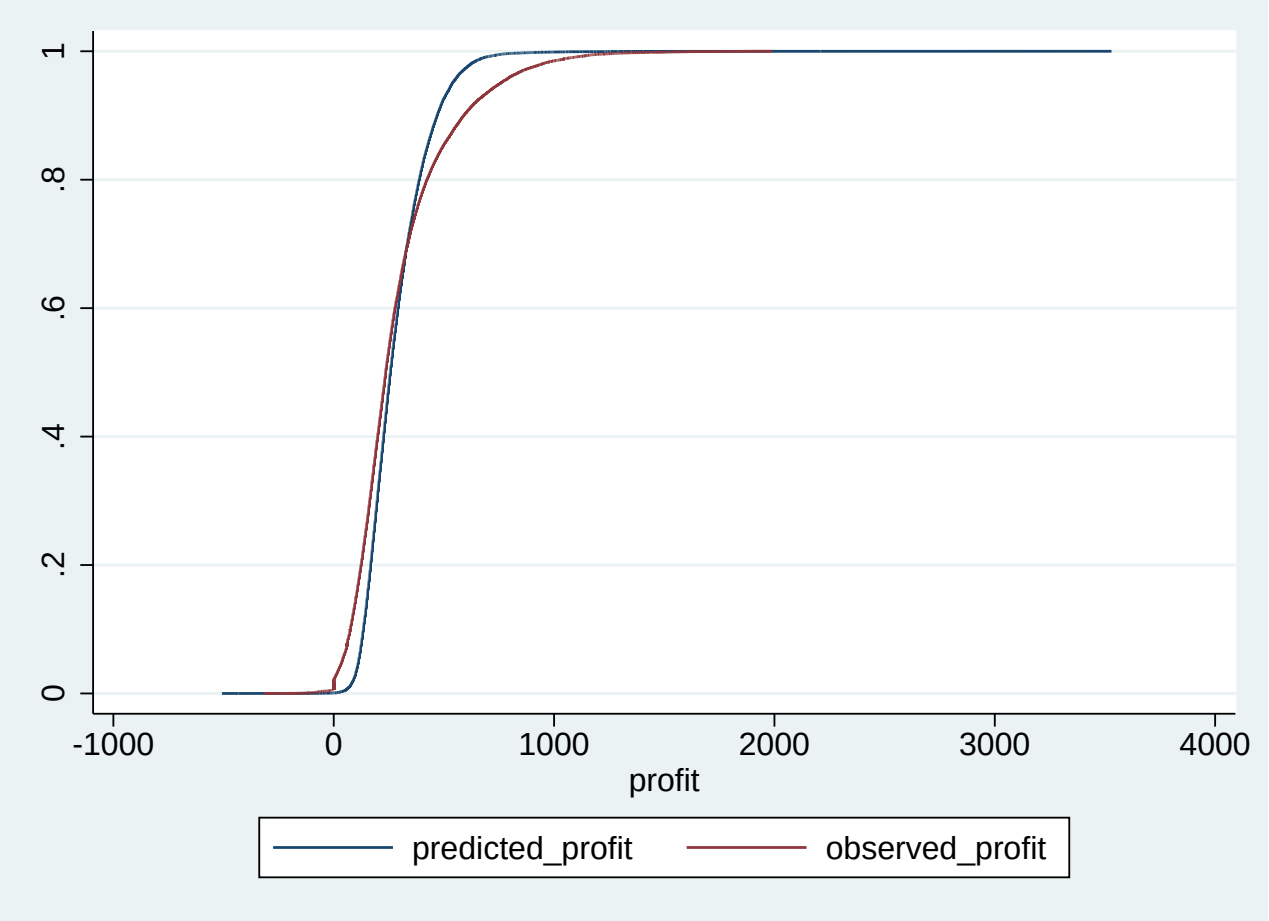

Table 13: Optimal Contract: on the basis of total profits–Only considering contracts common to NR and R subsamples:

Optimal	Observed Contract											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	65	25	9	70	89	231	109	201	299	130	110	1338
19	13	2	0	0	6	16	13	5	5	1	3	64
20	12	9	0	72	24	91	68	98	30	56	39	499
24	0	1	0	8	7	24	7	21	12	10	3	93
25	3	3	6	13	23	57	20	60	62	29	22	298
26	0	4	0	4	23	11	6	4	10	2	34	98
28	190	40	38	174	209	895	547	1598	1001	741	394	5827
29	7	55	33	185	317	1280	492	2013	1218	934	655	7189
35	65	0	2	53	2	85	57	161	33	97	6	561
36	3	0	0	124	5	188	140	332	45	155	35	1027
38	488	5	15	288	96	1350	1012	3309	1321	1325	917	10126
Total	846	144	103	991	801	4228	2471	7802	4036	3480	2218	27120

Table 14: Optimal Contract Ranking

Only considering contracts common to NR and R subsamples

Rank	Offer ID	Expected Revenue	Expected FC	Expected Fee	Expected Profit	Best/Worst Offer ID	Expected Revenue	Expected FC	Expected Fee	Expected Profit
10	16	173.42	108.32	38.99	153.77	38 (1.9 5.99 6 60)	186.00	107.96	60.82	183.91
	(0 2.99 6 0)	(143.76)	(88.25)	(55.51)	(126.65)	20 (0 2.99 12 75)	175.68	95.06	65.35	153.19
7	19	286.82	207.88	71.88	287.64	29 (0 4.99 6 75)	301.54	219.99	73.53	303.61
	(0 2.99 12 60)	(290.88)	(225.90)	(64.98)	(287.92)	16 (0 2.99 6 0)	272.46	208.03	48.92	275.98
10	20	540.81	458.23	76.4	535.76	28 (0 4.99 6 60)	566.26	478.45	84.88	563.72
	(0 2.99 12 75)	(684.87)	(623.71)	(61.17)	(681.50)	16 (0 2.99 6 0)	531.23	452.19	63.27	517.24
6	24	195.97	122.55	57.43	190.71	38 (1.9 5.99 6 60)	200.13	127.36	37.77	176.07
	(0 3.99 9 75)	(212.40)	(149.32)	(63.08)	(208.89)	16 (0 2.99 6 0)	189.35	127.62	37.77	176.07
4	25	405.80	318.12	82.09	395.79	28 (0 4.99 6 60)	408.77	320.46	82.18	406.60
	(0 3.99 12 60)	(500.16)	(424.98)	(75.19)	(494.65)	16 (0 2.99 6 0)	380.92	312.21	57.51	366.36
8	26	322.28	240.97	72.60	311.18	28 (0 4.99 6 60)	327.03	244.17	73.9	324.12
	(0 3.99 12 75)	(404.59)	(324.86))	(79.72)	(397.19)	16 (0 2.99 6 0)	313.42	243.31	53.64	290.62
2	28	204.62	126.19	64.27	201.51	38 (1.9 5.99 6 60)	204.59	127	63.76	202.24
	(0 4.99 6 60)	(195.03)	(111.83)	(83.19)	(192.13)	16 (0 2.99 6 0)	192.71	127.56	43.29	171
3	29	266.57	185.48	71.43	264.15	38 (1.9 5.99 6 60)	267.68	187.71	70.61	265.20
	(0 4.99 6 75)	(232.44)	(159.49)	(72.95)	(229.45)	16 (0 2.99 6 0)	252.23	181.44	52.05	223.66
4	35	391.86	310.9	73.82	386.98	28 (0 4.99 6 60)	402.48	317.42	79.68	398.83
	(1.9 4.99 12 60)	(429.05)	(346.26)	(82.79)	(426.08)	16 (0 2.99 6 0)	391.57	320.28	55.82	360.02
4	36	287.62	209.94	68.06	285.12	38 (1.9 5.99 6 60)	295.69	216.18	70.74	292.92
	(1.9 4.99 12 75)	(267.07)	(193.66)	(73.41)	(264.23)	16 (0 2.99 6 0)	283.86	214.46	48.44	254.93
1	38	246.21	160.94	73.60	242.11	38 (1.9 5.99 6 60)	246.21	160.94	73.60	242.11
	(1.9 5.99 6 60)	(233.18)	(148.76)	(84.43)	(230.01)	16 (0 2.99 6 0)	231.89	158.18	51.48	198.88

Notes: 1. Numbers in parentheses under offer ID are contract parameter.

2. Numbers in parentheses under expected values are corresponding observed value.

Table 15: Optimal Contract: on the basis of total profits by subgroups

Optimal	Observed Contract of High FICO Consumers											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	144	2	1	165	8	342	190	349	77	214	55	1547
19	0	0	0	1	0	0	1	0	0	0	0	2
20	2	0	0	56	1	102	26	74	9	57	5	332
24	0	0	0	1	0	0	0	0	0	0	0	1
25	0	2	0	10	6	4	11	2	0	5	2	42
26	0	0	0	1	0	2	1	1	0	0	0	5
28	5	0	1	54	2	29	84	90	5	46	42	358
29	0	0	0	151	3	174	229	403	13	167	81	1221
35	12	1	0	103	5	245	103	189	23	78	29	788
36	10	0	0	146	2	259	127	295	15	126	23	1003
38	29	0	1	239	0	218	149	362	46	214	86	1344
Total	202	5	3	927	27	1375	921	1765	188	907	323	6643
Optimal	Observed Contract of Middle FICO Consumers											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	2	7	3	9	35	183	41	193	107	96	53	729
19	0	0	0	0	1	4	0	0	0	0	0	5
20	55	15	0	30	41	113	120	127	46	89	80	716
24	23	6	0	6	23	101	60	104	50	46	46	465
25	26	3	33	21	59	334	9	564	397	221	39	1706
26	32	4	0	10	12	45	21	64	33	30	16	267
28	67	11	30	19	96	559	217	1067	650	410	145	3271
29	111	5	1	30	34	185	151	331	147	126	138	1259
35	5	0	0	3	0	14	10	43	17	18	5	115
36	36	0	0	19	1	55	63	147	14	65	37	437
38	125	1	1	38	22	409	337	1487	359	502	382	3663
Total	482	52	68	185	324	2002	1029	4127	1820	1603	941	12633
Optimal	Observed Contract of Low FICO Consumers											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	12	2	6	0	13	29	8	73	72	21	41	277
19	1	1	2	0	8	32	3	66	60	17	33	223
20	0	0	1	0	6	15	2	33	21	13	20	111
24	1	21	9	2	103	139	19	300	397	149	81	1221
25	7	8	9	1	66	73	31	142	185	99	102	723
26	0	1	2	0	6	13	1	6	20	7	2	58
28	7	10	12	1	55	51	28	88	136	47	118	553
29	0	10	9	1	56	67	15	123	188	79	76	624
35	30	11	6	2	34	49	33	112	196	54	88	615
36	3	2	1	1	8	12	12	86	47	25	14	211
38	133	14	1	4	55	168	123	462	489	262	251	1962
Total	194	80	58	12	410	648	275	1491	1811	773	826	6578

Table 16: Optimal Contract Ranking for Subgroup
Only considering contracts common to NR and R subsamples

	High FICO Consumers		Middle FICO Consumers		Low FICO Consumers	
Offer ID	Expected Profit	Rank	Expected Profit	Rank	Expected Profit	Rank
16	139.01	1	126.63	11	150.64	11
(0 2.99 6 0)	(81.786)		(122.46)		(144.11)	
19	246.99	8	271.48	7	305.89	10
(0 2.99 12 60)	(302.22)		(325.92)		(266.80)	
20	448.7	6	537.49	10	624.17	6
(0 2.99 12 75)	(678.43)		(707.24)		(779.04)	
24	192.84	6	207.82	4	207.82	8
(0 3.99 9 75)	(205.36)		(214.42)		(192.07)	
25	260.30	2	389.44	4	427.79	8
(0 3.99 12 60)	(332.21)		(477.48)		(525.91))	
26	278.23	6	331.22	5	362.55	7
(0 3.99 12 75)	(376.32)		(410.71)		(458.23)	
28	188.87	2	210.87	3	201.51	2
(0 4.99 6 60)	(200.20)		(190.82)		(173.35)	
29	218.84	2	277.41	3	282.94	3
(0 4.99 6 75)	(202.47)		(237.62)		(248.62)	
35	376.95	3	383.64	7	402.71	6
(1.9 4.99 12 60)	(476.65)		(425.34)		(435.48)	
36	249.56	2	274.23	6	349.41	6
(1.9 4.99 12 75)	(245.15)		(261.79)		(292.19)	
38	165.58	1	196.59	1	342.55	2
(1.9 5.99 6 60)	(166.17)		(178.91)		(311.98)	

Notes: 1. Numbers in parentheses under offer ID are contract parameter.

2. Numbers in parentheses under expected values are corresponding observed value.

Table 17: Summary Statistics on Consumption

Contract	Subsample	Mean	Median	StDev	N	Contract	Subsample	Mean	Median	StDev	N
All	R	506.33	0	1579.82	72982	26	R	467.75	0	1367.50	1210
	NR	617.40	0	1834.85	125175		NR	1813.17	751.79	1813.17	4377
1	R					27	R	488.82	0	1414.27	2153
	NR	516.17	0	1761.47	1587		NR				
2	R					28	R	477.60	0	1462.11	4024
	NR	596.73	0	1804.46	88305		NR	490.85	0	1509.02	2479
3	R					29	R	551.05	0	1646.57	3890
	NR	277.07	0	1301.65	2748		NR	607.28	0	1794.09	7923
16	R	393.99	0	1116.50	791	30	R	515.05	0	2232.91	2904
	NR	633.05	0	2098.04	895		NR				
17	R	504.29	0	1943.43	1189	31	R	518.37	0	1620.97	5511
	NR						NR				
18	R	573.71	0	2294.81	1215	32	R	509.69	0	1513.63	5450
	NR						NR				
19	R	498.99	0	1628.59	952	33	R	487.63	0	1531.48	4040
	NR	699.78	69.99	1625.43	159		NR				
20	R	1628.59	0	1477.73	892	34	R	473.91	0	1443.94	4027
	NR	2590.26	1041.72	7131.28	146		NR				
21	R	465.39	0	1446.32	1314	35	R	529.24	0	1599.30	3148
	NR						NR	521.02	0	1366.61	4209
22	R	565.10	0	1631.46	2356	36	R	525.72	0	1556.52	3132
	NR						NR	1366.61	0	1359.16	4209
23	R	519.23	0	1554.13	1984	37	R	487.75	0	487.749	4594
	NR						NR				
24	R	512.43	0	1615.05	1968	38	R	508.41	0	1455.37	8555
	NR	1463.29	332.06	2650.60	1010		NR	417.98	0	1149.84	2219
25	R	509.12	0	1382.71	1194	40	R	496.59	0	1586.00	6489
	NR	1182.58	455.65	1914.02	869		NR				

Table 18: Optimal Contract: on the basis of consumption–Only considering contracts common to NR and R subsamples:

Optimal	Observed Contract											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	5	26	0	24	53	131	37	142	82	78	66	644
19	2	6	0	2	9	2	2	1	2	0	2	28
20	51	54	65	248	354	1464	305	889	686	369	232	4717
24	0	0	0	0	0	0	0	0	0	0	0	0
25	41	13	0	124	68	264	76	170	78	82	36	952
26	37	5	8	159	58	591	89	220	148	100	33	1448
28	10	2	10	11	33	178	14	81	58	28	22	447
29	4	0	31	7	58	333	23	103	168	37	12	776
35	3	1	0	0	5	3	2	10	3	6	6	39
36	14	0	4	28	31	199	40	119	64	32	38	569
38	14	0	11	47	75	495	87	366	239	93	167	1594
Total	181	107	129	650	744	3660	675	2101	1528	825	614	11214

Table 19: Optimal Contract Ranking for Consumption

Rank	Offer ID	Expected Profit	Best Offer ID	Expected Profit	Worst Offer ID	Expected Profit
11	16 (0 2.99 6 0)	294.95 (288.16)	26 (0 3.99 12 75)	376.95	16 (0 2.99 6 0)	294.95 (288.16)
2	19 (0 2.99 12 60)	1114.13 (699.79)	20 (0 2.99 12 75)	1135.62	38 (1.9 5.99 6 60)	900.74
1	20 (0 2.99 12 75)	3527.92 (2590.27)	20 (0 2.99 12 75)	3527.92 (2590.27)	16 (0 2.99 6 0)	3005.82
5	24 (0 3.99 9 75)	1358.71 (1463.29)	20 (0 2.99 12 75)	1408.92	16 (0 2.99 6 0)	1188.61
8	25 (0 3.99 12 60)	2028.07 (1182.59)	20 (0 2.99 12 75)	2204.4	16 (0 2.99 6 0)	1929.59
2	26 (0 3.99 12 75)	2157.57 (1813.18)	20 (0 2.99 12 75)	2208.31	16 (0 2.99 6 0)	1861.12
10	28 (0 4.99 6 60)	288.79 (426.60)	20 (0 2.99 12 75)	348.37	16 (0 2.99 6 0)	266.81
6	29 (0 4.99 6 75)	482.16 (601.29)	20 (0 2.99 12 75)	507.94	16 (0 2.99 6 0)	427.18
9	35 (1.9 4.99 12 60)	772.18 (521.01)	20 (0 2.99 12 75)	847.95	16 (0 2.99 6 0)	718.59
5	36 (1.9 4.99 12 75)	253.78 (370.12)	20 (0 2.99 12 75)	274.28	16 (0 2.99 6 0)	216.80
4	38 (1.9 5.99 6 60)	293.23 (375.39)	20 (0 2.99 12 75)	303.34	25 (0 3.99 12 60)	241.61

Notes: 1. Numbers in parentheses under offer ID are contract parameter.

2. Numbers in parentheses under expected values are corresponding observed value.

Table 20: Optimal Contract: on the basis of Potential Profit in the Future–Only considering contracts common to NR and R subsamples:

Optimal	Observed Contract											
Contract	16	19	20	24	25	26	28	29	35	36	38	Total
16	70	74	70	536	389	2003	831	2752	1767	1421	634	10547
19	5	0	2	2	0	21	12	47	17	22	7	135
20	481	9	10	175	137	956	746	2417	834	951	845	7561
24	3	0	1	3	2	3	12	12	3	4	10	53
25	169	52	45	144	203	900	497	1561	1043	720	406	5740
26	135	2	1	59	26	131	204	583	146	158	170	1615
28	0	0	0	2	1	0	2	1	0	1	0	7
29	0	0	0	0	0	1	0	0	1	0	1	3
35	1	0	0	0	0	7	0	3	4	1	0	16
36	14	0	0	0	3	3	5	7	4	5	17	58
38	0	0	0	0	0	0	0	0	0	0	0	0
Total	878	137	129	921	761	4025	2309	7383	3819	3283	2090	25735

Table 21: Optimal Contract Ranking for Potential Profit in the Future

Rank	Offer ID	Expected Profit	Best Offer ID	Expected Profit	Worst Offer ID	Expected Profit
3	16 (0 2.99 6 0)	3548.52 (3201.59)	20 (0 2.99 12 75)	3898.12	28 (0 4.99 6 60)	3254.86
4	19 (0 2.99 12 60)	2835.67 (3046.16)	16 (0 2.99 6 0)	3212.03	20 (0 2.99 12 75)	2678.54
3	20 (0 2.99 12 75)	8415.64 (7753.17)	16 (0 2.99 6 0)	8876.28	29 (0 4.99 6 75)	8089.15
6	24 (0 3.99 9 75)	3372.90 (3503.83)	16 (0 2.99 6 0)	3751.38	29 (0 4.99 6 75)	3120.59
2	25 (0 3.99 12 60)	5371.65 (5275.82)	16 (0 2.99 6 0)	5574.08	29 (0 4.99 6 75)	4943.07
3	26 (0 3.99 12 75)	5552.82 (5529.96)	16 (0 2.99 6 0)	5858.11	29 (0 4.99 6 75)	5159.89
10	28 (0 4.99 6 60)	3708.59 (3595.97)	16 (0 2.99 6 0)	4169.07	38 (1.9 5.99 6 60)	3667.86
9	29 (0 4.99 6 75)	5270.39 (5436.21)	16 (0 2.99 6 0)	5766.87	38 (1.9 5.99 6 60)	5220.47
7	35 (1.9 4.99 12 60)	6596.32 (6921.32)	16 (0 2.99 6 0)	7019.67	38 (1.9 5.99 6 60)	6368.83
7	36 (1.9 4.99 12 75)	5507.12 (6079.12)	16 (0 2.99 6 0)	5908.23	38 (1.9 5.99 6 60)	5324.51
11	38 (1.9 5.99 6 60)	4344.69 (4122.8)	20 (0 2.99 12 75)	4848.53	38 (1.9 5.99 6 60)	4344.69 (4122.8)

Notes: 1. Numbers in parentheses under offer ID are contract parameter.

2. Numbers in parentheses under expected values are corresponding observed value.

Table 22: Consumer Characteristics for different targets

Variable	FC and Fee		Consumption		Dynamic profit	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std.dev
Time	66.07	41.39	76.82	48.06	52.31	51.95
Num of Checks	2.45	2.72	2.31	2.40	2.02	2.02
EFX Bal.	19726.33	13531.11	18554.96	18554.96	19673.56	14213.58
CCC Bal.	4084.20	2824.14	4519.80	2976.37	5225.89	3092.03
Pb Bal.	1084.81	2113.03	5717.31	5361.63	5933.98	6076.01
Purchase	81.95	226.40	255.07	421.88	186.77	382.67
Payment	354.38	454.76	423.29	548.36	397.58	512.53
EFX card num	14.31	6.05	11.90	5.75	12.67	6.67
All credit limit	84720.76	45918.96	63787.12	41318.58	63203.43	49640.54
CCC credit limit	9102.65	2583.04	9398.98	2820.08	2820.08	3039.18
Behavior score	714.01	37.86	714.35	34.21	34.21	71.26
Beacon score	725.52	42.50	723.61	45.18	705.9	39.50
CCC Utilization ratio	.46	.29	.49	.29	.68	.27
EFX Utilization ratio	.25	.15	.33	.21	.42	.28
Total Bal. in first 3 months	17911.59	12597.19	16654.47	13319.93	17462.11	12346.03
Num of trades opened in last 6 months	.44	.63	.38	.61	.81	.89
Num of Tradelines with update within 3 months with Balance >= 50% of Credit limit	.97	1.08	1.04	1.31	1.51	1.39
Num of trades that have delinquency within 2 years	.0005	.02	.0005	.02	.002	.03
Num of tradelines	5.22	2.91	4.35	2.82	4.42	2.38
Num of promotional bankcard inquiries in last 2 months	4.40	3.37	4.30	3.31	3.96	3.13